



UC Santa Cruz Fort Ord Natural Reserve
2018-2019 Annual Report
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UC SANTA CRUZ



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EXECUTIVE SUMMARY

This report provides an overview of activity at UC Santa Cruz Fort Ord Natural Reserve (FONR), in Marina, California for the fiscal year 2018-2019. FONR is a 600 acre reserve that protects maritime chaparral, grassland, and oak woodland on part of the former Fort Ord army base. Reserve staff and interns monitor and maintain habitat for multiple protected species throughout the reserve. As part of the University of California Natural Reserve System, FONR provides a living laboratory and outdoor classroom for researchers, K-12 students, university students and faculty, and the greater Monterey Bay community. Research, teaching, and public service goals continued to increase this past year. In FY2018-2019 Reserve Field Manager Joe Miller was assisted by Assistant Steward Brandon Cluff, Bird Bander Rachel Perpignani, Restoration Steward Brett Bell, as well as multiple UC and CSU student employees and interns. In the previous Fiscal Year 2017-2018, users increased by 50 percent and user days by 75 percent. This increase has slowed; however, use is still on the rise at FONR. Individual users increased by nearly 15 percent and use days have nearly doubled to over 6000 in 2018-2019. The model of teaching interns who then become part-time seasonal staff, has greatly increased the ability to expand and better support research and stewardship as well as assist with classes and community groups.



Figure 1: Heerman's kangaroo rat

The Fort Ord Natural Reserve consists of maritime chaparral habitat that is home to many rare and endemic species; as well as grasslands, coastal scrub, and oak woodland habitat. For much of the 20th century the land was occupied by the Fort Ord US Army Base. FONR staff now uses the 600-acre reserve to serve the community; helping to achieve regional conservation and education goals by supporting research, education, and outreach. The site was chosen as a UC Reserve due to the unique vegetation communities and numerous sensitive and listed plant and animal species that occur throughout the reserve (including the federally endangered, state-threatened sand gilia, state-endangered seaside bird's beak, and the federally threatened Monterey spineflower).



Figure 2: FONR Field Manager Joe Miller presents avian natural history to students from Marina, CA

This past year we offered internship opportunities, continued animal monitoring, and monitored long-term vegetation plots with faculty and undergraduate intern assistance. UC Santa Cruz undergraduate researchers continued a long-term population study of Coast Horned Lizard, *Phrynosoma blainvillii*, a species of special concern. This work has expanded to include an important habitat evaluation for the species, which is being led by undergraduate research Danielle Davis. Reserve staff has helped to organize and manage volunteer field crews to assist

UCLA graduate researchers in a large-scale artificial vernal pool experiment on the Bureau of Land Management Fort Ord National Monument to study the endangered California Tiger Salamander. Staff assisted in conservation efforts of rare orchids on former Fort Ord lands in surrounding cities. Staff also continued to assist Army contractors with continued environmental cleanup onsite. New partnerships were formed with local non-profit organizations, university internship agencies, and educational institutions. UCSC FONR stayed actively engaged in efforts to facilitate research on adjacent protected lands, as well as on reserve property. The following report highlights these and additional efforts.

In additional service to greater University of California goals in the Southern Monterey Bay area, FONR staff assisted University of California Monterey Bay Education, Science and Technology Center (UCMBEST Center) with stewardship on an additional 400 acres of open space adjacent to the natural reserve in Marina, CA. This work included trespass abatement, invasive plant monitoring, and rare plant restoration activities related to mitigation for MBEST developable properties. As with most reserve activities, FONR staff included undergraduate students in these activities - providing hands on learning opportunities for those entering the natural science and land management fields.



Figure 3: CSUMB Intern Jazmin Rios fences endangered *Cordylanthus rigidus* ssp. *littoralis* seedlings.



Figure 4: Cabrillo College ecology students take field notes at UCSC FONR.

EDUCATION

Instructional use at FONR has reached its highest level and supports a variety of classes that span multiple disciplines. In 2018-2019 reserve staff met regularly with classes to help support and develop teaching activities, interpret and identify flora and fauna, and help with student research projects. FONR is roughly one hour from the UCSC campus, minutes away from CSU Monterey Bay, and within an hour of several other higher education institutions in the greater Bay Area. Classes included a wide variety of disciplines including biology, ecology, environmental studies, earth sciences, and art from multiple institutions and including several UC's, CSUs, and Community Colleges (Table 1).

CLASS VISITS

In FY 2018-2019 FONR supported several repeat classes from previous years. Disciplines included ecology, biology, earth science, botany, art, and field method classes. Introductory field methods classes such as UCSC BIO 82 (Introduction to Field Methods), UCSC ENVS 104 (Introduction to Environmental Field Methods), and CSUMB ENV 350 (Quantitative Field Methods) make extensive use of reserve resources and staff and provide transformative experiences for students early in the educational careers. FONR provides an excellent venue for these classes due to the high biodiversity, accessibility, and relatively close proximity to UCSC. In addition to repeat users, FONR supported new visits from Cal Poly San Luis Obispo, San Francisco State University, San Jose State University, Stanford University, and Hartnell College.



Figure 5: CSU Monterey Bay Quantitative Field Methods students work on transects in maritime chaparral habitat at FONR

TABLE 1. FORT ORD NATURAL RESERVE CLASS USE - FISCAL YEAR 2018/2019

Course Number/Name	Institution	Instructor
University of California Santa Cruz		
BIOE 117: Systematic Botany	University of California Santa Cruz	Kathleen Kay
BIOE 82: Introduction to Field Research and Conservation	University of California Santa Cruz	Abe Borker, Kristen Heady, Gage Dayton, and Abe Borker
BIOE 114: Herpetology	University of California Santa Cruz	Barry Sinervo
ENVS 104: Introduction to Environmental Field Methods	University of California Santa Cruz	Josephine Lesage
BIOE 124: Mammalogy	University of California Santa Cruz	Alan Shabel
BIOE 137: Molecular Ecology	University of California Santa Cruz	Beth Shapiro

ENVS 182/183: Environmental Studies Internship	University of California Santa Cruz	Joe Miller
Environmental Studies 107: Natural History Field Quarter	University of California Santa Cruz	Chris Lay
ENVS 17: Curation of Natural History Collections	University of California Santa Cruz	Chris Lay
Other University of California		
IB 104: Natural History of the Vertebrates	University of California Berkeley	Alan Shabel
California State University Monterey Bay		
SICP 500-519: Scientific Illustration Program	California State University Monterey Bay	Anne Caudle, Jennifer Keller, Andrea Dingledein
BIO 195: Special Topics in Wildlife Research	California State University Monterey Bay	Gerick Bergsma
ENV 350: Quantitative Field Methods	California State University Monterey Bay	Robert Burton
ART 31999: Field Sketching	California State University Monterey Bay	Andrea Dingledein
BIO 340: Ecology	California State University Monterey Bay	Gerick Bergsma
BIO 364: Mammalogy	California State University Monterey Bay	Jenny Duggan
BIO 360: Natural History of CA Wildlife	California State University Monterey Bay	Jenny Duggan
SL 95-500: CSUMB Service Learning	California State University Monterey Bay	Joe Miller
Other California State University		
ENVS 189: Coastal Field Studies	San José State University	Rachel Lazzeri-Aerts
BIOL 514/814: Botany	San Francisco State University	Jason Cantley
BOTANY 433: Field Botany California Plant Diversity	California Polytechnic State University, San Luis Obispo	Jenn Yost
Other University		
BIOHOPK 182H: Stanford at Sea	Stanford University	Daniel Cryan
California Community College		

BIO 11C: Ecology	Cabrillo Community College Aptos, CA	Allison Gong
BIO 47: Ecology	Hartnell College Salinas, CA	Rachel Anderson
K-12 Education		
Green Careers Program - Watsonville Wetlands Watch	Pajaro Valley High School Watsonville, CA	Staff
Wetland Stewards Program – Watsonville Wetlands Watch	Pajaro Valley High School Watsonville, CA	Staff
All Marina California Kindergarten and First Grade Classes – Nature Field Trip	J.C. Crumpton Elementary School Ione Olson Elementary School Marina Vista Elementary School	FONR Staff and Interns, CSUMB Return of the Natives Staff and Interns

INDEPENDENT UNDERGRADUATE RESEARCH AND SERVICE LEARNING

Multiple undergraduate research projects were supported by UCSC FONR staff in FY2018-2019. Students from UCSC and CSUMB worked on research including, but not limited to, coast horned lizards, wildlife travel corridors, small mammal personality and fear experiments, and herpetology. Service-learning internships covered topics related to experiential learning for k-12 students. These projects involve many hours of individual mentorship by FONR staff, and create great collaboration opportunities between reserve staff and faculty of supporting institutions. See “Current Research” below for a list of individual projects.

INTERNSHIP AND VOLUNTEER PROGRAM



Figure 6: UCSC and CSUMB interns worked with FONR staff to facilitate multiple K-12 field trips in FY2018-2019.

In FY2018-2018 FONR staff facilitated over 40 internship and volunteer positions for students from UCSC and CSU Monterey Bay. Participants were involved in a wide variety of stewardship, ecology, public service, research installations, and course facilitation internships. Agencies that provided class credit for these internships include the UC Santa Cruz Environmental Studies Internship Program, CSUMB Science Internship Program, and the CSUMB Service Learning Institute. FONR interns gain valuable experience while they assist staff in facilitating research, education, and public outreach. Interns are involved in a wide variety of activities including field data collection, repair and maintenance of reserve facilities, land stewardship, rare plant surveys, invasive species control, k-12 environmental education, flora and fauna monitoring, small mammal trapping, working with k-12 and public outreach efforts, and faculty research. Interns were also able to make connections and learn from the larger conservation community through a variety of community projects. All of the undergraduates who participate in internships at FONR gain research and practical skills, connect with faculty and other students, and get real world experience that cannot be acquired in a traditional classroom.

RESEARCH AND MONITORING

FONR was established because of the unique and rare flora and fauna that occur throughout the 600 acres. Faculty and graduate students from multiple institutions use the reserve for research. Below we provide a short overview of some of the ongoing research projects on the reserve during the past year.



Figure 7: Drone image of habitat in UCSC FONR North Parcel

PRELIMINARY SURVEYS OF ABIOTIC FACTORS INFLUENCING ABOVEGROUND FUNGAL INFECTIONS ON CENTRAL CALIFORNIA MARITIME CHAPARRAL MANZANITAS

UCSC Environmental Studies graduate student Jon Detka's research focuses on exploring the influence of reduced summer marine fog exposure and drought-stress on aboveground fungal disease dieback and mortality in maritime chaparral shrubs (*Arctostaphylos: Ericaceae*). A rapidly changing global climate is likely to increase the prevalence of drought conditions and

reduce the duration and geographic extent of summer maritime fog conditions along the Central California Coast. *Arctostaphylos* spp. are the most diverse group of endemic species in California maritime chaparral and increased drought stress, coupled with reduced wetting associated with summer maritime fog conditions, could increase the susceptibility of *Arctostaphylos* spp. to necrotrophic foliar fungal diseases and decrease the prevalence of biotrophic foliar fungal diseases. Increased disease mortality associated with necrotrophic foliar fungi among *Arctostaphylos* spp. has several potentially important conservation implications as efforts shift to conserving communities with high species endemism. Conservationists and restorationists will be better equipped to accommodate changes in range dynamics of these species given an increased understanding of their reliance on fog and its relation to changes in foliar disease prevalence.

DETERMINING FIRE HISTORY AT FORT ORD NATURAL RESERVE

Fort Ord Natural Reserve (FONR) in Marina, CA is home to a fire adapted shrub community and has some of the oldest extant maritime chaparral in California. The last predicted fire was 100+ years ago, based on previous studies. Mentored by Dr. Laurel Fox, UCSC Undergraduate Selena Vengco performed the following study. She was also a UCSC Norris Center for Natural History research grant recipient. Selena sought to determine the age of the last fire, initially taking age measurements on *Arctostaphylos pumila*, which only germinates post fire. Vengco targeted the oldest stems on the reserve and aged them using standard dendrochronological methods. *A. pumila* was not able to date back the last fire because individual stems die while the initial genet remains to grow. The study also researched historical Monterey Bay Area newspapers and organizations to find land use history of FONR and found that FONR was likely a ranch before its acquisition by the US army. Based on previous stem samples, the results were able to strengthen the relationship between age, height, and circumference which can be used to assess age structure dynamics on the FONR.

RESOURCE PARTITIONING BETWEEN MONTEREY DUSKY-FOOTED WOODRATS (*NEOTOMA FUSCIPES LUCIANA*) AND BRUSH RABBITS (*SYLVILAGUS BACHMANI*) IN MARITIME CHAPARRAL HABITAT

Resource partitioning is an ecological and evolutionary mechanism that allows species to share resources such as food or space, may be key to reducing competition and promoting species coexistence, and occurs differently in various habitats. There are few field studies done on small mammals in an undisturbed chaparral habitat. Browsers in a central California maritime chaparral, at Fort Ord Natural Reserve, could be partitioning sandmat manzanita (*Arctostaphylos pumila*). Mentored by Dr. Laurel Fox, UCSC Undergraduate Gozong Zina Lor performed the



following study. She was also a UCSC Norris Center for Natural History research grant recipient. The study used motion-sensitive cameras to passively observe browsing activity of two dominant browsers, Monterey dusky-footed woodrat (*Neotoma fuscipes luciana*) and brush rabbit (*Sylvilagus bachmani*). Lor compared browsing activity to see how woodrats and rabbits are partitioning sandmat manzanita. She also compared browsing activity near and far to oak woodlands and if predator activity was a possible influence on browsing activity. Results suggest that woodrats and rabbits are partitioning sandmat manzanita by browsing height and across the reserve by location, near and away oak woodlands. Woodrats browsed at higher heights and closer to oak woodlands than rabbits. Assessing how predators influence browsing activity of woodrats and rabbits requires additional data. Documenting resource partitioning in an undisturbed habitat is beneficial for understanding the plant-animal interactions and predict the possible consequences of disturbances, such as fire, that would change the composition of the habitat.

Figure 8: Dusky-footed woodrat at UCSC FONR

LONG-TERM RESEARCH EXAMINING THE ECOLOGY OF FLORA AND FAUNA IN MARITIME CHAPARRAL

UC Santa Cruz faculty member Dr. Laurel Fox has been working on the ecology and conservation of maritime chaparral for nearly three decades. Her work has resulted in a variety of important publications that are providing insight into life history of rare species and factors that influence the abundance and distribution of species throughout the region. This past year she supported several undergraduate researchers who are assisting with a variety of projects examining plant demographics and the impact herbivores have on structuring communities. UCSC FONR interns assisted Dr. Laurel Fox with her field data collection.

HABITAT USE, ACTIVITY PATTERNS, AND THERMAL PREFERENCE OF *PHRYNOSOMA BLAINVILLII* (COAST HORNED LIZARD)



Figure 9: Dani Davis describes her coast horned lizard research to visitors from Cabrillo College.

UCSC Environmental Studies/Ecology and Evolutionary Biology major Danielle Davis is working on the following senior research project: *Phrynosoma blainvillii* are listed as a species of special concern in California with a known population on Fort Ord Natural Reserve land. This species ranges from the southern end of the Baja California peninsula to northern central California, west of the deserts and the Sierra Nevada. As an ectotherm, a certain range of environmental temperatures are important for allowing movement. FONR represents the northern most coastal location for *P. blainvillii* throughout its range. This study focuses on observing the daily and seasonal activity patterns, habitat use, and thermal preference of horned lizards at FONR. Observations will be taken along a determined transect incorporating the various habitats present using ArcGIS to spatially locate each observation.

This study will help fill a gap in our knowledge about this species' behavior at the northern extent of its coastal distribution. Results from this study will provide important data on the ecology and distribution of *P. blainvillii* on the reserve and serve as a foundation for future research and conservation.



Figure 10: Adult coast horned lizard at FONR

COMPARING EFFICIENCY OF DIFFERENT SURVEY METHODS FOR DETECTING SNAKES AT THE UC FORT ORD NATURAL RESERVE

CSUMB UROC funded an undergraduate research project conducted by Yucheol Shin. Drift fence surveys during the summer and fall of 2018 focused on capture efficiency of different survey methods, species diversity, species



Figure 11: Gopher snake in open dune habitat at FONR.

abundance, and habitat association of herpetofauna across the FONR. To meet our survey goals, we constructed 6 drift fence arrays across three primary habitat types (maritime chaparral, coast oak woodland, annual grassland) so that there were two arrays in each habitat type. Each array consisted of Y-shaped fence lines (three fence arms placed roughly 120 degrees apart), four pitfall traps (one buried in the center of the fence line and three buried at the end of each fence arm), and six funnel traps (two traps per fence arm, placed at each side of the fence). Each array was also associated with pre-established nearby coverboards (which are part of the ongoing FONR herp surveys). This study design enabled sampling of herpetofaunal diversity across different habitats using different methods.

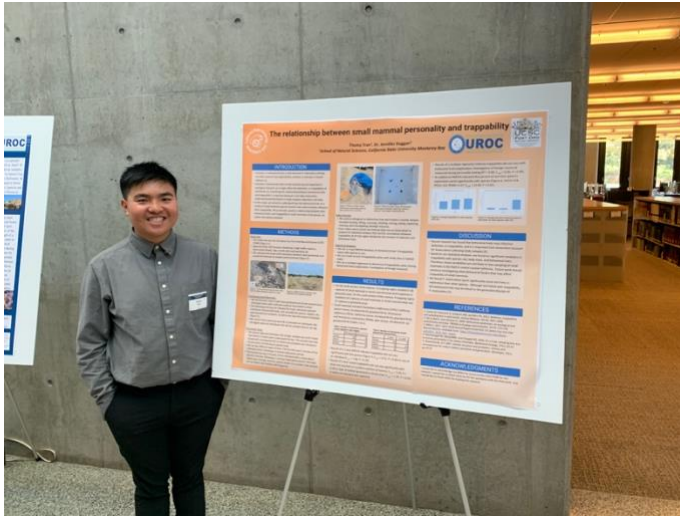
EPIPHYTIC LICHENS AND BIRD COMMUNITIES IN OAK WOODLANDS

Dr. Gerick Bergsma (CSUMB) is studying how oaks function as a foundation species for woodland ecosystems throughout Central California. The epiphytic lichen, *Ramalina menziesii*, commonly grows on oaks, and can form dense filamentous masses that hang up to 2m from the tree branches. Because of their size and morphology, lichen create considerable physical structure, which may create foraging and habitat structure for insectivorous birds. Furthermore, they are known to capture moisture and dust-borne nutrients from the air, thereby enriching soil moisture and nutrient levels underneath the tree. This may also affect the understory habitat and foraging opportunities for ground feeding birds. Dr. Bergsma's study is examining the relationship between lichen cover and avian abundance, biodiversity, and foraging behavior. His results will help our understanding of how epiphytic lichens affect arthropod and bird communities.

OAK WOODLAND ECOLOGICAL COMMUNITY ANALYSIS

Kat Patrice and Cristina Vance are working with Dr. Gerick Bergsma. Their project focuses on how arthropod communities in Coast Live Oak trees differ with varying amounts of epiphyte cover. Trees were chosen based on the amount of lichen present; eight of the oak trees had a significant amount of lichen present, while the other eight did not. Arthropods were sampled using the beat method, sweep nets, pitfall traps, brushings, and lichen clippings. Arthropod samples were then analyzed in the lab to identify organisms to family. When comparing results from different areas on and around a tree (e.g. the brush within the drip line of the trees, the lichen, and the tree itself) they found few differences between arthropod communities with high and low lichen cover. Although these results indicate lichens do not appear to have an impact on arthropod abundance, future sampling across seasons and over a greater spatial scale is needed.

PERSONALITY EFFECTS OF FORAGING SMALL RODENTS



Within natural community settings, small animals are faced with foraging decisions that influence survival. Thomy Tran and Miya Fukitomi are studying how personalities impact foraging patterns and risk assessment of several small mammal species (*Peromyscus maniculatus*, *Peromyscus boylii*, *Peromyscus truei*, *Chaetodipus californicus*, and *Dipodomys heermanni*) to determine how personality influences decision-making across a gradient of predator risk. One of the decisions that these animals face is where they choose to forage and whether or not it is beneficial to perceive the risk of predation by

foraging in an open area. Recent studies suggest that populations and species often exhibit behavioral syndromes, which are suites of correlated behaviors across situations. A population or species can demonstrate a behavioral syndrome with each individual showing a behavioral type (e.g. more bold or more shy). We know that vegetation offers herbivores protection from predators, but do the personalities of these small rodents have an impact on where they choose to forage? The undergraduate researchers are using a manipulative giving up-density (GUD) experiment, combined with video behavioral analysis, to measure how costs of predation alter behavior. The hypothesis is that animals characterized as bold will forage in open areas where risk of predation is higher.

COLORATION SELECTION IN ENSATINAS AT FORT ORD UC RESERVE

Ensatina eschscholtzii salamanders create a ring complex surrounding the central valley of California that allows for reproductive interactions creating hybrid contact zones. The Pajaro river marks the contact zone between the Monterey Ensatina (*E. e. eschscholtzii*) to the south and the yellow-eyed Ensatina (*E. e. xanthoptica*) to the north.



Figure 12: Monterey Ensatina in oak leaf litter

Ensatina eschscholtzii eschscholtzii is a cryptic subspecies typically found to have a brown dorsal and white to orange tinted underbelly. However, at Fort Ord Natural Reserve, leucistic (no melanin) and low melanin orange morphed salamanders have been found. These morphs suggest that *E. e. eschscholtzii* may be locally adapting by becoming cryptic to the light-colored dune sands in the maritime chaparral habitat present there. We propose to test this prediction by scoring predator attacks on clay models consisting of a) light colored morphs resembling leucistic salamanders, b) the orange morphed variation of *E. e. eschscholtzii* and c) normal brown-backed *E. e. Eschscholtzii*. If we find fewer predation marks on light models, this may indicate selective advantages in the lighter coloration of the leucistic salamanders. By tracking predation frequencies in darker *E. e. eschscholtzii* and leucistic models we can better understand speciation and how animals can locally adapt

to their environments. This knowledge can help researchers protect and recognize species that are capable of rapid evolution in our quickly changing world. This research was conducted by UCSC Undergraduate Catlyn Rich (former BIO 82 student) and Dr. Sean Reilly and was the recipient of an UCSC Norris Center for Natural History Undergraduate Research Grant.



Figure 13: UCSC Chancellor Cynthia Larive and CSUMB undergraduate Kyra Petrilli get to know a coast horned lizard

POPULATION SURVEYS OF COAST HORNED LIZARD, PHRYNOSOMA BLAINVILLII

Danielle Davis, UCSC Environmental Studies/Biology undergraduate student, is working on a project that is establishing a long-term mark-recapture survey to monitor *Phrynosoma blainvillii*. She is collecting life history and habitat use information on this rare species as well as establishing a long-term monitoring program for the reserve. This research involves the PIT (passive integrated transponder) tagging of horned lizards which reside along a study transect will be monitored long term.

LONG TERM BAT MONITORING

Bethany Schulze is a graduate student working on bats along the central coast. At Fort Ord, she is conducting year-round monitoring efforts using bat acoustic data loggers. This information provides data on bat use throughout the year and is providing insight into the temporal shift in bat activity and species composition at the reserve.

FLORA AND FAUNA MONITORING

Joe Miller (Reserve Field Manager), Brett Bell (Reserve Restoration Steward), and undergraduate interns conducted a variety of flora and fauna monitoring on FONR lands. These efforts collect critical baseline information of flora and fauna and, importantly, engage students in a wide range of research and stewardship techniques that provide them with a variety of skillsets. Activities include photo point surveys, herpetology cover board surveys, wildlife camera surveys, pitfall trap surveys, bird banding, endangered plant monitoring, and the establishment of long-term chaparral vegetation monitoring plots.



Figure 14: Bird banding intern Alicia Long works to gather data about a dark-eyed junco

COASTAL FOG MONITORING

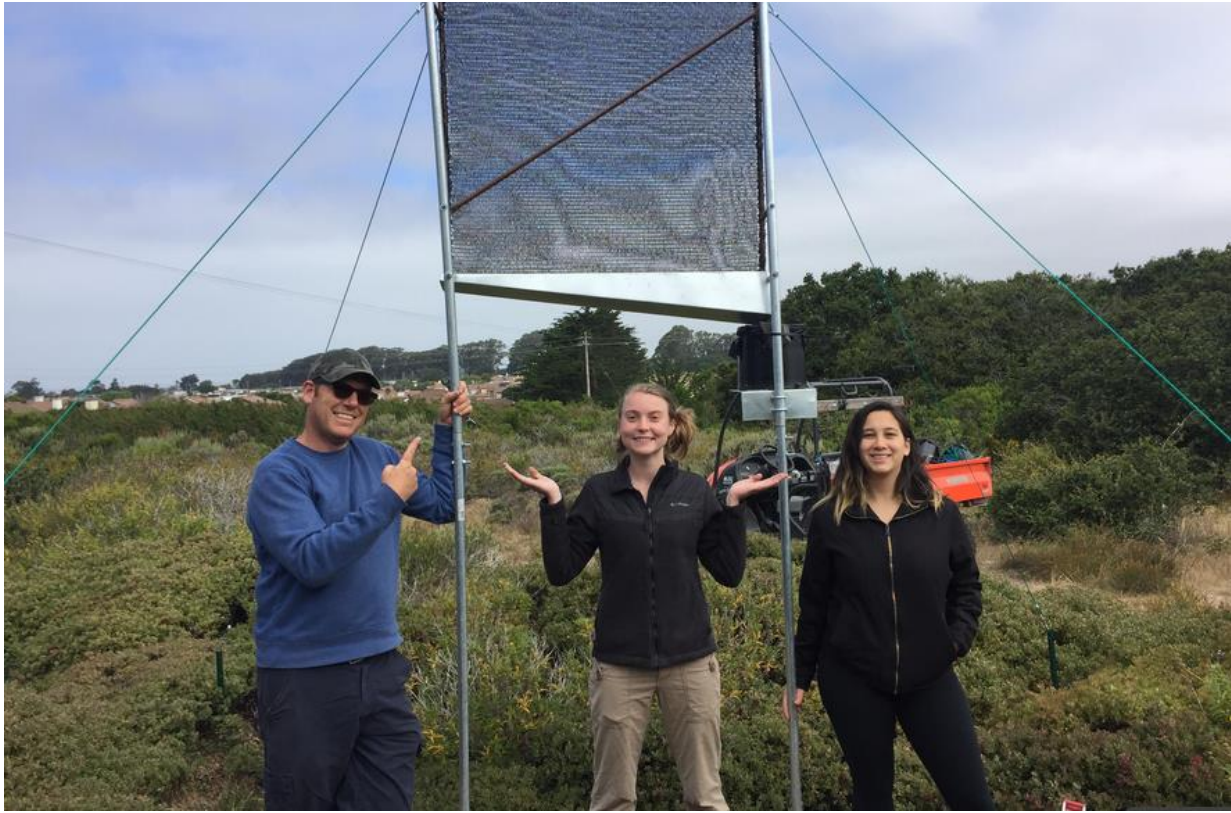


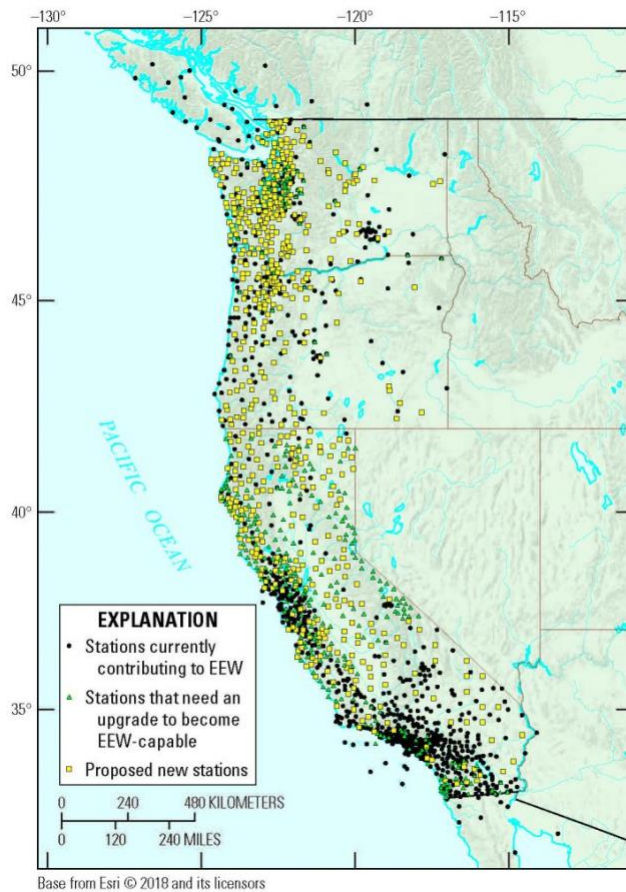
Figure 15: FONR Field Manager Joe Miller, Columbia Community College student Carina Swann, and CSUMB undergraduate Blanche Duann install a fog collector

Dr. Daniel Fernandez continues to conduct his long-term monitoring of coastal fog at stations on the reserve. Fog is a significant source of summer water for many of the plants that occur along the central coast. His work is providing important information on how fog patterns are changing from year to year. With the assistance of numerous undergraduate and graduate students, UCSC FONR staff built an additional 8 collectors that are placed on a coast to inland gradient. These stations will be monitored long term to measure changes in coastal fog as well as the efficiency of fog collectors to collect water that could then be utilized for other uses (e.g. irrigation etc.).

ARCTOSTAPHYLOS SEED BANKS AND ANIMAL FORAGING

Dr. Tom Parker is studying a variety of abiotic and biotic factors that influence the distribution of Manzanita throughout the state. His work at Fort Ord is focused on quantifying seed banks of *Arctostaphylos pumila* and *A. tomentosa* and how density of seeds in the soil influence foraging effort of small mammals.

SEISMIC MONITORING AND SHAKEALERT EARTHQUAKE EARLY WARNING SYSTEM



Today, the technology exists to detect earthquakes so quickly that an alert can reach millions of people before strong shaking arrives. UC Berkeley and partners are developing and implementing the ShakeAlert earthquake early warning system to identify and characterize an earthquake within few seconds after it begins. We quickly calculate the expected intensity of ground shaking, and can send warnings to people and infrastructure in harm's way. To reliably distribute warnings for all parts of the State with high earthquake hazard, it is important to have a robustly operating, dense network of seismic stations capable of providing data that can be used in ShakeAlert. The blue dots on the adjacent map represent the stations contributing to ShakeAlert now. Particularly in Northern California, more sites are needed (green triangles, yellow squares). UC Berkeley and CISN partners are looking for locations where we can install new earthquake monitoring stations. UCSC Fort Ord Natural Reserve's station went online in Summer 2019. In addition to contributing to ShakeAlert, the new stations will also support the mission of the CISN, to operate a reliable, modern,

statewide system for producing earthquake information for the benefit of public safety, emergency response, and loss mitigation.

EFFECTS OF HUMAN DISTURBANCES ON SPACE USE OF *NEOTOMA FUSCIPES* (DUSKY-FOOTED WOODRATS)

Recent observations of Monterey dusky-footed woodrats occurring unexpectedly in open shrubland habitat adjacent to the UC FONR campsite suggest the species may shift space use in response to human disturbances at the campsite. Under the direction of Dr. Jenny Duggan, Undergraduate Devin Jimenez is examining the impacts of camping activities on both the population density and habitat use of Monterey dusky-footed woodrats on/near the UC FONR campsite. This field work was done using radio collars and telemetry monitoring. The Monterey dusky-footed woodrat is a species of special concern in the state of California and given the importance of outdoor recreation in the Monterey area, it is important land managers understand the effects of camping activities on this species.

ANALYSIS OF ARGENTINE ANT (*LINEPITHEMA HUMILE*) HABITAT DISTRIBUTION

Coast Horned lizards (*Phrynosoma blainvilli*) thrive best in chaparral environments with an abundance of ants. Horned lizards within the UC Santa Cruz Fort Ord Natural Reserve feed on the native carpenter ant species. Land

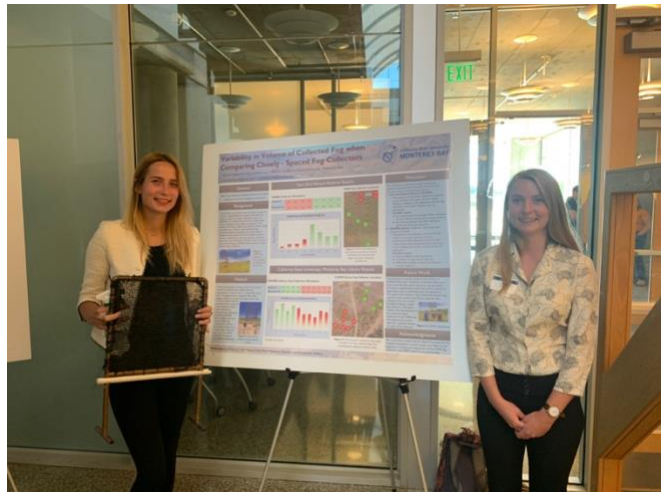
within the reserve is generally dry, however, urbanization surrounding the reserve has led to an increase in the local water supply. Argentine ants (*Linepithema humile*) are an invasive species that are attracted to moist, wet areas. Through competitive practices, Argentine ants overtake habitats previously occupied by native species. Ant preference for Horned lizards is driven by body size, rather than abundance. The small bodies of the Argentine ants force the Horned lizard to become more selective with its prey. As Horned lizards occupy chaparral habitats, it is assumed that Argentine ant abundance would be less in these environments. A survey of the current distribution of Argentine ants was conducted to examine differences in abundance between habitats. This project was part of a CSUMB undergraduate research class, and was conducted by Rene Nunez, Samantha Scalise, and Will Gorham.

SMALL MAMMAL BEHAVIORAL STUDY: EFFECT OF DOMESTIC DOG SCENT

Small nocturnal mammals play an important role in many ecosystems, however there are many anthropogenic threats to their success, including the introduction of domestic predators like dogs. The purpose of this study is to investigate how the scent of domestic dogs, affects the foraging behavior of small nocturnal mammals around the UCSC Fort Ord Natural Reserve. This will be accomplished by deploying foraging trays (trays filled with sand, and seeds) with and without the presence of domestic dog hair scent. Giving up densities at each site will be used to make conclusions. This project was part of a CSUMB undergraduate research class and was conducted by Environmental Science student Madalyn Price.

VARIABILITY IN VOLUME OF COLLECTED FOG WHEN COMPARING FOG COLLECTORS AT DIFFERENT LOCATIONS

Carina Swann (Columbia Community College) & Yulia Loshkareva (CSUMB) conducted the a study on how fog accumulation varies within close distances and changes across slight elevation shifts. The fog harvesting technology used in this research consists of a double layer reshel mesh net supported by a copper frame that “drains” into a trough that then funnels into a rain gauge bucket. In order to determine the variation in the amount of water collected within a small area ten fog collectors were deployed behind the CSUMB library within a 0.5-acre plot and eight fog collectors on the Fort Ord Natural Reserve on a larger plot around 30-acre area. The FONR collectors are spaced along different elevations. Their findings indicate that the amount of fog water varies considerably at relatively fine spatial and elevational scales.

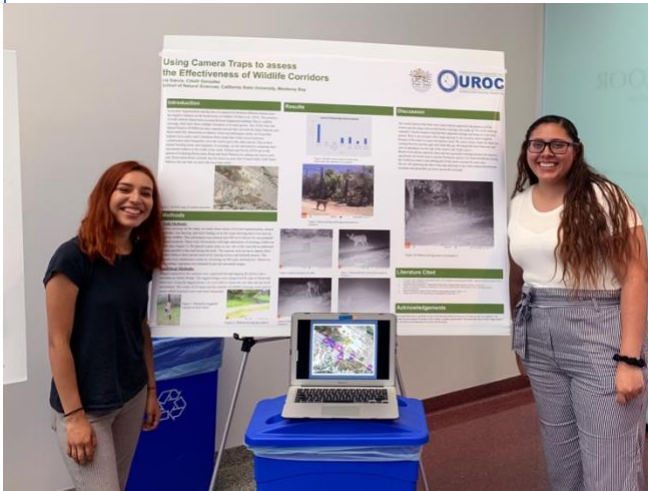


DID RHIZOBIA ASSOCIATED WITH INVADING LEGUMES ESCAPE BACTERIOPHAGE ENEMIES?

Dr. Ellen Simms, Mohsin Tariq, and Marriam Zafar conducted field a study at FONR focused on helping understand the factors that promote biological invasions. Many plants in the legume family are invasive weeds, perhaps because they cooperate with bacteria called rhizobia to obtain a reliable supply of nitrogen. For example, the legume French broom and its rhizobia have become invasive in America after being introduced from Europe. Introduced species might become invasive by escaping enemies that plague them in their native range. Like other bacteria, rhizobia are often attacked by viruses. Did French broom become invasive in America because its partner rhizobia escape viruses that plagued them back home? To begin answering this question, rhizobia and associated viruses will be collected from European (native) and American (introduced) populations of French broom. If American populations of French broom rhizobia have escaped their enemies, they should be infected by fewer viruses. However, American rhizobium viruses might have evolved to infect the introduced rhizobia. To test this idea, rhizobia and associated viruses will be collected from a native legume and the viruses will be tested to discover if they can infect rhizobia associated with French broom. This work will help understand how viruses could be used to manipulate host populations.

For release from bacteriophage infection to explain invasiveness of rhizobia and their partner legumes, bacteriophages must control rhizobium populations in their home range but not in the invasive range. This pattern requires that bacteriophages be specialized and more easily infect sympatric than allopatric rhizobia. As a first step toward addressing this issue, the host ranges of rhizobial bacteriophages collected from three European and three American populations of *Genista monspessulana* will be assessed in vitro by inoculation onto single-isolate lawns of Bradyrhizobium genotypes isolated from these same populations. The number of bacteriophages isolated from native and non-native range populations will also be compared. To test whether indigenous American bacteriophages might control introduced Bradyrhizobium populations, the host ranges of bacteriophages isolated from bradyrhizobia associating with the native legume, *Lupinus arboreus*, will also be tested against Bradyrhizobium genotypes isolated in the survey described above. This work will test whether the Enemy Escape Hypothesis applies to an economically and ecologically important microbe associated with an invasive legume. It will further examine how bacteriophage host ranges evolve in response to shifts in host population changes. In so doing, it will enhance scientific understanding of how bacteriophages affect mutualistic interactions between hosts and beneficial bacterial symbionts.

USING CAMERA TRAPS TO ASSESS THE EFFECTIVENESS OF WILDLIFE CORRIDOR PLANNING AT UCSC FORT ORD NATURAL RESERVE



Undergraduates Citlalli Gonzales and Iris Garcia, mentored by UCSC Fort Ord Natural Reserve Field Manager Joe Miller, used tracking and wildlife cameras to assess locations of frequent road crossings of wildlife between UCSC FONR reserve parcels in Marina, CA. This project will be used to measure the effectiveness of the wildlife corridor that was created when the reserve boundaries were established under the habitat management plan in 1997. A detailed report is being produced and will be provided to transportation planning agencies to inform future planning of crossing areas in the area.

PUBLIC SERVICE

FONR continues to increase engagement in public service and community outreach. Public schools, universities, NGOs, conservation entities, and a variety of community organizations used the reserve this past year. New partnerships emerged in FY2018-2019 including North Monterey County Parks and Recreation, Pacific Grove Museum of Natural History, UC Agriculture and Natural Resources, The Monterey Bay Drone, Automation, and Robotics Technology (DART), Scouts BSA, and others. Below are a few highlights from the year in public service.

PUBLIC SERVICE HIGHLIGHTS

WATSONVILLE WETLANDS WATCH – PAJARO VALLEY HIGH SCHOOL

In FY 2018-2019 FONR staff created a partnership with the Watsonville Wetlands Watch program from Pajaro Valley High School in Watsonville, CA. Two school programs, the Green Careers program and the Wetlands Stewards program, that focus on learning about careers in natural science, land stewardship, and conservation principals visited the reserve to learn about careers in natural sciences and the environment in general. On multiple visits, Watsonville Wetlands Watch high school students learned about wildlife monitoring, nature journaling, fog collector construction, drone mapping, and land stewardship. During the visits, UC and CSU undergraduates presented their research to the students and researchers



Figure 16: A family meets "Bandit the California King Snake" at Pajaro Valley High School



and staff highlighted career pathways and ways to gain skills and network. In addition, the FONR Field Manager attended a Nature Night event at Pajaro Valley High School, where he hosted a table that taught focused on local natural history and herpetology. This important partnership has proven to be a great way to inspire future scientists and conservation leaders by exposing them to all the variety of work that is conducted in the UC Natural Reserve System.

Figure 17: Restoration Steward Brett Bell leads Pajaro Valley High School students on a hike in maritime chaparral

NATURE DETECTIVES – MARINA CITY ELEMENTARY SCHOOLS



Figure 18: UCSC undergraduate researcher Dani Davis presents a gopher snake to students on the "Nature Detectives" field trip

In collaboration with CSUMB Return of the Natives (RON) program, FONR hosted several hundred kindergarten and first grade classes from Marina elementary schools. Staff and interns visited each classroom prior to field trips in order to meet students and provide an overview of what they might expect to see at the reserve. In-class activities included an art project that helps university staff measure nature and science knowledge before and after the trip. Classes were then brought to the reserve by bus and parents of the students are also encouraged to attend. Once at the reserve, students are led on a short hike to visit stations where undergraduates teach them about a variety of natural history topics. Funding for busses is provided by the UCSC Reserves as public schools in Marina are financially challenged and transportation costs often present an unsurmountable hurdle for the schools. Kids learn about insects, mammals, reptiles, and birds from university students and reserve staff. For some of these students, this is their first exposure to a hands-on learning activity focused on science in the outdoors - their enthusiasm is infectious. Nature Detectives served approximately 600 elementary students and community members this year. This program was started in 2013 and we plan to continue the program next year. In addition to helping the public-school students, this event is a great way for university students to gain valuable teaching experience.



Figure 19: FONR Field Manager Joe Miller speaks at Olson Elementary School in Marina, CA



Figure 20: Alexandra Ahmad presents wildlife game camera photos to elementary school visitors at UCSC FONR

UCANR IGIS DRONECAMP

In cooperation with CSUMB, UC Agriculture and Natural Resources (UCANR), Monterey Bay DART (Drone, Automation, and Robotics Technology) office, and Marina Municipal Airport; Fort Ord Natural Reserve was able to help host the UCANR Informatics and GIS (IGIS) DroneCamp in Spring 2019.

DroneCamp is designed for participants with little to no experience in drone technology, and who are interested in using drones for a variety of real-world mapping applications. This training has an emphasis on agriculture and natural resources; but the methods for flight operations, data processing, and analysis are applicable to a broad range of disciplines, including archeology, land surveys, and facilities management. Tickets were sold at a reduced cost to UC students and affiliates, and FONR helped reduce that cost further by offering free camp accommodation at the reserve. Staff and attendees learned much from the conference, and plans have been made to host the conference again in the future.



Figure 21: Proximity to universities and ease of access make FONR a great location for educational; conferences such as UCANR IGIS DroneCamp



Figure 22: UCANR staff instructs on proper drone safety at FONR

RESERVE USE

2018 – 2019 represented a record level of use for the reserve; supporting more individuals and groups than ever before (Appendix 1). The largest user group was undergraduate students who used the reserve for coursework and independent research. K-12 students were the next largest group. The increase in K-12 was a direct result of our targeted outreach to local schools and nonprofits. Approximately 20 different NGO, community, K-12, affiliated, and governmental entities used the reserve throughout the year (Table 2).

TABLE 2. NGO, GOVERNMENTAL, K-12, AND AFFILIATED USER GROUPS

Ventana Wildlife Society	California Academy of Sciences	Girl Scouts of California’s Central Coast
California Native Plant Society	Monterey Bay Tracking Club	El Sausal Middle School Ventana Alliance Club
Bureau of Land Management	UC Genomics Consortium	University of California Agriculture and Natural Resources
Fort Ord Reuse Authority	Ecological Society of America	Olson Elementary School
California Department of Fish and Wildlife	CSUMB SEEDS club	Los Arboles Middle School
North Monterey County Parks and Recreation	UCSC Office of Physical Education, Recreation, and Sports	Marina Vista Elementary School
Ventana Wilderness Alliance	CSUMB Return of the Natives	Crumpton Elementary School
UC Santa Cruz Arboretum	Alisal High School	UCSC Kenneth Norris Center for Natural History
CSUMB Sciences Internship Program	CSUMB Service Learning Institute	UCSC Environmental Studies Internship Office
Pacific Grove Museum of Natural History	The Monterey Bay Drone, Automation, and Robotics Technology (DART)	UC Monterey Bay Education, Science and Technology Center (MBEST)
US Department of Fish and Wildlife	Soquel High School	Scouts BSA

APPENDICES

APPENDIX 1. USE DATA FOR FY 2018-2019

RESERVE USE DATA Academic year: 2018-2019																												
Campus: University of California, Santa Cruz																												
Reserve: Fort Ord Natural Reserve																												
	UC Home		UC Other		CSU System		CA Comm College		Other CA College		Out of State College		International University		Government		NGO/Non-Profit		Business Entity		K-12 School		Other		Total			
	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs		
UNIVERSITY- LEVEL RESEARCH																												
Faculty	1	13	2	2	3	101	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	8	118
Research Scientist/Post Doc	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Research Assistant (non-student/faculty/postdoc)	1	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	
Graduate Student	2	40	0	0	1	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	54	
Undergraduate Student	11	160	0	0	116	576	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133	742	
Professional	0	0	3	6	0	0	0	0	0	0	0	0	0	0	0	2	26	0	0	0	0	0	0	0	0	5	32	
Other	1	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	3	29		
Volunteer	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	2	8		
SUBTOTAL	17	252	6	9	120	691	6	6	0	0	0	0	2	2	0	0	2	26	0	0	0	0	3	11	156	997		
UNIVERSITY - LEVEL INSTRUCTION (CLASS)																												
Faculty	13	32	1	1	9	30	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	66	
Research Scientist/Post Doc	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
Research Assistant (non-student/faculty/postdoc)	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	
Graduate Student	7	13	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	17	
Undergraduate Student	260	1160	20	20	427	2493	45	60	35	35	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	789	3769	
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15	30	0	0	0	15	30	
Professional	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	6	0	0	3	6		
Other	0	0	0	0	15	30	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	5	7	21	38		
SUBTOTAL	282	1209	22	22	453	2557	47	63	35	35	0	0	0	0	0	1	1	0	0	0	18	36	6	8	864	3931		
OTHER																												
Faculty	0	0	1	1	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	
Undergraduate Student	46	89	16	32	93	134	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	159	258	
K-12 Instructor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	19	1	6	14	25			
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	558	610	0	0	0	558	610		
Professional	0	0	11	15	2	5	0	0	0	0	0	0	0	0	20	21	2	2	0	0	0	0	70	90	105	133		
Other	1	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	46	47	52			
Docent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1	2		
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0	0	30	30	0	0	0	36	36		
SUBTOTAL	47	94	28	48	98	143	4	4	0	0	0	0	0	0	20	21	9	10	0	0	601	659	117	142	924	1121		
	UC Home		UC Other		CSU System		CA Comm College		Other CA College		Out of State College		International University		Government		NGO/Non-Profit		Business Entity		K-12 School		Other		Total			
	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs		
HOUSING																												
TOTALS	346	1555	56	79	671	3301	73	35	35	0	0	2	2	20	21	12	37	0	0	619	695	126	161	1944	6049			

APPENDIX 2. UCSC NATURAL RESERVE COMMITTEE AND CHARGE

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

2019-2020 NATURAL RESERVES ADVISORY COMMITTEE

CHARGE

The committee provides oversight of on- and off-campus natural reserves of instructional and research interest. It is responsible for developing program vision and policy for the management and use of the UCSC Campus Reserve and of the four UC Natural Reserves System holdings: Año Nuevo Island Reserve, Landels-Hill Big Creek Reserve, Younger Lagoon Reserve and Fort Ord Reserve. The committee coordinates with the system wide NRS Advisory Committee that advises on policy for all NRS reserves. In addition to the chair (Faculty Director), membership of the committee is comprised of faculty advisors to each reserve, one faculty representative at large, one non-senate academic appointment, one staff representative, one graduate student, two undergraduate students, and ad hoc faculty members as needs arise. The Faculty Director, in consultation with the Dean and the Administrative Director of the UCSC Natural Reserves, appoints the committee. Membership terms begin September 1 unless otherwise specified.

DURATION OF APPOINTMENTS

Faculty Director: 5 years

Faculty Advisors: 3 years

Non-Senate Academic, Staff, and Students: 1 year

Members may be reappointed at the discretion of the Faculty Director in consultation with the Administrative Director.

Hours/Quarter: Chair/NRS Representative-20, Members-10

Reports to: Division of Physical & Biological Sciences Dean

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