University California, Santa Cruz

Younger Lagoon Reserve

Annual Report 2017-2018

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Executive Summary

Over the past year Younger Lagoon Reserve continued to thrive as a living laboratory and outdoor classroom focused on supporting University-level teaching, research and public service while meeting the campus' Coastal Long Range Development Plan (CLRDP) requirements for the protection and enhancement of all natural lands outside of the development areas of the Coastal Science Campus, including native habitat restoration of the 47-acre "Terrace Lands" as outlined in UCSC CLRDP and Coastal Development Permit. Over the past year we continued to increase our support of undergraduate course use. Most formal undergraduate education users were within the Environmental Studies and Ecology and Evolutionary Biology departments. Younger Lagoon Reserve-affiliated internships also supported over 80 undergraduate students who were involved with research, education, and stewardship. The majority of interns were involved in restoration and monitoring activities on the Terrace Lands engaging in a wide range of projects, including working closely with faculty research projects on cost effective methods for native habitat restoration (PI, Karen Holl), evolution of the threespined stickleback (co-PIs Eric Palkovacs and Ben Wasserman), and grassland response to drought (co-PIs Michael Loik and Kathleen Kay), internship curriculum/handbook creation, small mammal research, invasive species management, and more. Beyond UCSC use, YLR continued to support and increase use by other groups such as the Monterey Bay Aquarium Watsonville Area Teens Conserving Habitats Program, Watsonville Wetlands Watch, Cabrillo College, Santa Cruz Bird Club, local K-12 programs, and other community groups.

Restoration activities in FY 2017-2018 included weed control, planting of over 2 acres, seed collection, and wetlands work. Beyond restoration work we continued to conduct other on-the-ground stewardship activities including trash hauls, removal of illegal camps, fence repair, and public education. This was the seventh year of CLRDP CCC compliance monitoring for restored Coastal Bluffs, Wetland Buffer, Coastal Scrub, and Grassland areas. YLR is meeting or exceeding restoration targets for nearly all monitored sites and has meet the restoration goals for Phase 1. FY 2017-2018 represented the eighth full year of implementation of the CLRDP CCC Beach Access Management Plan related activities at Younger Lagoon Reserve. The University submitted a NOID to the CCC in September 2018 that summarizes the findings of the Beach Access Management Plan to date.

In Summary, YLR continued to offer excellent field locations for undergraduate, graduate, and faculty ecological research, support ongoing research and meet all CLRDP related activities and requirements.

Introduction

This report provides an overview of the activities that were conducted at Younger Lagoon Reserve (YLR) during the 2017-2018 fiscal year (July 1, 2017 - June 30, 2018). Younger Lagoon continued to see increases in use and activity in general. Providing an outdoor classroom and living laboratory allows for experiential learning opportunities. These opportunities have profound impacts on students both professionally and personally. This was the ninth year we had fulltime staff on site managing the Reserve. As a direct result, the level of academic and public engagement increased and the Reserve is on target for implementing its obligations required under the Coastal Long Range Development Plan (CLRDP).

Younger Lagoon represents a unique reserve within the UCSC's Natural Reserve portfolio as it has open public access to a portion of the Reserve. Along with the challenges of public access (i.e. impacts to resources, protecting research equipment, protecting endangered and threatened species, implementing regulations, etc.) having public present on-site provides opportunities for outreach and education. During the past year, we continued to implement restoration activities on the Terrace Lands portion of the reserve and, as a direct result, interacted frequently with public users. These interactions have continued to provide opportunities for reserve staff and students to discuss the short and long-term objectives and goals of the restoration work, interpret the flora and fauna of YLR, and discuss ongoing planning and development efforts of the Coastal Science Campus (CSC).

CLRDP Activities

Overview

This year represented the ninth year of CLRDP related activities at Younger Lagoon Reserve. The California Coastal Commission certified the CLRDP for the "Terrace Point" property in 2008. In July of 2008, approximately 47 acres of natural areas of the "Terrace Point" property were incorporated into the University of California Natural Reserve System as part of UCSC's Younger Lagoon Reserve. The inclusion of the 47 acres into YLR, along with continued management of the lagoon portion of YLR, was a requirement of the California Coastal Commission for the UCSC Coastal Science Campus development.

The CLRDP requires that the entire Reserve be protected and used as a living laboratory and outdoor classroom and that the newly incorporated Natural Reserves lands are restored over a 20-year period. Fulfilling the University's mission to support research and teaching, we continue to incorporate research and teaching into all aspects of restoration, monitoring, research and protection throughout YLR. The increased lands and access to restoration and monitoring projects are providing expanded opportunities for undergraduate experiential learning opportunities via class exercises, research opportunities, and internships.

NOID 2 (10-1) & NOID 9 (18-1) Beach Access Management Plan

This year represented the seventh full year of Beach Access Management Plan related activities at Younger Lagoon Reserve. In March 2010, the California Coastal Commission (CCC) approved the University of California's Notice of Impending Development for Implementation Measure 3.6.3 of the CLRDP (NOID 2). Implementation Measure 3.6.3 of the CLRDP required that (through controlled visits) the public have access to Younger Lagoon Reserve beach and that a monitoring program be created and implemented to document the condition of native flora and fauna within Younger Lagoon and its adjacent beach. The monitoring plan was to be implemented over a 5-year time period. At the end of the 5-year period (Winter 2015) results were to be compiled and included in a report that summarizes and assesses the effect of controlled beach access on flora and fauna. That report was submitted to the California Coastal Commission in 2016.

The CLRDP requires that University submit a NOID to the CCC that summarizes findings of the Beach Access Management Plan every five years. That NOID (NOID 9) was initially submitted in the Fall of 2016; however, it was withdrawn due to CCC staff work load and was resubmitted in summer of 2017. Although CCC staff recommended approval of NOID 9 as submitted, CCC Commissioners raised questions regarding beach access at the July 2017 meeting, and YLR staff

withdrew NOID 9 prior to the Commissioners vote in order to try and better address these questions. The University resubmitted NOID 9 to the CCC in September 2018.
In September 2018, the Commission approved UCSC's NOID 9 to continue the beach tour program though through 2020 with the addition of five special conditions. These special conditions were at the suggestion of Commission staff, and included and included 1) requiring that the be offered without admission to the Seymour Center), 2) additional tour outreach and advertising, 3) additional tour signage, 4) additional tour monitoring and reporting requirements, and 5) a threat to open the beach to additional public access should the conditions not be met, jeopardizing not just the research integrity of the reserve, but also the security of the west side of the Marine Lab, including the seawater system and marine mammal research program.

We estimate that implementation of the NOID 9 special conditions by the Seymour Center will cost approximately $15,000/year. The campus must submit a new Younger Lagoon Beach Public Access Management Plan NOID in 2020, at which point the Commission could ask for additional public access requirements, which could result in the need for additional funding.

Seymour Marine Discovery Center docent-led tours of the beach continued to be offered 2-4 times a month throughout FY 2017-2018 and biological monitoring of the lagoon and adjacent beach was conducted quarterly in FY 2017-2018. A detailed report on activities under the Beach Access Management Plan is included as Appendix 1. NOID 9 and the CCC Staff Report for NOID 9 are included as Appendix 5.

NOID 3 (10-2) Specific Resource Plan for the Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve

The Resource Management Plan (RMP) within the CLRDP provides a broad outline with general recommendations and specific guidelines for resource protection, enhancement, and management of all areas outside of the mixed-use research and education zones on the CSC site (areas that will remain undeveloped). In addition to resource protection, the CLRDP requires extensive restoration, enhanced public access/education opportunities on site, and extensive monitoring and reporting requirements. The entire project is to be completed over 20 years and, as a condition of inception into the University of California Natural Reserve System, UCSC Campus has committed to providing perpetual funding for the project and continued management of YLR.

The SRP for Phase 1A of restoration (first 7 years) was approved by the CCC in September 2010 (NOID 3, 10-2). Phase 1A projects included Priority 1 weed removal, re-vegetation, baseline monitoring and selection of reference systems. This year marked the conclusion of the SRP for Phase 1A. A summary report for Phase 1A of Restoration is included as Appendix 6.

The SRP for Phase 1A of restoration outlined detailed success criteria for each of the reserve's habitat types (Ruderal, Coyote Brush Grassland-Scrub, and Grassland, Coastal Bluffs, Wetlands, and Wetland Buffers). These criteria set an initial threshold of species richness and cover for specific habitat types throughout the restoration area. These criteria were further refined at the recommendation of the SAC based on results from reference site monitoring of local coastal terrace prairie grassland, seasonal wetland, and coastal scrub sites (See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016 and 2016-2017 Annual Reports). FY 2017-2018 marked the sixth year of compliance monitoring for restored Coastal Bluffs, Wetland Buffer, Coastal Scrub, and Grassland areas. A detailed compliance monitoring report is included in Appendix 2.

Restoration of the Terrace Lands continued throughout FY 2017-2018. Activities included weed control, planting, seed collection, and wetlands reconnection work.

<u>Monitoring efforts in 2018-2019</u>

During the 2018-2019 field season, UCSC graduate students Josie Lesage, Justin Luong, and professor Dr. Karen Holl will conduct restoration compliance monitoring at restoration sites 2, 4 and 6 years post planting as per CLRDP requirements, as well as at any sites that have fallen below compliance standards.

NOID 5 (12-2) Public Coastal Access Overlook and Overlook Improvements Project

In August 2012, the California Coastal Commission (CCC) approved the University of California's Notice of Impending Development NOID 5 (12-2) Public Coastal Access Overlook and Overlook Improvements Project. Construction on the Public Coastal Access Overlook and Overlook Improvements Project ("Overlooks Project") began in the winter of 2012/2013 and was completed in the spring of 2013. The project consisted of three new public coastal access overlooks, and improvements to two existing overlooks at UCSC's Marine Science Campus. Several of the overlooks, which are sited at the margins of development zones, therefore are within what is now the Younger Lagoon Reserve: Overlooks C and A are within development zones at the margin of the YLR, while the sites of overlooks D, E and F are within areas incorporated into the YLR as a condition of approval of the CLRDP. The project constructed publicly-accessible overlooks from which to view the ocean coast (Overlook F), Younger Lagoon (Overlook D), a seasonal wetland (W5) (Overlook A), and campus marine mammal pools (Overlook C) for which public access is otherwise limited due to safety hazards or for the protection of marine wildlife and habitats. The facilities include interpretive signs and public amenities such as bicycle parking and benches to enhance public access to, and enjoyment of, these restricted and/or sensitive areas.

NOID 6 (13-1) Coastal Biology Building and Associated Greenhouses; Site Improvements Including Road, Infrastructure and Service Yards; Public Access Trails and Interpretative Panels; Wetland Connection in Specific Resource Plan Phase 1B; Sign Program; Parking Program; Lighting Plan.

In August 2013, the California Coastal Commission (CCC) approved the University of California's Notice of Impending Development NOID 6 (13-1) Coastal Biology Building and Associated Greenhouses; Site Improvements Including Road, Infrastructure and Service Yards; Public Access Trails and Interpretative Panels; Wetland Connection in Specific Resource Plan Phase 1B; Sign Program; Parking Program; Lighting Plan. This project included development of a new seawater lab building, three new parking lots along with a parking management program, a research greenhouse complex, and associated site work including storm water treatment and infiltration features. It also consisted of campus utility and circulation improvements to serve both the new lab building and future campus development under the CLRDP. The Project developed a complex of public access and interpretive facilities, including pedestrian access trails, interpretive program shelters, educational signage, and outdoor exhibits. This project initiated campus wide parking, sign, and lighting programs. This project also included mandated wetland restoration and habitat improvements as described in the Specific Resource Plan Phase 1B.

<u>SRP Phase 1B</u>

The Resource Management Plan within the CLRDP requires the reconnection of Upper Terrace wetlands W1 and W2. Wetland W1, on the western margin of the Upper Terrace, is a former agricultural ditch, probably constructed to drain the adjacent agricultural field. It is separated from wetland W2 (located immediately to the east) by a slightly elevated berm that may partially represent spoils left from the ditch construction. The SRP for Phase 1B of restoration detailed Younger Lagoon Reserve's approach for implementing these mandated wetland restoration and habitat improvements.

To reconnect hydrology between W1 and W2, five brush packs (ditch plugs) were installed within W1 in the summer of 2016 and 2017 (See 2016-2017 Annual Report and SRP Phase 1 Summary Report). As the hydrology of the site begins to shift to become more favorable to wetland plants, native wetland plants will be installed on the site. All of the brush packs are currently intact and functioning as designed. Although not yet observed, the ditch plugs may create small open water pool habitat and potentially provide new breeding habitat for amphibians.

SRP Phase 1B is now complete. A summary report for Phase 1B of Restoration is included as Appendix 6.

<u>Domesticated Animals</u>

In 1999, when the University purchased the land for the expanded CSC, a special exception was made in the campus code to allow leashed dogs on the bluff top trail that rings the YLR Terrace Lands. Since that time, the site had become popular with dog owners, many of whom do not obey the leash law. The CLRDP requires that all domesticated animals be eliminated from the campus. Parallel to the start of construction, implementation of the campus "no dog" policy began in May 2015 and continued in FY 2017-2018. New signage and other activities were implemented to educate the community and the public about the policy change. Student Ambassadors from the campus Police Department were brought on site to help inform the public about the new "no dog" policy. In addition, a new temporary sign was installed at the CSC entrance about the new policy, and existing trail signs were modified to reflect the change as well. These trail signs were temporarily removed in 2017 to allow for construction of the new trails and are scheduled to be replaced by the end of calendar year 2018.

Scientific Advisory Committee (SAC) Meetings / Recommendations

A critical component of the CLRDP was the creation of a Specific Restoration Plan (SRP) guided by a Scientific Advisory Committee (SAC). The SAC is comprised of four members: Dr. Karen Holl (SAC chair) Professor and Chair of the Department of Environmental Studies at UCSC; Tim Hyland, Environmental Scientist, State Parks, Santa Cruz District; Bryan Largay, Conservation Director, Land Trust of Santa Cruz County; and Dr. Lisa Stratton, Director of Ecosystem Management, Cheadle Center for Biodiversity and Ecological Restoration, University of California, Santa Barbara (UCSB). SAC members met as a group with reserve staff on-site in May 2018. Discussion topics included current and future projects under the CLRDP; a recap of SRP Phase 1; SRP Phase 2 planning; and restoration, research, and teaching activities at YLR.

<u>Management and Monitoring Recommendations:</u>

Coastal prairie is notoriously difficult to restore and maintain. The 2011 coastal prairie site – which was impacted by construction and drought, has fallen below its success targets. The SAC recommended monitoring this site (and any others that fall below target) once a year rather than every other year, and replanting or changing management regimes if the sites do not rebound.

<u>Research Recommendations:</u>

SAC members recommend that future research include 1) investigations into the inclusion of native annual forbs in restoration efforts – including burn box treatments, and 2) strategies for reducing herbivory pressure from mollusks, rabbits, and corvids on restoration plantings.

Summaries of ongoing research projects undertaken at the direction of the SAC are below.

Effects of Multi-Year Storage on Germination of California Native Species

Successful restoration of California coastal prairie and sage scrub ecosystems relies on a properly stored native seed stock. Senior thesis student, Madison Ginn, quantified the percent germination of 25 native plant species collected coastally near Santa Cruz, CA for restoration at the Younger Lagoon Reserve (YLR). The purpose of the study was to inform seed management at YLR and beyond and to understand how multi-year storage affects the percent germination and time to germination of a subset of these species. One hundred seeds from each collection year of the 25-study species were sown into four replicate containers in a 5 × 5 seed grid and monitored weekly for germination. The main results and recommendations are listed below.

- Results showed mixed effects of seed age on percent germination and time to germination, with over half of all study species demonstrating a decrease in germination and half showing an increase in time to germination with increasing age. Germination of the remaining species either did not vary with seed age or showed some interannual variation but with no obvious directional trend.
- Eighteen of the 25 species showed at least 30% mean germination without complicated germination triggers. A few species (e.g., *Achillea millefolium*, *Bromus carinatus, Navarretia squarrosa,* and *Prunella vulgaris*) had >70% germination.
- These species-specific results indicate a necessity to test all available seed stock when possible to ensure best seed management and increase restoration success. If this is not feasible, seed should be used within a couple years post collection, as a majority of the California native species tested show a decrease in percent germination over time.

Non-chemical methods of the reduction of exotic plant cover and facilitation of native coastal prairie and scrub restoration

A major challenge to restoring California coastal prairie and sage scrub ecosystems is controlling invasive exotic species. Senior thesis student, Zachary Sieburt, collected data on the second year of an experiment comparing three treatments for controlling exotic species, which included (1) applying black plastic tarp for 6 weeks following the first rains and prior to native species planting to kill recently germinated seedlings, (2) applying cardboard mulch recycled from a local bike shop immediately prior to planting, and (3) applying paper mulch purchased from a local supplier immediately prior to planting. Each treatment was replicated four times. Wood mulch was applied to all plots at the time of planting with 12 native species (four species each of shrubs, forbs, and grasses) in January 2017. Mr. Sieburt collected data on the survival and cover of native planted species, as well as total cover of exotic grasses, exotic forbs, mulch, and thatch. The main results and recommendations are listed below.

- There was no significant treatment effect on survivorship of individual planted native species or on total cover of native species, exotic grasses, or exotic forbs, which is likely because wood mulch was applied in all treatments.
- Cover of two of the 12 planted species, *Elymus glaucus* and *Horkelia californica* were higher in cardboard than the other two treatments.
- Since the costs and outcomes of the different treatments were similar and cardboard was much more logistically challenging to implemented, paper and wood mulch seem like the most practical combination of treatments to provide short-term control of invasive exotic species at the time of native plant establishment. Moreover, the paper mulch is biodegradable and can be applied at the time of planting.

<u>Management Recommendations:</u>

At their 2018 meeting, SAC members discussed the outcome of the SRP for Phase 1A and 1B of restoration and goal setting/planning for the SRP for Phase 2 of restoration.

SRP Phase 1 Implementation Summary

The SRP for Phase 1A of restoration (first 7 years) was approved by the CCC in September 2010 (NOID 3, 10-2). The SRP for Phase 1B of restoration (upper terrace wetland work) was approved by the CCC in July 2013 (NOID 6, 13-1). Phase 1A projects included Priority 1 weed removal, re-vegetation, baseline monitoring and selection of reference systems. Phase 1B projects included work in wetland areas, including the reconnection of upper terrace wetlands 1 and 2. Both Phase 1A and Phase 1B of restoration are now complete.

Over the past seven years, Younger Lagoon Reserve has successfully implemented Phase 1 of the Specific Resource Plan for the Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve. Nearly all Priority 1 weeds have been eliminated from the Terrace Lands. Over ten acres have been planted with native species. Nearly all of those plantings are meeting or exceeding their success criteria targets. Upper terrace wetland reconnection work has been completed. In addition, teaching, research, and public service was incorporated into every aspect of SRP Phase 1 implementation. (See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016 and 2016-2017 Annual Reports).

A detailed summary report for Phase 1 of restoration is included in Appendix 6.

SRP Phase 2

The SRP for Phase 2 of restoration (second seven years) will follow the same success criterial for each of the reserve's habitat types, and will encompass approximately 8.5 acres of restoration in the middle terrace. The SRP for Phase 2 of Restoration is included in Appendix 7.

Photo Documentation

Photo point locations were established at ten locations within YLR. These locations were chosen to ensure coverage of all major areas on the Terrace. Photos were taken on May 8, 2018. At each photo point we collected the following information:

1. Photo point number
2. Date
3. Name of photographer
4. Bearing
5. Camera and lens size
6. Coordinates
7. Other comments

Photos are included in Appendix 4.

Restoration Activities

Restoration activities continued on the Terrace area of YLR and throughout the lagoon portion of the Reserve. Implementation was conducted largely by undergraduate students and community volunteers; thus, utilizing the reserve in a manner consistent with the programmatic objectives (facilitating research, education, and public service) of the University of California, Natural Reserves as well as leveraging funding to increase restoration work. Here we summarize some of the restoration activities that occurred on YLR during the past year.

Figure 1. Volunteers and undergraduate student interns spread mulch in preparation for native planting.

Priority One Weed Removal

Under the SRP, all priority-one weeds (Ice plant, Jubata grass, Monterey cypress, Cape Ivy, Panic veldgrass, Harding grass, French Broom and Monterey Pine) are to be controlled as they are detected throughout the Terrace Lands. Elimination of reproductive individuals is the goal; however, YLR is surrounded by priority-one weed seed sources and it is likely that there will always be a low level of priority-one weeds persisting on the terrace. In FY 2017-2018, reserve staff conducted weed patrols of the entire terrace, continued removing ice plant from the coastal bluffs, removed all Jubata grass re-sprouts from the terrace, removed all French Broom re-sprouts from the terrace, and removed all Cape Ivy re-sprouts from the west arm of the lagoon. In FY 2018-2019, reserve staff will continue weed control projects and patrols. Due to the long-lived seed bank of French Broom, proximity of mature Jubata grass and Panic veldgrass on adjacent properties, and known ability of Cape Ivy fragments to re-sprout, regular patrols and maintenance of these sites will be critical. Removal of new recruit Monterey Pine and Cypress will continue as will targeted removal of current individuals.

<u>Seed Collection and Plant Propagation</u>

In the summer and fall of 2017, reserve staff consulted with local experts to determine appropriate seed collection sites and collected seeds for restoration growing. These seeds were collected by YLR staff and student interns and propagated by the UCSC Teaching Greenhouse in the fall and winter of 2017/2018.

<u>Restoration Planting</u>

In FY 2017-2018, approximately 2 acres of upland areas including northern coastal scrub habitats and coastal terrace prairie were planted with native seedlings (Figure 1 and Figure 2).

Figure 2. 2018 Restoration Sites.

Education

Instructional use at Younger Lagoon Reserve continued to increase this year. Courses encompassed a wide variety of disciplines. The increase in course use is a direct result of having fulltime staff on site that are able to actively engage faculty and students through outreach efforts in the classroom as well as providing on-the-ground assistance in teaching activities. The proximity of Younger Lagoon to the campus enables faculty and students to easily use the Reserve for a wide variety of instructional endeavors ranging from Restoration Ecology to Animal Tracking.

Undergraduate Students – Providing hands-on learning opportunities for future leaders

YLR's proximity to the UCSC Campus and Long Marine Laboratory make it an ideal setting for undergraduate teaching and research (Figure 2). In FY 2017-2018 the reserve hosted classes in Coastal Field Studies, Ecology, Marine Ecology, Entomology, Freshwater Ecology, Ornithology, Invertebrate Zoology, Molecular Ecology, Restoration Ecology, Ecological Field Methods, Systematic Botany of Flowering Plants, Plant Physiological Ecology, Ecology and Conservation Supercourse, College 8 Service Learning Practicum, Freshwater / Wetland Ecology, and Animal Tracking (Table 1).

Figure 3. Dr. Michael Loik and students from *ENVS 162/L - Plant Physiological Ecology/Lab* in the field.

Internships and Senior Theses

In FY2017-2018, YLR staff sponsored over 70 undergraduate interns through the UCSC Environmental Studies Internship Office (Figure 3). The students ranged from entering freshman to graduating seniors and spent between 6 and 15 hours a week working on on-going restoration projects at the reserve. These projects included invasive species removal, re-vegetation with native species, seed collection, and propagation. Student-interns report a deep appreciation for the opportunity to obtain hands-on experience in their field of study.

Figure 4. Undergraduate student interns propagate native restoration seedlings at the UCSC Thimann Greenhouse.

Table 1. Younger Lagoon Courses

Course Title	Institution (Department)	Instructor's Name
BIO 11C - Ecology	Cabrillo Community College	Eva Salas
ENVS 189 – Coastal Field Studies	San Jose State University	Rachel Lazzeri-Aerts
BIOE 107 – Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	James Estes
BIOE 108 – Marine Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Roxanne Beltran
BIOE 117/L – Systematic Botany of Flowering Plants	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Kathleen Kay
BIOE 121/L – Ornithology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Bruce Lyon
BIOE 122/L - Invertebrate Zoology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Baldo Marinovic
BIOE 137 – Molecular Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Beth Shapiro
BIOE 151ABCD/ENVS109ABCD – Ecology and Conservation in Practice Supercourse	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology and Dept. of Environmental Studies)	Don Croll and Gage Dayton
BIOE 155 - Freshwater Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Eric Palkovacs
CLEI 55 - College Eight: Service Learning Practicum	University of California, Santa Cruz (College Eight)	Susan Watrus
CLEI 55 - Sustainability Internship	University of California, Santa Cruz (College Eight)	Susan Watrus
ENVS 15 – Natural History of the UCSC Campus	University of California, Santa Cruz (Dept. of Environmental Studies)	Ryan Carl

ENVS 104A/L - Environmental Field Methods (Summer)	University of California, Santa Cruz (Dept. of Environmental Studies)	Josie Lesage
ENVS 160 - Restoration Ecology	University of California, Santa Cruz (Dept. of Environmental Studies)	Karen Holl
ENVS 162/L - Plant Physiological Ecology/Lab	University of California, Santa Cruz (Dept. of Environmental Studies)	Michael Loik
ENVS 167 - Freshwater / Wetland Ecology	University of California, Santa Cruz (Dept. of Environmental Studies)	Katie L Monsen
ENVS 83 / 183 - Younger Lagoon Reserve Stewardship Interns	University of California, Santa Cruz (Dept. of Environmental Studies)	Tim Brown
ENVS 84 / 184 - Younger Lagoon Reserve Stewardship Interns	University of California, Santa Cruz (Dept. of Environmental Studies)	Tim Brown
OPERS Animal Tracking class	University of California, Santa Cruz (OPERS)	Chris M Lay
Dorris Duke Conservation Scholars Program	University of California, Santa Cruz (Dorris Duke Conservation Scholars Program at UCSC)	Erika Zavaleta

Research

Due in part to its relatively small size and lack of facilities, YLR is unlikely to host many single-site research projects in biology or ecology. However, as one of the few remaining coastal lagoons in California, YLR is well suited to act as one of many research sites in a multi-sited project. Additionally, the close proximity to campus makes it an ideal place for faculty to conduct pilot and our small-scale studies as well as for undergraduate research opportunities. In FY 2017-2018 we approved seven research applications. Examples and summaries of new and ongoing research are included below.

Faculty Research Highlight: Evolution of the Threespine Stickleback

Natural selection is important for organisms to adapt to their environment. When environments change, selection may also. Professor Eric Palkovacs and graduate student Ben Wasserman are exploring whether fluctuating selection can maintain genetic diversity, unlike directional selection, which reduces diversity but increases fitness using the threespine stickleback inhabiting Younger Lagoon.

Typically, anadromous populations of threespine stickleback are covered in a continuous row of bony armor plates (20 or more) but freshwater resident populations have few plates (10 or less). This phenotype is known to be determined primarily by which copy of a single gene *Ectodysplasin-A* (*Eda*) the individual has. In the ocean, marine predators select for high plate counts (and *C* alleles), whereas in freshwater it is believed that the energetic cost means that low plate counts (and *L* alleles) are selected for since the strength of selection from predators is less or absent.

In Younger Lagoon and other seasonally closed estuaries in California, stickleback may experience freshwater-style selection for low plate counts during the summer months when the estuary is separated from the ocean and there are no fish predators, but experience marine selection for high plate counts following the estuary breach, when their data show that most individuals are released into the ocean (Figure 4). Palkovacs and Wasserman have collected threespine stickleback from Younger Lagoon every month starting in February of 2014. By counting the plates and determining which copies of the *Eda* gene these individuals have, they can determine how the strength of selection changes over time, and whether both copies of the *Eda* gene can persist in the population over time.

Since their study includes both historic high- and low-rainfall years, they can determine the range of fluctuation over which persistence of allelic diversity is possible. As climate change alters the frequencies of different types of rain years, they might even be able to predict what type of climatic conditions would lead to the loss of genetic diversity.

So far, Palkovacs and Wasserman have tested whether fluctuations in natural selection due to seasonal environmental shifts can function to maintain genetic diversity in a system where stable selection would drive a population to fixation. In threespine stickleback inhabiting intermittently ocean-connected estuaries, they found that traits associated with freshwater and marine residency fluctuate seasonally as predicted. Palkovacs and Wasserman have completed field collections, taken most of the trait measurements, and started the genotypic data collection. They hope to have answers to their questions about the importance of different drivers of interannual variability in future years.

Figure 5. Lagoon breach 2018.

Faculty Research Highlight: Institute for the Study of Ecological and Evolutionary Climate Impacts (ISEECI) Drought Experiment

Several UC Natural Reserve sites in California are participating in the International Drought Experiment. The experiment is compliant with the *DroughtNet* protocol for comparison to 100 other sites worldwide (drought-net.org). Effects of drought on plant growth and biodiversity are being measured at a number of grassland and shrubland sites along a north-south and coastal-inland gradient in California. At UCSC, professors Michael Loik, Kathleen Kay, and Karen Holl are collaborating with graduate student Justin Luong on this project.

The UCSC Drought Experiment was built with support from the Institute for the Study of Ecological and Evolutionary Climate Impacts (ISEECI) during 2015 at three sites including Younger Lagoon UC Natural Reserve, the UCSC Arboretum, and the UCSC Campus Natural Reserve. The main goal of the experiment is to better understand how long-term drought affects which plant species grow, and by how much, in California coastal prairie. The UCSC Drought Experiment sites span an elevation gradient of about 300 m with changes in rainfall, temperature, and fog. Fog-collectors are co-located with shelters at each site. Initial plot establishment made up the laboratory section activities for ENVS 162/L Plant Physiological Ecology at Younger Lagoon, the Arboretum, and the Campus Natural Reserve during Spring 2015.

Effects of soil water on species composition and productivity will be compared for invaded grassland with 60% rainfall removal, and for ambient, invaded coastal prairie grassland ("control"; no rainfall shelters). At Younger Lagoon, Loik et al. are also conducting experiments with a restoration context by comparing effects of drought on planted native seedlings in comparison to planted native seedlings with 60% rainfall removal. Loik et al. also have water addition plots available for experiments. There are n = 5 plots per treatment. Size = 2 X 2 m, with a 1 m buffer around the 4 m^2 square plot.

Shelter construction commenced in July 2015. Plots were trenched to 50 cm deep and lined with 6 mil plastic to prevent lateral water flow and root encroachment. Shelters were initially constructed of lightweight metal and rainfall is intercepted using clear, v-shaped polycarbonate troughs. In 2017, the shelters were rebuilt using wooden posts. Rainfall interception commenced during the first significant rainfall between 2 -3 November 2015. With *ISEECI* support, Loik et al. began to automatically monitor soil moisture and temperature, as well as air temperature and relative humidity near the ground under the shelters in 2016.

Figure 6. Undergraduate students visit the experimental *DroughtNet* shelters.

During 2018, the drought experiment activities at YLR focused on: 1. Continued measurements of monitoring of plots in accordance with the International Drought Experiment protocol; 2. Continued collection of micrometeorological data from a sensor system set up in a prior year; 3. Continued monitoring of survival and species-specific growth with an additional measurement of aerial cover of California native plant seedlings as well as composition of species cover under drought, control and watering treatments; and 4. Measurement of plant functional traits including specific leaf area, leaf thickness, carbon:nitrogen ratios and carbon and nitrogen isotopes for eight native California plant species. Highlights for each are summarized below.

<u>1. Measurements and monitoring of plots in accordance with the International Drought Experiment protocol</u>

Loik and Luong measured aboveground net primary productivity (ANPP) and plant diversity of IDE drought shelter and control plots at YLR, as well as at the UCSC Arboretum and UCSC Campus Reserve lands at Twin Gates. These data represent year three of the IDE treatment. Loik and Luong's early analyses suggest a "reverse shelter" effect at YLR for winter 2017, for which plants under shelters grew more than plants in control plots. Loik and Luong are currently analyzing data from 2015 – 2017 as part of the IDE cross-site study.

2. Continued monitoring of the micrometeorological conditions on control and drought plots.
Loik and Luong continued monitoring air and soil temperature (two depths), soil moisture (two depths), photosynthetically active radiation, solar radiation, relative humidity, and fog interception at 30 minute frequency. Loik and Luong monitored conditions below rain interception shelters as well as on open control plots. Some of these data will be used for some of the first manuscripts from the drought project at YLR. Loik and Luong also have sensors on plots with planted native seedlings under rain-out shelters and control (open) plots.

3. Continued monitoring of survival and growth of California native plant seedlings under drought, control and watering treatments
This work was started by Professor Kathleen Kay, Ecology and Evolution, UC Santa Cruz in 2016 and is being continued by Justin Luong, Environmental Studies, UC Santa Cruz. Seedling survival and species-specific growth measurements have been conducted annually. In addition, Luong has begun measurements of aerial cover for all surviving native California seedlings, and monitoring the composition of plant species cover recorded within all 15 plots planted with native California seedlings.

4. Measurements of plant functional traits of eight native California plant species
In order to better understand the effects of drought on the establishment of native California plants, Loik and Luong tested for effects of the drought shelters on the California native plant seedlings within the restoration drought experiment (described in section 3) at YLR, started in 2016. Focal species include: *Stipa pulchra*, *Bromus carinatus* (Poaceae), *Sidalcea malviflora* (Malvaceae), *Mimulus aurantiacus* (Scrophulariaceae), *Artemisia californica*, *Achillea millefolium* (Asteraceae), *Eschscholzia californica* (Papaveraceae), and *Sisyrinchium bellum* (Iridaceae). Loik and Luong collected leaf samples in order to measure drought specific functional traits: specific leaf area (leaf area ÷ oven dried weight), leaf thickness, leaf carbon:nitrogen (CN) ratios and $\delta^{13}C$ to determine water use efficiency. Loik and Luong hypothesize that the planted seedlings that have survived to 2018 will have functional traits that

confer drought tolerance, such as low specific leaf area, high leaf strength, high vein length per unit area, and low water use efficiency [measured via $\delta^{13}C$]. Survival, cover and species composition data have been analyzed, while leaf functional traits such as leaf thickness, specific leaf are, elemental and isotope analyses are currently being processed.

Thus far, Loik and Luong's results show that the twelve native plant species selected for restoration likely are adapted to drought, as the majority of species show no significant differences in species-specific growth, cover or survival. However, there are exceptions; for example, *E. californica* was shown to have lower cover in shelter treatments. Conversely, *S. malviflora* were found to benefit in survivorship from the shelter treatment, further indicating their potential drought resistance. Interestingly, *S. pulchra* was found to have greater survival when given water for establishment in the first year of planting, even as they are known to be slower competitors for resources like water compared to common extant invasive species such as *Avena barbata* or *Raphanus sativus*. In terms of growth, *A. millefolium* and *S. pulchra* were both found to have greater cover in shelter plots. Additionally, *A. millefolium* was found to have greater spreading distance in shelter treatments.

Results suggest that watering in the first year to increased establishment could be beneficial for some native species such as *S. pulchra* but irrelevant to the survival of most. Combined with the community composition results, Loik and Luong suspect that native species with greater growth in shelter plots are experiencing competitive release, as shelter plots were found to have less exotic grasses and exotic forbs. Shelter plots also had less thatch, which could have potentially affected plant growth. Further experiments are needed to determine whether differences are caused by release from direct competition for water, or due to alternations in local nutrient cycling based on varying thatch depth and cover. The addition of results from ongoing functional trait analyses will further illuminate the importance between different drought adaptations, as no clear patterns are seen at this time. If there is no correlation between drought functional traits and survival or growth, differences would likely be due to competitive release.

Undergraduate Research Highlights

Undergraduate Madison Ginn completed a senior thesis, entitled 'Mixed effects of multi-year storage on germination of California native species' with the UCSC Natural Reserves in June

2018. Ginn worked closely with Reserve Director, Elizabeth Howard, Restoration Steward Tim Brown, Graduate Student Josie Lesage and Faculty Advisor Karen Holl to ensure that her results and recommendations would influence future restoration and management activities.

Public Service

Public service use at Younger Lagoon Reserve continued to increase this year. Public service users encompassed a wide variety of groups. The increase in public service use is a direct result of having fulltime staff on site that are able to actively engage public groups through outreach efforts as well as providing on-the-ground assistance in public service activities. The proximity of Younger Lagoon to the town of Santa Cruz enables members of the public to easily use the Reserve for a wide variety of approved endeavors ranging from birding to K-12 teaching.

Monterey Bay Aquarium Watsonville Area Teens Conserving Habitats (WATCH) Program

YLR's proximity to the urban center of the city and county of Santa Cruz make it an ideal setting for public service. In FY 2017-2018 the reserve continued its partnership with the Seymour Marine Discovery Center (SMDC) and the Monterey Bay Aquarium Watsonville Area Teens Conserving Habitats (WATCH) program. WATCH is a program offered only at Pajaro Valley, Watsonville and Aptos high schools in Watsonville, California. This year-long program begins in the summer and extends throughout the school year. During the two-week summer component, students explore the Pajaro River Watershed and Younger Lagoon Reserve, meet with local scientists and participate in inquiry-based learning. They also learn about environmental issues in their community and participate in local restoration efforts. After the summer, the same students enroll in a WATCH science class at their high school and develop their own field research project based on an environmental topic at either Elkhorn Slough (Pajaro Valley and Watsonville High Schools) or Younger Lagoon Reserve (Aptos High School). Students visit their field sites once a week for ten weeks in the fall to collect data, and work during the winter and spring to analyze, write-up, and present their data (Figure 5). They work with Monterey Bay Aquarium staff and teachers, SMDC staff, YLR staff and undergraduate interns, as well as scientists and educators from the community to complete their projects. Upon completion of the projects, students receive a scholarship and community service hours needed for graduation.

Figure 7. WATCH program participant explores the lagoon.

Reserve Use

The greatest educational user group for YLR in FY 2017-2018 was once again undergraduate education, a breakdown of all user groups is included in Table 2. YLR was used by UC Santa Cruz, UC Santa Barbara, CSU Monterey Bay, CSU San Jose, University of Utah, Cabrillo College, Aptos High School, Half Moon Bay High School, Pacific Collegiate School, Pajaro Valley High School, Watsonville High School, California Academy of Sciences, Land Trust of Santa Cruz County, Seymour Marine Discovery Center, Santa Cruz Bird Club, Audubon California, and several local and regional volunteer groups (Table 3).

Table 2. Younger Lagoon Total Use

RESERVE USE DATA
Period from July 1, 2017 to June 30, 2018

University of California, Santa Cruz
Younger Lagoon Reserve

	UC Home Users	UC Home Days	UC Away Users	UC Away Days	CSU System Users	CSU System Days	CA Com'ty. Colleges Users	CA Com'ty. Colleges Days	Other CA Colleges Users	Other CA Colleges Days	U.S. Colleges Users	U.S. Colleges Days	Int'l Colleges Users	Int'l Colleges Days	Gov't Users	Gov't Days	NGOs Users	NGOs Days	For-Profit Business Users	For-Profit Business Days	K-12 Schools Users	K-12 Schools Days	Others Users	Others Days	TOTALS Users	TOTALS Days
UNIVERSITY-LEVEL RESEARCH																										
Faculty	7	83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	83
Research Assistant	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Graduate Student	5	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	101
Undergraduate Student	30	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	412
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	120	5	120
SUB-TOTALS	42	596	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	120	48	720
UNIVERSITY-LEVEL CLASSES																										
Faculty	12	24	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	27
Research Scientist	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Graduate Student	44	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	85
Undergraduate Student	635	2219	0	0	22	22	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	707	2341
Professional	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6
SUB-TOTALS	694	2333	0	0	23	23	51	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	774	2464
PUBLIC SERVICE																										
Faculty	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Research Scientist	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Graduate Student	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
Undergraduate Student	107	107	0	0	0	0	0	0	0	0	11	22	0	0	0	0	0	0	0	0	0	0	0	0	118	129
K-12 Instructor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	0	197	199	0	0	199	204
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	76	0	0	56	76
Professional	7	13	0	0	0	0	0	0	0	0	1	2	0	0	1	1	5	21	0	0	0	0	1	1	15	38
Other	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	0	0	0	0	1687	2387	1708	2422
Docent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	40	40	40
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	255	255	260	260
SUB-TOTALS	137	143	1	1	0	0	0	0	0	0	12	24	0	0	1	1	8	41	0	0	258	280	1983	2683	2400	3173
TOTALS:	**873**	**3072**	**2**	**5**	**23**	**23**	**51**	**102**	**0**	**0**	**12**	**24**	**0**	**0**	**1**	**1**	**8**	**41**	**0**	**0**	**258**	**280**	**1994**	**2809**	**3222**	**6357**

*Other includes members of the public who took the SMDC's daily tour. All daily tours in FY 2017-2018 visited the Younger Lagoon / Marine Mammal Overlook. We include 10% of the total number of SMDC daily tour participants in our reserve-use estimate.

Table 3. Younger Lagoon Group Affiliations

University of California Campus	**Non-governmental organizations**
University of California, Santa Barbara	Audubon Society
University of California, Santa Cruz	Bird School Project
	California Academy of Sciences
California State Universities	Land Trust of Santa Cruz County
California State University, Monterey Bay	Monterey Bay Aquarium WATCH Program
California State University, San Jose	
	Santa Cruz Bird Club
California Community College	Seymour Marine Discovery Center
Cabrillo Community College	Watsonville Wetlands Watch
Universities outside California	**Governmental Agencies**
University of Utah	California State Parks
	Volunteer Groups
K-12 system	UCSC Wilderness Orientation
Aptos High School	
Half Moon Bay High School	
Pajaro Valley High School	
Watsonville High School	

Summary

FY 2017-2018 was a successful year for YLR. The reserve continued to move forward with restoration, initiated new projects, strengthened collaborations, and developed new relationships. The increase in student and course use is a direct result of having superb staff on sight that are actively engaged with students, faculty, and the public. In turn, we are able to achieve our mission of supporting education, research, and public education as well as meet the environmental stewardship obligations the University of California has committed to with the California Coastal Commission and the State of California in general. We look forward to continuing this exciting and important work in FY 2018-2019.

UCSC 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 systemwide 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 and two undergraduate students. 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

MEMBERSHIPS

Faculty Director of the Natural Reserve System	Don Croll Professor, Ecology & Evolutionary Biology Long Marine Lab, Center for Ocean Health (831) 459-3610 – croll@biology.ucsc.edu
Younger Lagoon Reserve Faculty Advisor	Karen Holl Professor, Environmental Studies Environmental Studies Department (831) 459-3668 – kholl@ucsc.edu

Año Nuevo Reserve Faculty Advisor	Daniel Costa Professor, Ecology & Evolutionary Biology Long Marine Lab, Center for Ocean Health (831) 459-2786 – costa@biology.ucsc.edu
UCSC Campus Reserve Faculty Advisor	Greg Gilbert Professor, Environmental Studies Environmental Studies Department (831) 459-5002 – ggilbert@ucsc.edu
Fort Ord Reserve Faculty Advisor	Laurel Fox Professor, Ecology & Evolutionary Biology Coastal Biology Building (831) 459-2533 – fox@biology.ucsc.edu
Landels-Hill Big Creek Reserve Faculty Advisor	Peter Raimondi Professor, Ecology & Evolutionary Biology Long Marine Lab, Center for Ocean Health (831) 459-5674 – raimondi@biology.ucsc.edu
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	Alex Jones, MS – Manager Campus Natural Reserve Natural Sciences II, Rm 465

Joe Miller -- Field Manager
Fort Ord Natural Reserve
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831-459-4971—jotmiller@ucsc.edu

Younger Lagoon Reserve Scientific Advisory Committee (SAC)

Charge

As outlined in the in the CLRDP, restoration, enhancement, and management activities on the Marine Science Campus will be guided by a Scientific Advisory Committee (SAC) that is made up of independent professionals and academicians experienced in and knowledgeable about the habitats of the natural areas on the Marine Science Campus. The SAC shall guide the development of Specific Resource Plans, which shall be consistent with the performance standards set forth in the Resource Management Plan (RMP), and which may be adapted periodically based on findings from ongoing restoration work. The RMP goals and performance standards may be adjusted as directed by the SAC in coordination with the Executive Director to ensure the success of Campus restoration, enhancement, and management efforts. As such, the RMP goals and performance standards are not static requirements per se so much as initial guidelines that may be refined during the SAC process so long as such refinement is consistent with current professional restoration, enhancement, and management goals and standards, and with achieving high quality open space and natural habitat area in perpetuity consistent with this CLRDP. RMP adjustments in this respect may require a CLRDP amendment, unless the Executive Director determines that an amendment is not necessary.

The committee provides guidance for the restoration, enhancement, and management efforts at YLR, and collaborates with YLR staff on the creation and implementation of the Specific Resource Plan as outlined in CLRDP Implementation Measure 3.2.10 (below).

Implementation Measure 3.2.10 – Natural Areas Habitat Management. *Within six (6) months of CLRDP certification, the University in consultation with the Executive Director of the California Coastal Commission shall convene a scientific advisory committee (SAC) to guide the restoration, enhancement, and management of natural areas (i.e., all areas outside defined development zones, except for Younger Lagoon Reserve) on the Marine Science Campus (see Appendix A). Natural areas restoration, enhancement, and management may be completed in up to three phases corresponding to dividing the natural area into thirds (i.e., where Phase 1 accounts for at least one-third of the natural area, Phase 1 plus Phase 2 accounts for at least two thirds, and all of the three phases together account for all of the natural area). All restoration, enhancement, and management activities shall be guided by Specific Resource Plans developed by the University in accordance with the SAC and the criteria contained in the Resource Management Plan (Appendix A) and current professional standards for such plans. The SAC shall be responsible for guiding development of Specific Resource Plans and shall complete its work on the Specific Resource Plan for Phase I restoration and enhancement efforts within four (4) months of convening. The content of Specific Resource Plans shall be consistent with the performance standards set forth in Appendix A, which may be adapted periodically based on findings from ongoing restoration work. The University shall file a Notice of Impending Development for Phase I work within one (1) year of CLRDP certification. All natural areas restoration and enhancement shall be completed within 20 years of CLRDP certification, with interim benchmarks that at least one-third of the restoration and enhancement shall be* *completed within seven years of CLRDP certification and that at least two-thirds shall be completed within 14 years of CLRDP certification.*

The SAC was seated in January 2009. In addition to the chair, membership of the committee is comprised of three independent professionals and academicians experienced in and knowledgeable about the habitats of the natural areas on the Marine Science Campus. Brief bios of the four SAC members are below.

Dr. Karen Holl- Professor, Environmental Studies, University of California at Santa Cruz (UCSC).

Dr. Karen Holl has been on the faculty in the Environmental Studies Department at the University of California, Santa Cruz for over 15 years. She has conducted research on restoration ecology in a wide variety of ecosystems, including tropical rain forests, eastern hardwood forests, chaparral, grassland, and riparian systems in California. She has published over 50 journal articles and book chapters on restoring damaged ecosystems and is on the editorial board of the journal Restoration Ecology. She teaches the Restoration Ecology class at UCSC and supervises many of the undergraduate students who work on the UCSC Natural Reserves. She regularly advises numerous public and private agencies along the Central California Coast on land management issues. She recently was selected as an Aldo Leopold Leadership Fellow. Dr. Holl's expertise in restoration ecology, experimental design and data analysis, as well as her affiliation with UCSC and her excellent rapport with University students and staff make her an irreplaceable member of the Scientific Advisory Committee.

Dr. Holl received a Ph.D. in Biology from Virginia Polytechnic Institute and State University, and a Bachelors degree in Biology from Stanford University.

Tim Hyland - Environmental Scientist, State Parks, Santa Cruz District.

Mr. Hyland has worked in the field of wildlands restoration for over 15 years. Much of his work has focused on coastal scrub, dune, and wetland restoration at sites throughout the Central Coast, including Wilder Ranch State Park (located approximately one mile west of YLR). He has extensive experience in restoration planning and implementation, vegetation mapping, exotic species control, and native plant propagation. In addition, Mr. Hyland is highly skilled in public education and outreach. His long tenure with California State Parks and direct experience in designing and implementing large-scale restoration projects make him a valuable member of the Scientific Advisory Committee.

Mr. Hyland has a B.A. from California Polytechnic State University, San Luis Obispo.

Bryan Largay – Conservation Director, Land Trust of Santa Cruz County.

Mr. Largay has worked in the fields of hydrology, water quality, and wetlands for fourteen years with a focus on restoration and wildlife habitat. He has conducted wetland restoration, watershed hydrology, and water quality investigations and designed measures to control erosion and treat water quality problems using vegetation. Much of his work has focused on collaborative water quality protection projects with agricultural landowners and growers. He has worked to solve water resource problems with a broad array of individuals, including scientists, planners, engineers, growers, private landowners, and contractors. Prior to joining the staff of The Land Trust of Santa Cruz County, he worked as the Tidal Wetland Project Director at Elkhorn Slough National Estuarine Research Reserve (ESSNER) and participated in the Tidal Wetland Project as a member of the Science Panel and Model Advisory Team. Mr. Largay's experience working on complex, large-scale restoration projects with agricultural neighbors in a non-profit setting make him a very important addition to the Scientific Advisory Committee.

Mr. Largay received an M.S. in Hydrologic Sciences at U.C. Davis, and a Bachelor's degree at Princeton University.

Dr. Lisa Stratton - Director of Ecosystem Management, Cheadle Center for Biodiversity and Ecological Restoration, University of California, Santa Barbara (UCSB).

Dr. Lisa Stratton has worked in the field of science-based restoration for over 15 years. She has extensive experience in restoration planning and implementation in conjunction with campus construction projects. Much of her work at UCSB has focused on involving students and faculty in the Cheadle Center's restoration projects. Dr. Stratton's work at the UCSB has provided her with a rare understanding of some of the unique challenges and opportunities YLR staff face as they undertake the restoration project at YLR. Her combined experience in wildlands restoration and management, scientific research, and working within the University of California system make her a very important member of the Scientific Advisory Committee.

Dr. Stratton received a Ph.D. in Botany and Ecology from the University of Hawai'i, a M.S. in Conservation Biology and Sustainable Development from the University of Wisconsin-Madison, and a Bachelors degree in Comparative Literature from Stanford University

Publications

Lesage, Josie, 2018. Compliance Monitoring Report for Coastal Prairie and Coastal Scrub Restoration Sites at Younger Lagoon Reserve, Spring 2018. Prepared for the California Coastal Commission and Younger Lagoon Reserve Scientific Advisory Committee, 2018.

Appendix 1. California Coastal Commission monitoring report

Younger Lagoon Reserve

Beach Monitoring Report

2018

***Watsonville Area Teens Conserving Habitats* (WATCH) *Program* Participants at Younger Lagoon**

Elizabeth Howard and Gage Dayton
Younger Lagoon Reserve

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Appendices

Overview and Executive Summary

In March 2010, the California Coastal Commission (CCC) approved the University of California's Notice of Impending Development Implementation for Implementation Measure 3.6.3 of the CLRDP (NOID 10-1). NOID 10-1 requires that (through controlled visits) the public have access to Younger Lagoon Reserve beach and that a monitoring program be created and implemented to document the condition of native flora and fauna within Younger Lagoon and its beach. The monitoring plan was to be implemented over a 5-year time period. At the end of the 5-year period (Winter 2015) results were to be compiled and included in a report that summarizes and discusses the potential effect of controlled beach access on flora and fauna at Younger Lagoon and submitted as a NOID to the CCC.

The campus began implementing the public access plan and monitoring program in spring 2010, and submitted the report on the results of the monitoring to the Coastal Commission in February of 2016 as part of the Younger Lagoon Reserve Annual Report. The campus submitted NOID 9 (16-2) Public Access to and Within Younger Lagoon Reserve to the California Coastal Commission (CCC) in December 2016. At the request of local coastal staff, the campus withdrew NOID 9 (16-2) resubmitted it as NOID 9 (17-1) in June 2017. The campus presented NOID 9 (17-1) at the July 2017 CCC and although CCC staff found the NOID consistent with the CLRDP, Commissioner Brownsey requested the University provide significantly more tours to the beach and that children be allowed for free. Younger Lagoon Reserve staff withdrew the NOID prior to a vote in order to better address Commissioner Brownsey's requests. Over the last year, Younger Lagoon Reserve staff have worked with Seymour Marine Discovery Center staff to design a pilot program to significantly increase the number of tours offered per year, increase tour capacity, and offer the tours free for children 16 and under. Per IM 3.6.3 of the CLRDP (NOID 10-1), the University plans to resubmit NOID 9 to the CCC in 2018.

This document serves as both a summary report for activities under NOID 10-1 that have taken place since our previous report at the end of fiscal year 2017 and a summary report for the entire 8-year monitoring program. All year's results are included. Data collected indicate that Younger Lagoon Reserve (YLR) supports a wide variety of native flora and fauna, provides habitat for sensitive and threatened species, supports a very unique beach dune community, and is extensively used for research and education. In general, in comparison to the other local beaches surveyed native plant species richness is greatest at YLR and Natural Bridges; however, there is quite a bit of annual variation among the sites. A parameter that we quantified in 2012, and is evident from visual observation and photo documentation, is the presence of dune hummocks and downed woody material at YLR, both of which are almost entirely absent at local beaches due to human use. These features provide habitat for plant species such as the succulent plant dudleya, which grow on downed woody material and dune hummocks at YLR, as well as burrowing owls that use burrows in hummocks and seek shelter beneath downed woody material at YLR. The relatively natural state of YLR beach and dune vegetation is unique among most pocket beaches in Santa Cruz County and likely represents a glimpse into what many of the pocket beaches in the greater Monterey Bay area looked like prior to significant human disturbance. Open access to the beach would likely result in the loss of the unique ecological characteristics of the site and certainly reduce its effectiveness as a research area for scientific study. Controlled beach access through the Seymour Center docent led tours, provides an appropriate level of controlled access that enables people to see and learn about the lagoon habitat while limiting impacts to the system. We recommend that this continue.

Although only required to monitor the YLR beach, YLR staff, faculty, and the Scientific Advisory Committee decided to monitor nearby beaches with varying levels of use (Natural Bridges and Sand Plant Beach) during the first 5-year period in order to examine differences in the flora, fauna and use among the three sites. This effort required hundreds of hours of staff and student time, as well as coordination with State Parks staff. As reported in the 2015 YLR Beach Monitoring Report, beginning in the summer of 2015 and moving forward, YLR staff will continue to monitor YLR as required in IM 3.6.3; however, we will no longer monitor at Natural Bridges State Beach or Sand Plant Beach as the previous 5 years of data collection have provided us with adequate information to assess beach resources.

Introduction

Over 50 years ago, the University of California Natural Reserve System (UCNRS) began to assemble, for scientific study, a system of protected sites that would broadly represent California's rich ecological diversity. Today the UC Natural Reserve System is composed of 39 reserves that encompass approximately 750,000 acres of protected natural land available for university-level instruction, research, and public service. The University of California Natural Reserve System supports research and education through its mission of contributing "*to the understanding and wise management of the Earth and its natural systems by supporting university-level teaching, research, and public service at protected natural areas throughout California*." By creating this system of outdoor classrooms and laboratories and making it available specifically for long-term study and education, the NRS supports a variety of disciplines that require fieldwork in wildland ecosystems. UC Santa Cruz administers four UC Reserves: Younger Lagoon Natural Reserve, Año Nuevo Island Reserve, Landels-Hill Big Creek Reserve, and Fort Ord Natural Reserve.

The objective of the beach monitoring program is to document the presence and distribution of flora and fauna within Younger Lagoon Natural Reserve (YLR) and to evaluate changes in distribution and density over time. Additionally, YLR staff decided to monitor nearby beaches with varying levels of use (Natural Bridges and Sand Plant Beach) in order to examine differences in the flora and fauna among the three sites. Importantly, the data collected in this study provides a quantitative assessment of various attributes (species composition, abundance, etc.) but it is realized that the sites vary significantly from one another and that there is no replication. Thus, although these data comparisons are informative there are significant constraints that make meaningful statistical comparisons between the sites impossible. As such, results shouldn't necessarily be used to create strict prescriptions.

This report is a report for activities under NOID 10-1 during Fiscal Year (FY) 2017-2018 (July 1, 2017 – June 30, 2018) which surveyed YLR. In addition, because of the upcoming NOID resubmission, although we are no longer monitoring Natural Bridges and Sand Plant beaches, we have included all year's results from all sites in this report in order to show the entire effort to date. Data for each monitoring objective have been added to previous year's data; thus, the results for this reporting period have been combined with all previous findings. As a result, this report provides a running summary of our findings starting from the inception of the study and running through the end of FY 2017-2018.

Younger Lagoon Access History

History of Public Access to Younger Lagoon Beach

Prior to 1972, Younger Beach was privately owned and closed to the public. The owners (Donald and Marion Younger) actively patrolled for, and removed, trespassers from their property, including the beach. In 1972, the Younger Family donated approximately 40 acres of their property to the University of California for the study and protection of the marine environment. These lands included Younger Lagoon and Beach (approximately 25 acres), and an adjoining parcel of land (approximately 15 acres) which became the site of the original Long Marine Laboratory (LML). At the time of their donation, Donald and Marion Younger intended that the lagoon, beach and surrounding slopes be protected in perpetuity by the University as a bird sanctuary.

In the years between the donation of the property and the start of LML construction (1976), the University leased the future LML site back to farmers who had been farming the property for the Younger family prior to the donation. During those years, the same no trespassing rules for the beach were enforced as they had been when the property was owned by the Younger family.

Once construction of LML began in 1976, the land was no longer under the watch of the farmers, and public pressure on the beach began to increase. Many Santa Cruz locals remember the next several years at Younger Beach fondly as it became a popular nude beach. The increased public access had a noticeable impact on the flora and fauna of the beach, and was not in accordance with the intention of the original donation by the Younger family. By 1978 discussions had begun between the University and the California Coastal Commission regarding the impact of uncontrolled public access to the beach. In 1981, it was decided that the impacts to Younger Beach were significant and the California Coastal Commission, under coastal permit P-1859, closed uncontrolled access to the beach.

After the approval of coastal permit P-1859, the University began to actively patrol the beach for trespass, educate the public about the closure, and use the site for research and education. After YLR was incorporated into the UCNRS in 1986, users were required to fill out applications, or contact NRS staff, for specific research, education, or outreach efforts. As the LML campus grew, a protective berm and fencing were constructed around the perimeter of the lagoon, and informational 'beach closed' signs were posted on the cliffs above the beach. Over time, trespass decreased and the reduced public access had a noticeable positive impact on the flora and fauna of the beach.

Public access to YLR beach came to the forefront again during the CLRDP negotiation process (2000-2008). At the time negotiations began, YLR supported a rich composition of plant and animal species despite being surrounded by agricultural and urban development. Reserve staff were concerned that any increase in public access could threaten the already heavily impacted habitat. At the time of CLRDP certification (2010), all parties agreed to the Beach Access Management Plan outlined in NOID 10-1. Under the Beach Access Management Plan, the YLR beach remains closed to unsupervised public access and the reserve is implementing a management and monitoring plan that includes docent-guided tours.

Because of the importance of maintaining a natural and pristine environment (Figure 1) and protecting scientific studies and equipment, uncontrolled access to YLR is not allowed. Uncontrolled use of YLR is likely to have a negative impact on native coastal flora and fauna that inhabit the reserve, hamper research endeavors, and impact the area for future scientific and educational endeavors. Rather than an open public access policy, users are required to fill out applications, or contact NRS staff, for specific research, education, or outreach efforts. In 2010 YLR began hosting docent-guided tours that are offered by the Seymour Marine Discovery Center (Seymour Center).

Beach Access Tours

From 2010 - 2017, docent-led beach tours were offered twice monthly through the Seymour Marine Discovery Center (Seymour Center). In addition, all of the docent led daily tours run by the Seymour Center (approximately 1,500 tours annually) include an informational stop about YLR that includes visual access to the beach. In October 2017, in an effort to meet Commissioner requests to increase the number of tours, Younger Lagoon Reserve staff met with Seymour Center staff to discuss the potential of providing more tours. Seymour Center staff analyzed historic tour data and identified those months during which tour demand had been met or exceeded (October-February), and those months during which there was higher demand (March-September). Based on these data, beginning in January 2018, we conducted a pilot program with the Seymour Center and began offering tours twice a month during the slower fall and winter months (October-February), and four times a month during the busier spring and summer months (March-September). The total number of tours offered in 2018 was increased from 24 to 38 (offering approximately 60% more tours). Moving forward, the Seymour Center will continue to offer tours between two and four times per month (depending on the season and demand), with the goal of continuing to offer at least 38 tours per year (depending on weather, docent availability, etc.), including tours on weekdays and on weekends.

The extent of the beach access area varies depending on tidal conditions and the location of plants, as foot traffic is only permitted seaward of the dune vegetation. Thus, the exact access area may vary slightly from the areas depicted in Figure 2 below and Figure 3.11 of the CLRDP. The trail provides an interpretive experience for visitors that begins with a narrative history of the UC Natural Reserve System (UCNRS), an overview of the lagoon, a walk through a restored coastal scrub habitat with opportunities to view the rear dune, and ends on the beach. Tours are led by Seymour Center docents trained in the natural history and ecology of YLR and provide detailed information about flora, fauna, geology, and the UCNRS. Tour curriculum, which was first presented to the Seymour Center docents during the regular winter docent-training program in 2010, focuses on the unique ecology of the YLR beach.

In addition to the docent-guided beach tours, visual access to the lagoon and back dune is provided to the public via a newly constructed overlook along McAllister Way. This overlook (Overlook E) is open to the public from dawn to dusk. Visual access to the Younger Lagoon beach and information about Younger Lagoon Reserve is also provided to all visitors taking the Seymour Center's docent-guided Reserved and Daily Tours via the Overlook C. Last year, nearly 15,000 visitors took these tours.

Public Education and Outreach Programming on the Coastal Science Campus

The YLR beach access tours are part of broader public education and outreach programming on the Coastal Science Campus offered through the Seymour Center.

Every year, over 60,000 people visit the Seymour Center. The Seymour Center provides marine science education to hundreds of classes, comprised of thousands of students, teachers, and adult chaperones from across the country. Many of the classes served come from schools classified as Title 1—schools with high numbers of students from low-income families. Scholarships are made available to Title 1 schools, making it possible for students to participate who would not otherwise have the opportunity to experience a marine research center. Teachers often incorporate the Seymour Center into their weeklong marine science field study courses.

In FY 2017-2018, The Seymour Center, Younger Lagoon Reserve and the Monterey Bay Aquarium continued their partnership supporting high school students in the Watsonville Area Teens Conserving Habitats (WATCH) program. WATCH students from Aptos High School designed and carried out field-based research projects in Younger Lagoon Reserve on topics including endangered fish, aquatic invertebrates, and birds. These students made repeated visits to the Reserve throughout the year. Find out more at: https://www.montereybayaquarium.org/education/teen-programs/watsonville-area-teens-conserving-habitats-watch

In April 2018, Younger Lagoon Reserve and the California Academy of Sciences partnered to host the third annual *Younger Lagoon Reserve Bioblitz.* A *bioblitz* is a community event that brings together a wide variety of people – citizen scientists - to rapidly inventory the living organisms found in a particular place. The *Younger Lagoon Reserve Bioblitz* was held during UCSC's Alumni Weekend, and was open to both alumni and members of the public. Participants explored the lagoon and beach areas as part of this event. A link to the event page can be found here:
https://www.inaturalist.org/projects/younger-lagoon-reserve-bioblitz-2018

Every year, dozens of children ages 7-14, enroll in weeklong summer science sessions known as Ocean Explorers. Students actively learn about and participate in marine research at the Seymour Center, and our associated Long Marine Laboratory, where participants work alongside marine mammal researchers and trainers. Participants gain experience with the scientific process, focusing on honing their observation and questioning skills. Ocean Explorers also investigate the coastal environment at field sites around Monterey Bay, including rivers and watersheds, sandy beaches, rocky intertidal areas, and kelp forests by kayak. Young participants generally come from Santa Cruz, Santa Clara, and San Mateo Counties. Full and partial scholarships are extended to low-income participants.

The Seymour Center actively promotes its activities with press releases and calendar listings throughout the region. Every year, traditional print ads are placed in newspaper and magazines. The Seymour Center's activities are also often covered in the local newspaper, the Santa Cruz Sentinel. Public radio ads run throughout the year on the NPR-affiliate, KAZU.

Coupons for discounted admissions are available in various formats. The most highly used program is through the many Bay Area municipal libraries. Called Discover and Go, hundreds of families from across the region utilize these discount coupons. The Seymour Center continued to connect with the public through Facebook, Twitter, Instagram, Pinterest, Flickr, and bi-monthly e-blasts.

While part of UC Santa Cruz, the Seymour Center must raise its ~$1.25 million budget annually (including all operating costs, salaries, and benefits). Earned revenue—admissions, program fees, facility rentals, and the Ocean Discovery Shop—makes up approximately half of its general operating requirements.


Figure 1. Burrowing owl on the beach at Younger Lagoon.

Study Areas

Flora, fauna, and human use were monitored at Natural Bridges State Park, Younger Lagoon Reserve, and Little Wilder/Sand Plant Beach from 2010-2015 (Figure 2). These three sites have similar characteristics (all have beach and lagoon habitat), are within close proximity to one another, and experience varying levels of human use. Although site characteristics are similar in many ways, they are also different in many ways, and these differences likely influence species composition. Three of the primary differences among the sites are human use levels, composition of adjacent upland habitat, and the overall size of the beach and wetland areas. Starting in FY 2015-2016 and moving forward, only Younger Lagoon Reserve has been and will continue to be monitored.

Younger Lagoon Reserve

Younger Lagoon Reserve is located in Santa Cruz County, approximately 4.5 miles from the main UC Santa Cruz campus; adjacent to the UC Santa Cruz Long Marine Laboratory. One of the few relatively undisturbed wetlands remaining on the California Central Coast, Younger Lagoon Reserve encompasses a remnant Y-shaped lagoon on the open coast just north of Monterey Bay. For most of the year, the lagoon is cut off from the ocean by a sand barrier. During the winter and spring months, the sand barrier at the mouth of Younger Lagoon breaches briefly connecting the lagoon to the ocean. The lagoon system provides protected habitat for 100 resident and migratory bird species. Approximately 25 species of water and land birds breed at the reserve, while more than 60 migratory bird species overwinter or stop to rest and feed. Opossums, weasels, brush rabbits, ground squirrels, deer mice, coyote, bobcat, woodrat, raccoon, and skunk are known to occupy the lagoon; gray and red foxes as well as mountain lion have also been sighted. Several species or reptiles and amphibians, including the California Red-legged Frog, also are found in the Reserve. Reserve habitats include salt and freshwater marsh, backdune pickleweed areas, steep bluffs with dense coastal scrub, pocket sand beach, grassland, and dense willow thickets.

Sand Plant Beach ("Little Wilder")

Sand Plant Beach is located in Santa Cruz County, approximately 1.5 miles west of YLR adjacent to Wilder Ranch State Park. Sand Plant Beach is approximately 23 acres and includes a pocket beach, dunes, cliffs and lagoon. It is open to the public for recreational use from dawn until dusk, 365 days a year; however, requires a hike to get to it and thus experiences less human use than many of the more accessible beaches in Santa Cruz. The surrounding Wilder Ranch State Park covers approximately 7,000 acres and allows human, bike and equestrian access. Much of the interior lagoon/upland habitat has been modified for agricultural production and/or ranching over the past century. Today most of the vegetation that persists inland of the lagoon is dominated by freshwater emergent vegetation and willow thickets. Major wetland restoration projects have increased native flora and fauna in the area (Friends of Santa Cruz State Parks, 2010).

Natural Bridges Lagoon

Natural Bridges Lagoon is located in Santa Cruz County, approximately 0.5 miles east of YLR on the urban edge of the city of Santa Cruz CA in Natural Bridges State Park. Natural Bridges Lagoon, beach, and State Park encompasses approximately 63 acres and includes a wide pocket beach, lagoon, cliffs, and diverse upland habitat (scrub, grass, iceplant, willow thicket, live oak, eucalyptus, and cypress). The park is world-renowned for its yearly migration of monarch butterflies and famous natural bridge. Natural Bridges State Park allows human access as well as dogs that are on leash and remain on paved roads and in parking lots (Friends of Santa Cruz State Parks, 2010). The beach is a popular destination at all times of the year; however, it is especially popular in the spring, summer, and fall months.

Figure 2. Study Areas.

Methods

User Data

User data from tours conducted by the SMDC, as well as research and education use of YLR, were recorded and maintained by SMDC and YLR Staff. User data from educational programs and fee collection are recorded and maintained by California State Parks staff for Natural Bridges State Parks. No user data was available for Sand Plant Beach.

Human Beach Use

We used remote cameras to quantify human use quarterly througout the study peroiod. Cameras were placed along the eastern edge of Sand Plant Beach and Natural Bridges Beach from FY 2010-2011 – FY 2014-2015 and at the western edge of Younger Lagoon from FY 2010-2011 – present with each separate quarterly sampling events each consisting of two days. Cameras were set to automatically take photos at 15 minute intervals. Number of people were quantified for 15 minute intervals during the day (camera times varied across sampling periods due to day length and postion; however, were standardized within each sampling period). The total survey area varied between sites and among individual sampling efforts due the placement of the camera and available habitat for human users at the time of the survey (i.e. often less beach area surveyed at Sand Plant Beach compared to Younger Lagoon and Natural Bridges). In order to control for area, specific regions of photos were chosen and number of individuals within each region were counted; thus, the number of people counted per unit area and time was standardized. We used the largest survey area during each sampling period to standardize use within each specific region of the beach during each sampling effort. Thus, if a particular site had more or less habitat monitored, the number of individuals was standardized across sites making comparisons comparable.

Photo Documentation of Younger Lagoon Natural Reserve

Photo point locations were established at four locations within YLR (Figure 3). These locations were chosen to ensure coverage of all major areas of the beach. Photos were taken once during the reporting period. At each photo point we collected photo point number, date, name of photographer, bearing, and camera and lens size.

Tidewater Goby Surveys

Tidewater goby surveys were conducted quarterly throughout the study period. Surveys were conducted using a 4.5 ft x 9 ft beach seine with 1/8 inch mesh. The objectives of the surveys were to document tidewater goby presence and evidence of breeding activity (determined by the presence of multiple size/age classes). All fish were identified to species and counted. When individuals exceeded ~50 per seine haul, counts were estimated. Sampling was conducted with the goal of surveying the various habitats within each site (e.g. sand, sedge, willow, pickleweed, deep, shallow, etc.); thus, different numbers of seine hauls were conducted at each site. Species richness was compared among sites.

Figure 3. Locations of monitoring points, plots, and regions for YLR beach. Monitoring areas varied between sampling efforts depending upon the high water mark, vegetation patterns, and water levels.

Species Composition and Coverage of Beach Dune Vegetation

Dune vegetation from the lowest (nearest to the mean high tide line) occurring terrestrial plant to 10 meters inland into the strand vegetation was surveyed quarterly throughout the study period. The exact location and extent of the area surveyed each time varied depending upon the location of the "lowest" plant detected during each sampling effort. At each location we established a 50-m east-west transect across the dune vegetation and measured the distance from the estimated mean high tide line to the "lowest" plant on the beach. Herbaceous species composition was measured by visual estimation of absolute cover for each species in ten 0.25 m^2 quadrats along the transect. Quadrats were placed every 5 m on alternating sides of the transect starting at a randomly selected point between 1 and 5 meters (a total of 10 quadrats per transect). A clear plastic card with squares representing 1, 5, and 10% of the sampling frame was used to help guide visual cover estimations. Species cover (native and exotic), bare ground, and litter were estimated at 5% intervals. Litter was specifically defined as residue from previous year's growth while any senescent material that was recognizable as growth from earlier in the current growing season was counted as cover for that species. After all cover estimates had been made, we conducted surveys within 2 m of either side of the transect (a 4 × 50 m belt). In the belt transects, individual plants were recorded as either seedlings or greater than 1 year old. Presence of flowers and seeds was also noted.

Non-avian Vertebrate Monitoring

Tracks

Vertebrate tracks were measured using raked sand plots at each site quarterly throughout the study period. Tracking stations were placed throughout the beach area in constriction zones where vegetation was absent. The objective of these surveys was simply to detect what species use the beach habitat. As such, size of plot varied from approximately depending upon the amount of available open sandy area at each location. Track stations were raked each evening and checked for tracks in the morning. Stations remained open for two days during each monitoring bout. Tracks were identified to species when possible. Species composition was summarized; however, abundance was not quantified due to the fact that most often tracks cannot be used to identify individual animals (e.g. a single individual could walk across the plot multiple times).

Small Mammals

Sherman live traps were placed for two nights every quarter of the study period - a total of 30 traps were placed used (60 trap nights per sampling bout). Traps were set at dusk and collected at dawn. Each trap was baited with rolled oats and piece of synthetic bedding material was placed in each trap to ensure animals did not get too cold. Individuals were identified to species, marked with a unique ear tag, and released at the site of capture.

Invertebrate Monitoring

Terrestrial invertebrates on beach habitat were monitored by placing 12 oz plastic containers (pit fall traps) at each tracking station (one at each corner of the plot) during tracking efforts. Traps were buried to the lip of the container and checked each morning and all individuals were collected, identified, and counted.

Avian Monitoring

We conducted ocular surveys of birds on the beach, lagoon, and cliff habitats quarterly throughout the study period. Survey locations were selected along one edge of the beach on the cliff. At Sand Plant Beach the entire beach area, fore portion of the lagoon, and western cliff were surveyed from the eastern edge of the lagoon (FY 2010-2011 – FY 2014-2015). At YLR the entire beach area, fore portion of the lagoon, and western cliff were surveyed from the eastern edge of the lagoon and the top and western face of the rock stack that is located at the beach/ocean edge was surveyed (FY 2010-2011 – present). At Natural Bridges surveys were conducted from the eastern edge of the beach on the cliff adjacent to De Anza Mobile Home Park or from the beach to the west; fore lagoon and approximately the western ¼ of the beach area (including beach/ocean interface) was included in the survey area (FY 2010-2011 – FY 2014-2015). Survey areas were chosen with the goal of surveying approximately the same area and types of habitat. Counts were recorded quarterly throughout the study. Surveys were conducted in the dawn or dusk hours within approximately 2 hours of sunrise or sunset and of one another. Data from the two days during each sampling effort were combined and individuals were identified and counted.

Results

User Data

Younger Lagoon Reserve

There were a wide variety of public and non-profit research and educational groups that used Younger Lagoon (Table 1). The greatest user group for YLR was undergraduate education, a breakdown of all user groups is included in Table 2. The greatest user group was “other” which consists primarily of public tour groups attending daily tours at the Seymour Center. Those users were provided an overlook of the beach, interpretive information via docent led tours, and opportunities to read interpretive material presented on signs about the reserve; however, did not access the beach. During the 17-18 fiscal year a total of 195 participants went on the Seymour Center docent led Younger Lagoon beach access tours, more than doubling the number of participants who went on the beach access tour in the previous year. Since the start of the Seymour Center docent led beach access tours, nearly 170 tours have gone out and more than 816 visitors have participated. The beach access tours are part of a broad offering of public outreach and education programming on the Coastal Science Campus managed by the Seymour Center, including K-12 school visits to the Seymour Center, the Ocean Explorers Summer Camp, Bay Area Libraries Discover and Go Program, as well as print, web, social media, and radio campaigns.

Despite ongoing staff efforts towards public outreach and education, some unauthorized uses of Younger Lagoon Reserve, including trespass and vandalism occurred in FY 2017-2018. Thus far, no significant damage to ecologically sensitive habitat areas, research sites, research equipment, or facilities has occurred. Reserve staff will continue their public outreach and education efforts, and continue to partner with UCSC campus police to ensure the security of the reserve and protect sensitive resources and ongoing research.

Table 1. Younger Lagoon user affiliations.

University of California Campus	**Non-governmental organizations**
University of California, Santa Barbara	Audubon Society
University of California, Santa Cruz	Bird School Project
	California Academy of Sciences
California State Universities	Land Trust of Santa Cruz County
California State University, Monterey Bay	Monterey Bay Aquarium WATCH Program
California State University, San Jose	
	Santa Cruz Bird Club
California Community College	Seymour Marine Discovery Center
Cabrillo Community College	Watsonville Wetlands Watch
Universities outside California	**Governmental Agencies**
University of Utah	California State Parks
	Volunteer Groups
K-12 system	UCSC Wilderness Orientation
Aptos High School	
Half Moon Bay High School	
Pajaro Valley High School	
Watsonville High School	

Table 2. Younger Lagoon Total Use.

RESERVE USE DATA
Period from July 1, 2017 to June 30, 2018

University of California, Santa Cruz
Younger Lagoon Reserve

	UC Home		UC Away		CSU System		CA Com'ty. Colleges		Other CA Colleges		U.S. Colleges		Int'l Colleges		Gov't		NGOs		For-Profit Business		K-12 Schools		Others		TOTALS	
	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days
UNIVERSITY-LEVEL RESEARCH																										
Faculty	7	83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	83
Research Assistant	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Graduate Student	5	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	101
Undergraduate Student	30	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	412
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	120	5	120
SUB-TOTALS	42	596	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	120	48	720
UNIVERSITY-LEVEL CLASSES																										
Faculty	12	24	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	27
Research Scientist	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Graduate Student	44	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	85
Undergraduate Student	635	2219	0	0	22	22	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	707	2341
Professional	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6
SUB-TOTALS	694	2333	0	0	23	23	51	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	774	2464
PUBLIC SERVICE																										
Faculty	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Research Scientist	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Graduate Student	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
Undergraduate Student	107	107	0	0	0	0	0	0	0	0	11	22	0	0	0	0	0	0	0	0	0	0	0	0	118	129
K-12 Instructor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	0	197	199	0	0	199	204
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	76	0	0	56	76
Professional	7	13	0	0	0	0	0	0	0	0	1	2	0	0	1	1	5	21	0	0	0	0	1	1	15	38
Other	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	0	0	0	0	1687	2387	1708	2422
Docent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	40	40	40
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	255	255	260	260
SUB-TOTALS	137	143	1	1	0	0	0	0	0	0	12	24	0	0	1	1	8	41	0	0	258	280	1983	2683	2400	3173
TOTALS:	**873**	**3072**	**2**	**5**	**23**	**23**	**51**	**102**	**0**	**0**	**12**	**24**	**0**	**0**	**1**	**1**	**8**	**41**	**0**	**0**	**258**	**280**	**1994**	**2809**	**3222**	**6357**

*Other includes members of the public who took the SMDC's daily tour. Although all tours include information on YLR, we estimate that 10% of these visitors can be reasonably counted as users.

Sand Plant Beach (Little Wilder)

Sand Plant Beach is located adjacent to Wilder State Park and is frequented by Wilder State Park visitors along a coastal bluff trail. Because of the size of Wilder Ranch State Park (over 7,000 acres, with over 35 miles of trails) and its multiple points of access, it is unknown exactly how many people visit Sand Plant Beach each year. However, even though it requires a hike it is one of the more popular beaches along this section of Wilder Ranch as there is relatively easy access along the coastal bluff trail. We surveyed Sand Plant Beach from FY10-11 – FY14-15.

Natural Bridges Lagoon

We did not obtain user data for Natural Reserves during the survey period; however, more than 925,000 people are estimated to have visited Natural Bridges State Park in 2005 (Santa Cruz State Parks 2010). The proportion of those visitors that use the beach and lagoon habitat is unknown. It is likely that the number of visitors remains in this range from year to year. We surveyed Natural Bridges Lagoon from FY10-11 – FY14-15.

Human Use During Survey Efforts

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Number of users at YLR beach during the survey efforts varied among beach as well as between sampling dates. However, the pattern of total use (Table 3; Figures 4-5) and the number of people per photo (15 minute interval standardized for area surveyed) was consistent across sampling periods. Examples of photos captured during a typical monitoring session in 2010 are included as Figure 6.

Table 3. Number of people observed in photo human use monitoring.

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
Natural Bridges	May, 2010	313	3.13
Sand Plant	May, 2010	92	1.21
Younger Lagoon	May, 2010	2	0.28
Natural Bridges	August, 2010	224	2.69
Sand Plant	August, 2010	15	0.17
Younger Lagoon	August, 2010	0	0
Natural Bridges	November, 2010	207	2.07
Sand Plant	November, 2010	7	0.17
Younger Lagoon	November, 2010	1	0.02
Natural Bridges	February, 2011	185	2.64
Sand Plant	February, 2011	10	0.25

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
Younger Lagoon	February, 2011	2	0.06
Natural Bridges	May, 2011	236	2.8
Sand Plant	May, 2011	13	0.38
Younger Lagoon	May, 2011	5	0.18
Natural Bridges	July, 2011	795	2.44
Sand Plant	July, 2011	7	0.25
Younger Lagoon	July, 2011	0	0
Natural Bridges	December, 2011	49	0.63
Sand Plant	December, 2011	39	1.16
Younger Lagoon	December, 2011	0	0
Natural Bridges	April, 2012	442	6.93
Sand Plant	April, 2012	120	2.05
Younger Lagoon	April, 2012	0	0
Natural Bridges	May, 2012	624	2.67
Sand Plant	May, 2012	14	0.19
Younger Lagoon	May, 2012	0	0
Natural Bridges	October, 2012	210	4.84
Sand Plant	October, 2012	83	1.06
Younger Lagoon	October, 2012	3	0.04
Natural Bridges	January, 2013	100	4.90
Sand Plant	January, 2013	24	0.81
Younger Lagoon	January, 2013	9	0.11
Natural Bridges	May, 2013	615	19.81
Sand Plant	May, 2013	21	0.52
Younger Lagoon	May, 2013	0	0
Natural Bridges	July, 2013	560	25.42
Sand Plant	July, 2013	29	0.96
Younger Lagoon	July, 2013	5	0.06
Natural Bridges	November, 2013	3.44	13.04
Sand Plant	November, 2013	6	0.19
Younger Lagoon	November, 2013	12	0.15
Natural Bridges	February, 2014	71	6.37
Sand Plant	February, 2014	6	0.20

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
Younger Lagoon	February, 2014	1	0.01
Natural Bridges	June, 2014	1723	21.01
Sand Plant	June, 2014	239	2.92
Younger Lagoon	June, 2014	2	0.02
Natural Bridges	August, 2014	852	23.68
Sand Plant	August, 2014	227	2.52
Younger Lagoon	August, 2014	2	0.02
Natural Bridges	November, 2014	2131	21.69
Sand Plant	November, 2014	146	1.78
Younger Lagoon	November, 2014	2	0.02
Natural Bridges	January, 2015	1889	23.04
Sand Plant	January, 2015	225	2.75
Younger Lagoon	January, 2015	11	0.13
Natural Bridges	April, 2015	699	7.13
Sand Plant	April, 2015	-	-
Younger Lagoon	April, 2015	0	0
Younger Lagoon	July, 2015	6	0.02
Younger Lagoon	October, 2015	0	0
Younger Lagoon	February, 2016	0	0
Younger Lagoon	May, 2016	1	0.02
Younger Lagoon	July, 2016	0	0
Younger Lagoon	November, 2016	0	0
Younger Lagoon	February, 2017	0	0
Younger Lagoon	April, 2017	0	0
Younger Lagoon	August, 2017	19	0.16
Younger Lagoon	October, 2017	6	0.05
Younger Lagoon	February, 2018	0	0
Younger Lagoon	May, 2018	27	0.22

[1]Standardized by area surveyed.

Figure 4. Photos captured by remote camera during the Spring 2010 monitoring effort. Top to bottom: Sand Plant Beach, Natural Bridges, and Younger Lagoon.

Photo Documentation of YLR

Photos were taken one time during each reporting period. Photos for this year's report are included as Appendix 1.

Tidewater Goby Surveys

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Evidence of breeding (multiple size classes) continued to be observed at YLR during the reporting period (Table 4).

Table 4. Fish species encountered during sampling efforts.

	Tidewater Goby	**Stickleback**	**Sculpin**	**Mosquito Fish**	**Halibut**	**CRLF [1]**	**Bluegill**
April 9, 2010							
Little Wilder	X	X					
Younger Lagoon	X	X					
Natural Bridges	X	X	X				
August 13, 2010							
Little Wilder	X	X					
Younger Lagoon	X	X					
Natural Bridges	X	X	X	X			
November 18, 2010							
Little Wilder	X	X					
Younger Lagoon	X						
Natural Bridges	X	X	X	X			
February 23, 2011							
Little Wilder	X	X					
Younger Lagoon	X						
Natural Bridges	X	X	X	X			
May 12, 2011							
Little Wilder	X	X					
Younger Lagoon	X	X	X		X		
Natural Bridges	X	X	X				
August 8, 2011							
Little Wilder	X	X					
Younger Lagoon	X	X					
Natural Bridges	X	X					
December 12, 2011							
Little Wilder	X	X					

Younger Lagoon	X				
Natural Bridges	X	X			
March 8, 2012					
Little Wilder	X	X			
Younger Lagoon	X				
Natural Bridges	X	X			
May 15, 2012					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X	X	X		
August 29, 2012					
Little Wilder	X	X			X
Younger Lagoon	X	X			X
Natural Bridges	X	X			
October 23, 2012					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X	X			
February 2, 2013					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X	X			
May 6, 2013					
Little Wilder	X	X			X
Younger Lagoon	X	X			X
Natural Bridges	X	X			
July 16, 2013					
Little Wilder	X	X			X
Younger Lagoon	X	X			
Natural Bridges	X	X		X	
November 14, 2013					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges					
February 21, 2014					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X				
May 2, 2014					
Little Wilder	X	X			
Younger Lagoon	X	X			

Natural Bridges	X		
August 11, 2014			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X	X	
November 25, 2014			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X	X	
January 26, 2015			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X		
April 13, 2015			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X	X	X
July 8, 2015			
Younger Lagoon	X	X	
November 4, 2015			
Younger Lagoon	X	X	
February 9, 2016			
Younger Lagoon	X	X	
May 13, 2016			
Younger Lagoon	X	X	
July 20, 2016			
Younger Lagoon	X	X	
November 17, 2016			
Younger Lagoon	X	X	
March 1, 2017			
Younger Lagoon			
May 3, 2017			
Younger Lagoon	X	X	
August 9, 2017			

Younger Lagoon	X	X					
November 9, 2017							
Younger Lagoon	X	X					
February 9, 2018							
Younger Lagoon	X	X					
May 2, 2018							
Younger Lagoon	X	X					
No. of sites	3	3	2	2	1	2	1

[1]CRLF = California Red-legged Frog (*Rana draytonii*). Tadpoles have been observed at Little Wilder. Juveniles, young of year, and adults have been observed at YLR and Little Wilder.

Species Composition and Coverage of Beach Dune Vegetation

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Evidence of reproduction (flowers, seeds, and seedlings) of native and non-native vegetation has been detected at all three sites. Distance from mean high tide to the lowest plant on the beach was consistently greatest at Natural Bridges and lowest at Sand Plant Beach and Younger Lagoon (Table 5). Plant cover was generally higher at Sand Plant and Younger Lagoon (as exhibited by proportion of bare ground) but varied across sampling efforts (Figure 5).

Native plant species richness was consistently greatest at Younger Lagoon; however, it varied across sampling periods (Figure 6). Mean proportion of non-native species was greatest at Natural Bridges (53%) and least at Younger Lagoon (27%) (Table 6).

Table 5. Distance (m) from mean high tide to the lowest plant on the beach.

Site	Spring, 10	Summer, 10	Fall, 10	Winter, 11	Spring, 11	Summer, 11	Fall, 11	Winter, 12	Spring, 12
Younger Lagoon	56	51	20	42	55	49	26	30	28
Sand Plant Beach	33	34	56	56	40	51	29	31	38
Natural Bridges	128	130	141	146	146	138	155	160	123

Site	Summer, 12	Fall, 12	Winter, 13	Spring, 13	Summer, 13	Fall, 13	Winter, 14	Spring, 14
Younger Lagoon	47	20	30	36	37.3	32.1	26.4	36.5
Sand Plant Beach	35	38	31	41	48.1	49.9	45.6	24.2
Natural Bridges	91	75	100	72	88.9	107.3	87.4	83.2

Site	Summer, 14	Fall, 14	Winter, 15	Spring, 15	Summer, 15	Fall, 15	Winter, 16	Spring, 16
Younger Lagoon	21.4	10	26.4	19.5	19.3	20.5	31.4	42.8
Sand Plant Beach	27.5	31	24.5	29.2				
Natural Bridges	74.3	89.4	71	75.8				

Site	Summer, 16	Fall, 16	Winter, 17	Spring, 17	Summer, 17	Fall, 17	Winter, 18	Spring, 18
Younger Lagoon	36.6	46.3	19.5	37.3	22.3	39.3	32	29

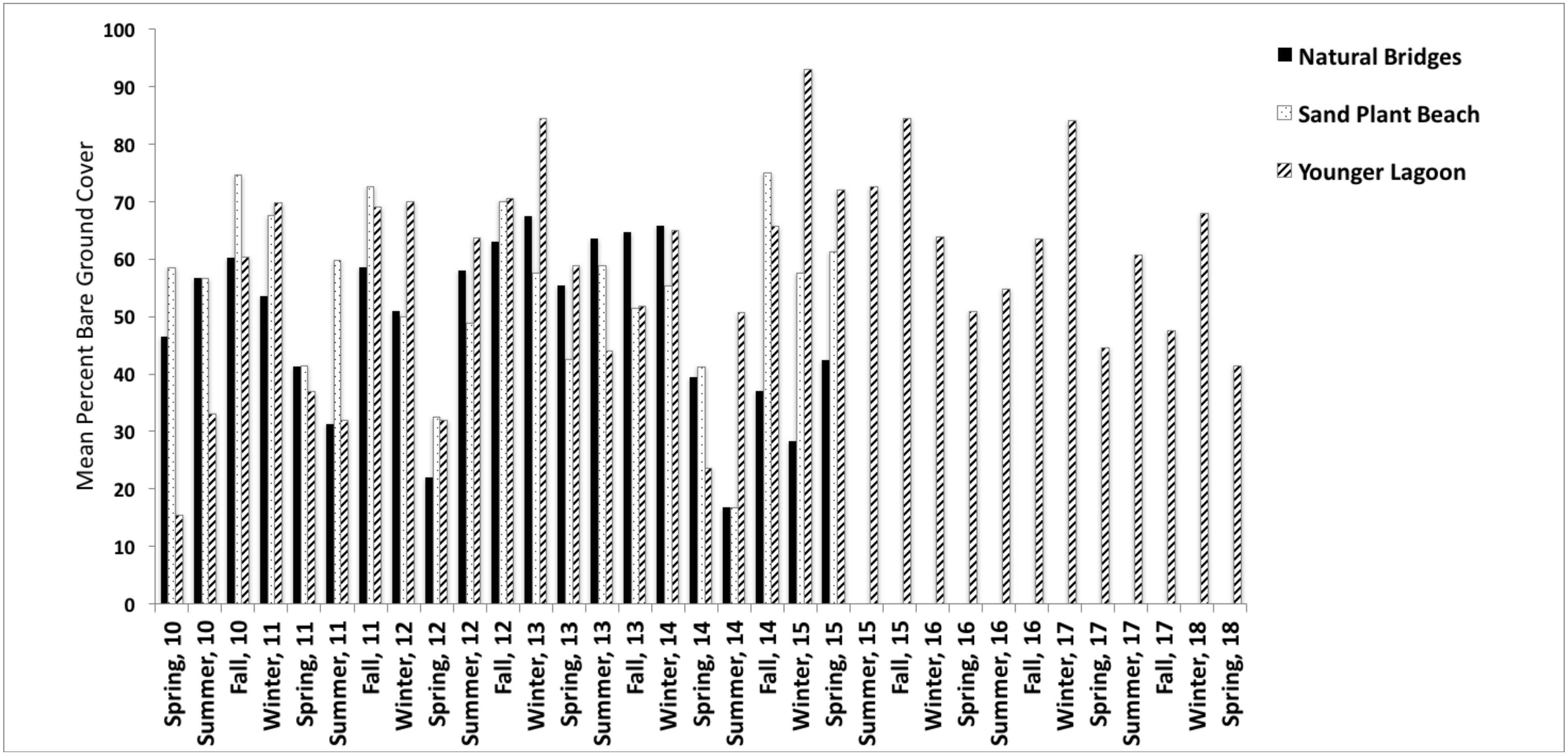

Figure 5. Mean percent bare ground encountered at each site.

Table 6. Number and proportion of native and non-native plant species encountered during surveys. Mean is calculated across all samples.

Site	Spring, 10	Summer, 10	Fall, 10	Winter, 11	Spring, 11	Summer, 11	Fall, 11	Winter, 12	Spring, 12
Natural Bridges									
Native	7 (41%)	8 (44%)	9 (60%)	8 (44%)	9 (43%)	6 (67%)	8 (62%)	9 (47%)	11 (48%)
Non-native	10 (59%)	10 (56%)	5 (40%)	10 (66%)	12 (57%)	9 (33%)	5 (38%)	10 (53%)	12 (52%)
Total	17	18	14	18	21	15	13	19	23
Younger Lagoon									
Native	11 (85%)	11 (85%)	11 (85%)	11 (73%)	12 (80%)	13 (81%)	9 (82%)	6 (50%)	6 (43%)
Non-native	2 (15%)	2 (15%)	2 (15%)	4 (27%)	3 (20%)	3 (19%)	2 (18%)	6 (50%)	8 (57%)
Total	13	13	13	15	15	16	11	12	14
Sand Plant Beach									
Native	7 (88%)	7 (63%)	7 (70%)	8 (80%)	7 (88%)	7 (88%)	9 (82%)	3 (33%)	4 (40%)
Non-native	1 (12%)	2 (37%)	3 (30%)	2 (20%)	1 (12%)	1 (12%)	2 (18%)	6 (67%)	6 (60%)
Total	8	9	10	10	8	8	11	9	10

Site	Summer, 12	Fall, 12	Winter, 13	Spring, 13	Summer, 13	Fall, 13	Winter, 14	Spring, 14
Natural Bridges								
Native	5 (35%)	10 (59%)	7 (88%)	9 (56%)	7 (37%)	6 (35%)	6 (43%)	10 (50%)
Non-native	9 (65%)	7 (41%)	8 (12%)	6 (44%)	12 (63%)	11 (65%)	8 (57%)	10 (50%)
Total	14	17	15	16	19	17	14	20
Younger Lagoon								
Native	12 (67%)	7 (88%)	9 (69%)	12 (75%)	13 (72%)	14 (74%)	10 (83%)	12 (67%)
Non-native	6 (33%)	1 (12%)	4 (31%)	4 (25%)	5 (28%)	5 (26%)	2 (17%)	6 (33%)
Total	18	8	13	16	18	19	12	18
Sand Plant Beach								
Native	2 (40%)	3 (50%)	4 (100%)	4 (67%)	6 (100%)	6 (100%)	5 (100%)	5 (83%)
Non-native	3 (60%)	3 (50%)	0 (0%)	2 (33%)	0 (0%)	0 (0%)	0 (0%)	1 (17%)

Total	5	6	4	6	6	6	5	6

Site	Summer, 14	Fall, 14	Winter, 15	Spring, 15	Summer, 15	Fall, 15	Winter, 16	Spring 16
Natural Bridges								
Native	5 (42%)	5 (45%)	4 (33%)	5 (31%)				
Non-native	7 (58%)	6 (55%)	8 (67%)	11 (69%)				
Total	12	11	12	16				
Younger Lagoon								
Native	9 (69%)	5 (62%	10 (67%)	10 (67%)	11 (73%)	2 (67%)	5 (100%)	10 (83%)
Non-native	4 (31%)	3 (38%)	5 (33%)	5 (33%)	4 (27%)	1 (33%)	0 (0%)	2 (17%)
Total	13	8	15	15	15	3	5	12
Sand Plant Beach								
Native	4 (50%)	4 (40%)	5 (50%)	4 (33%)				
Non-native	4 (50%)	6 (60%)	5 (50%	8 (67%)				
Total	8	10	10	12				

Site	Summer, 16	Fall, 16	Winter, 17	Spring, 17	Summer, 17	Fall, 17	Winter, 18	Spring, 18
Younger Lagoon								
Native	10 (83%)	8 (57%)	3 (60%)	13 (68%)	12 (70%)	13 (76%)	12 (70%)	9 (82%)
Non-native	2 (17%)	6 (43%)	2 (40%)	6 (32%)	5 (30%)	4 (24%)	5 (30%)	2 (18%)
Total	12	14	5	19	17	17	17	11

Site	Proportion of native and non-native species across all sample periods
Natural Bridges	
Native	**47%**
Non-native	**53%**
Total	
Younger Lagoon	

Native	**74%**
Non-native	**26%**
Total	
Sand Plant Beach	
Native	**68%**
Non-native	**31%**
Total	

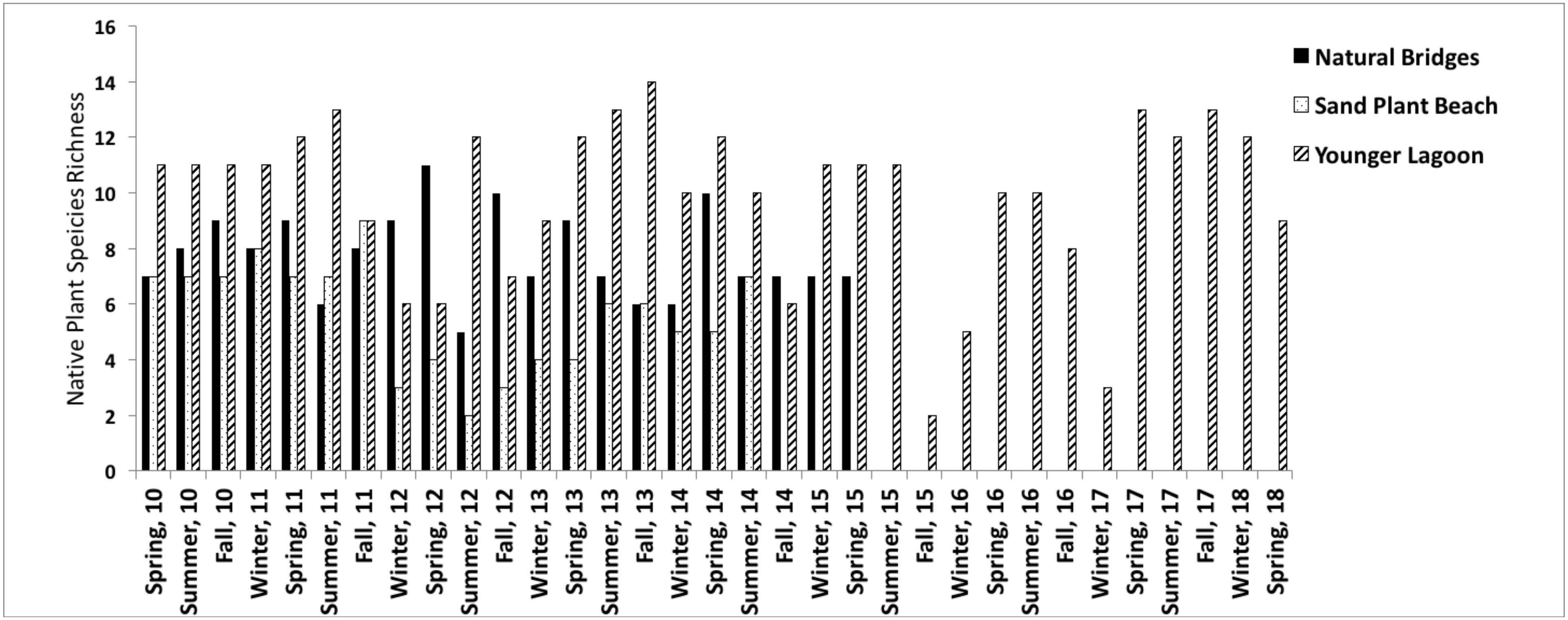

Figure 6. Number of native plant species encountered at each site.

Track Plate Monitoring

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Native species richness of mammals detected in raked sand plots was across all three sites (n = 8). Ground squirrel were not detected at Natural Bridges and opossum have not been detected in our track surveys at Sand Plant Beach or Younger Lagoon Reserve (Table 7). It is likely that ground squirrels occur at Natural Bridges and opossum are likely using upland habitat at Sand Plant Beach and Younger Lagoon Reserve; however, they were not detected in our survey efforts. Dogs and bicycles were detected at Natural Bridges and Sand Plant Beach and vehicles were detected at Natural Bridges (Table 7). Frequency of detection and species richness for each species is summarized in Table 8.

Table 7. Summary of track plate sampling effort at each site.

	Rodent[1]	**Raccoon**	**Cottontail**	**Bobcat**	**Skunk**	**Squirrel**	**Deer**	**Opossum**	**Coyote**	**Bicycle**	**Vehicle**	**Dog**	**Human**
May 1-2, 2010													
Little Wilder	X			X	X	X			X	X			X
Younger Lagoon	X	X		X	X								X
Natural Bridges	X	X		X	X				X	X	X	X	X
August 11-12, 2010													
Little Wilder		X		X	X							X	X
Younger Lagoon	X	X	X	X		X							
Natural Bridges	X	X	X									X	X
November 17-18, 2010													
Little Wilder	X		X	X					X				X
Younger Lagoon	X	X											X
Natural Bridges	X	X		X							X	X	X
February 8 -9, 2011													
Little Wilder	X			X	X				X	X			X
Younger Lagoon	X	X			X				X				
Natural Bridges		X		X					X		X		X
May 3 - 4, 2011													
Little Wilder	X		X	X									

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
Younger Lagoon		X	X	X	X				X				
Natural Bridges		X			X				X			X	X
July 22 - 23, 2011													
Little Wilder	X	X			X				X				X
Younger Lagoon	X	X	X	X	X								
Natural Bridges	X	X	X		X							X	X
March 8 & 9, 2012													
Little Wilder	X								X				X
Younger Lagoon				X					X				
Natural Bridges							X				X	X	X
May 15 & 16, 2012													
Little Wilder	X		X	X									X
Younger Lagoon	X	X		X					X				
Natural Bridges	X			X				X				X	X
August 16 & 17, 2012													
Little Wilder	X	X	X	X	X		X		X				X
Younger Lagoon	X	X		X		X	X						
Natural Bridges	X	X	X	X	X		X				X	X	X
October 22 & 23, 2012													
Little Wilder	X						X		X				X
Younger Lagoon		X		X					X				X
Natural Bridges			X		X		X				X		X
January 16 & 17, 2013													
Little Wilder	X			X					X				X
Younger Lagoon	X	X		X					X				X
Natural Bridges		X		X	X				X			X	X
May 15 & 16, 2013													
Little Wilder	X			X	X								X

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
Younger Lagoon	X	X		X					X				X
Natural Bridges	X	X			X							X	X
July 18 & 19, 2013													
Little Wilder	X	X		X					X			X	X
Younger Lagoon	X	X		X					X				
Natural Bridges		X		X	X						X	X	X
October 21 & 22, 2013													
Little Wilder		X		X									
Younger Lagoon		X		X					X				X
Natural Bridges	X	X			X				X		X	X	X
February10 &11, 2014													
Little Wilder	X	X		X									X
Younger Lagoon									X				X
Natural Bridges		X			X						X		X
April 27 & 28, 2014													
Little Wilder		X		X					X				X
Younger Lagoon		X							X				
Natural Bridges		X		X	X						X	X	X
July 30-31, 2014													
Little Wilder		X		X					X				X
Younger Lagoon		X		X					X				
Natural Bridges		X			X		X		X		X	X	X
November 4-5, 2014													
Little Wilder				X					X			X	X
Younger Lagoon		X		X					X				
Natural Bridges		X					X				X		X
January 26-27, 2015													
Little Wilder	X								X				X

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
Younger Lagoon	X	X		X			X						X
Natural Bridges	X				X		X		X		X	X	X
April 14-15, 2015													
Little Wilder	X	X							X				X
Younger Lagoon	X	X		X					X				
Natural Bridges	X				X		X		X		X	X	X
July 8-9, 2015													
Younger Lagoon	X			X	X								
									X				X
October 29-30, 2015													
Younger Lagoon		X		X									
February 2-3, 2016													
Younger Lagoon		X							X				
May3-4, 2016													
Younger Lagoon		X							X				
July 12-13, 2016													
Younger Lagoon		X		X									
November 9-10, 2016													
Younger Lagoon		X		X					X				
March 1-2, 2017													
Younger Lagoon	X	X		X									
April 25-26, 2017													
Younger Lagoon		X					X		X				X
August 2-3, 2017													
Younger Lagoon					X				X				
October 25-26, 2017													

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
Younger Lagoon		X					X		X	X			X
February 7-8, 2018													
Younger Lagoon	X			X	X								X
May 1-2, 2018													
Younger Lagoon	X								X				
	3	3	3	3	3	2	3	1	3	3	1	2	3

[1]Unidentified small rodent.

Table 8. Frequency of occurrence, and native species richness, of animals and human use types through spring 2017 track plate sampling efforts. Actual detections are included parenthetically.

Site	Rodent	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human	[1]Native sp. Richness
Little Wilder	(15) 71%	(10) 48%	(4) 19%	(15) 71%	(6) 29%	(1) 6%	(2) 10%	0%	(15) 71%	(2) 10%	0%	(3) 14%	(19) 91%	8
Younger Lagoon	(17) 53%	(21) 65%	(2) 6%	(23) 72%	(9) 28%	(2) 6%	(4) 12%	0%	(21) 65%	(1) 3%	0%	0%	(12) 37%	8
Natural Bridges	(9) 43%	(15) 71%	(4) 19%	(9) 43%	(13) 62%	0%	(8) 38%	(1) 5%	(9) 43%	(1) 5%	(14) 67%	(16) 76%	(21) 100%	8

[1]Bicycle, vehicle, dog, and human excluded.

Small Mammal Trapping

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. A total of 281 individual small mammals representing four species have been captured during small mammal trapping efforts (Table 9).

Table 9. Summary of Sherman trapping efforts

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
April 24 -25, 2010					
Little Wilder	8	5			**13**
Younger Lagoon	2				**2**
Natural Bridges			3		**3**
August 11-12, 2010					
Little Wilder	5	4			**9**
Younger Lagoon			1		**1**
Natural Bridges					**0**
November 15-16, 2010					
Little Wilder	5	1			**6**
Younger Lagoon				1	**1**
Natural Bridges		3	1		**4**
February 15-16, 2011					
Little Wilder	5				**5**
Younger Lagoon	6	5	0		**11**
Natural Bridges			2		**2**
April 29-30, 2011					
Little Wilder	4				**4**
Younger Lagoon	1				**1**
Natural Bridges					**0**
August 8-9, 2011					
Little Wilder	6	2			**8**
Younger Lagoon	3		3		**6**
Natural Bridges		1	5		**6**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
March 30, 2012					
Little Wilder	6				**6**
Younger Lagoon	1		1		**2**
Natural Bridges		5	2		**7**
May 15-16, 2012					
Little Wilder	4	1			**5**
Younger Lagoon	3				**3**
Natural Bridges		5			**5**
August 25-26, 2012					
Little Wilder	4				**4**
Younger Lagoon	3				**3**
Natural Bridges		4	2		**6**
November 5-6, 2013					
Little Wilder	2		1		**3**
Younger Lagoon	3				**3**
Natural Bridges		3	1		**4**
January 13-14, 2013					
Little Wilder	2		4		**6**
Younger Lagoon	2				**2**
Natural Bridges		2	1		**3**
May 1-2, 2013					
Little Wilder	1		1		**2**
Younger Lagoon	3		2		**5**
Natural Bridges		5			**5**
July 16-17, 2013					
Little Wilder	3		1		**4**
Younger Lagoon	1				**1**
Natural Bridges			1		**1**
October 22-23, 2013					
Little Wilder	5	1		1	**7**
Younger Lagoon	1				**1**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
Natural Bridges		1	2		**3**
February 12-13, 2014					
Little Wilder	2	1	1		**4**
Younger Lagoon	1		1		**2**
Natural Bridges		2			**2**
April 28-29, 2014					
Little Wilder	4	1			**5**
Younger Lagoon	3		1		**4**
Natural Bridges	1				**1**
July 30-31, 2014					
Little Wilder	1	1			**2**
Younger Lagoon	2				**2**
Natural Bridges	1		1		**2**
November 4-5, 2014					
Little Wilder	3	1			**4**
Younger Lagoon	4				**4**
Natural Bridges	2	1	3		**6**
January 26-27, 2015					
Little Wilder	3		1		**4**
Younger Lagoon	4		5		**9**
Natural Bridges			3		**3**
April 14-15, 2015					
Little Wilder	2		3		**5**
Younger Lagoon	3				**3**
Natural Bridges					**0**
July 8-9, 2015					
Younger Lagoon	7		1		**8**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
October 29-30, 2015					
Younger Lagoon	2		6		**8**
February 2-3, 2016					
Younger Lagoon			6		**6**
May 3-4, 2016					
Younger Lagoon			3	1	**4**
July 12-13, 2016					
Younger Lagoon			4		**4**
November 9-10, 2016					
Younger Lagoon	2		1		**3**
March 1-2, 2017					
Younger Lagoon	2		1		**3**
April 25-26, 2017					
Younger Lagoon			1		**1**
August 2-3, 2017					
Younger Lagoon					**0**
October 25-26, 2017					

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
Younger Lagoon	1	1	2		**4**
February 8-9, 2018					
Younger Lagoon	2				**2**
May 1-2, 2018					
Younger Lagoon	1		2		**3**
TOTAL	**142**	**56**	**80**	**3**	**281**

[1]Pema = *Peromyscus maniculatus*; Mica = *Microtus californicus*; Rema = *Reithrodontomys megalotis*; Rara = *Rattus norvegicus.* [2]Escaped before positive ID; however, suspected to be Norway Rat.

Invertebrate Monitoring

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Over all, Younger Lagoon consistently had the greatest number of individuals captured; however, patterns of species richness varied among sampling sessions (Figures 9-10). This may have been at least partially due to trapping methodology and disturbance as raccoons and perhaps coyote disturbed sample cups during some of the sampling efforts. Individuals were identified as distinct taxa; however, at the time of the writing of this report they have not been taxonomically keyed out.

Avian Surveys

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Avian species varied among sites and sampling dates (Table 10); however, number of species and abundance were consistently greatest at Natural Bridges and Younger Lagoon.

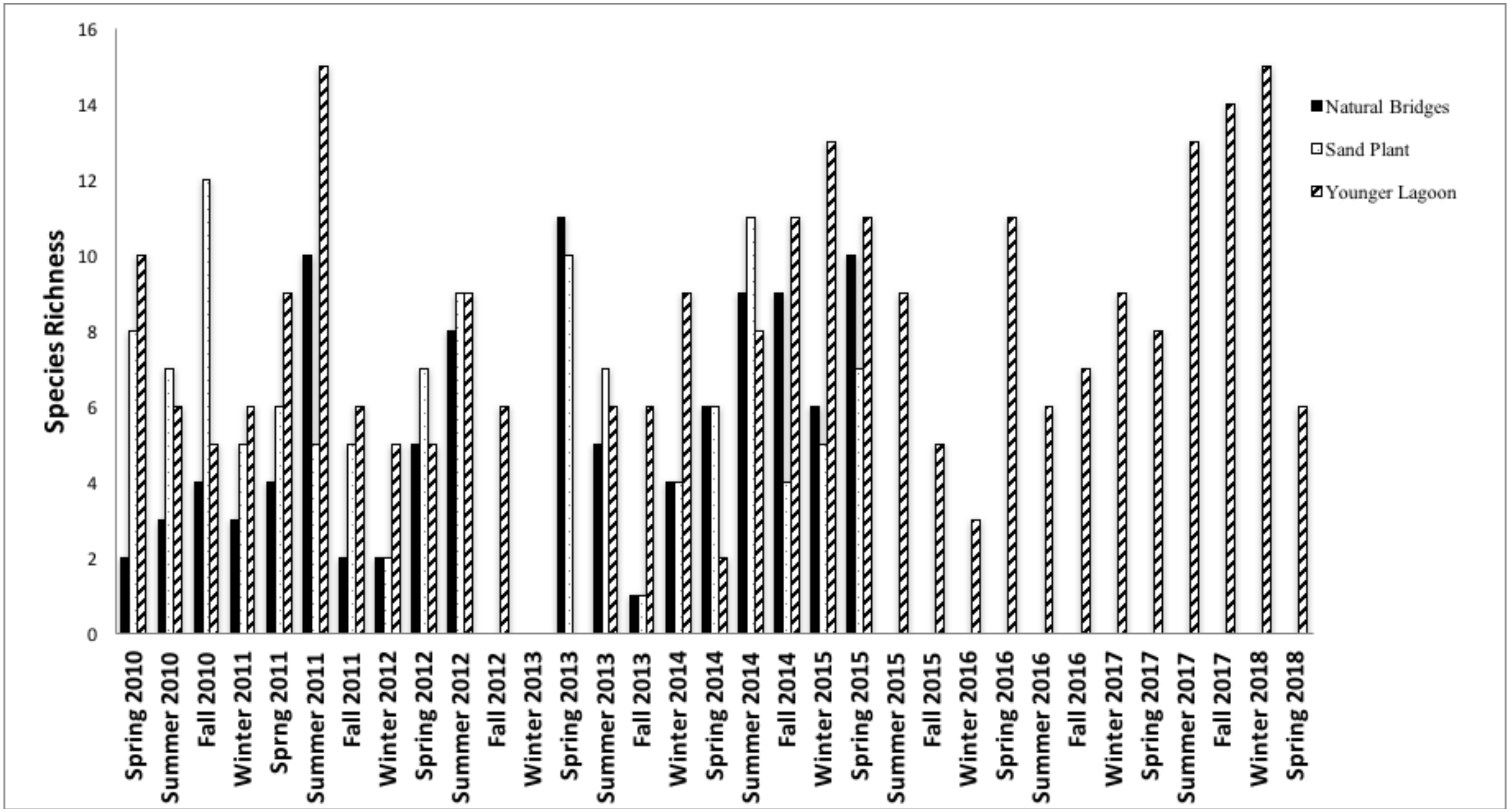

Figure 7. Species richness of invertebrates across all beaches

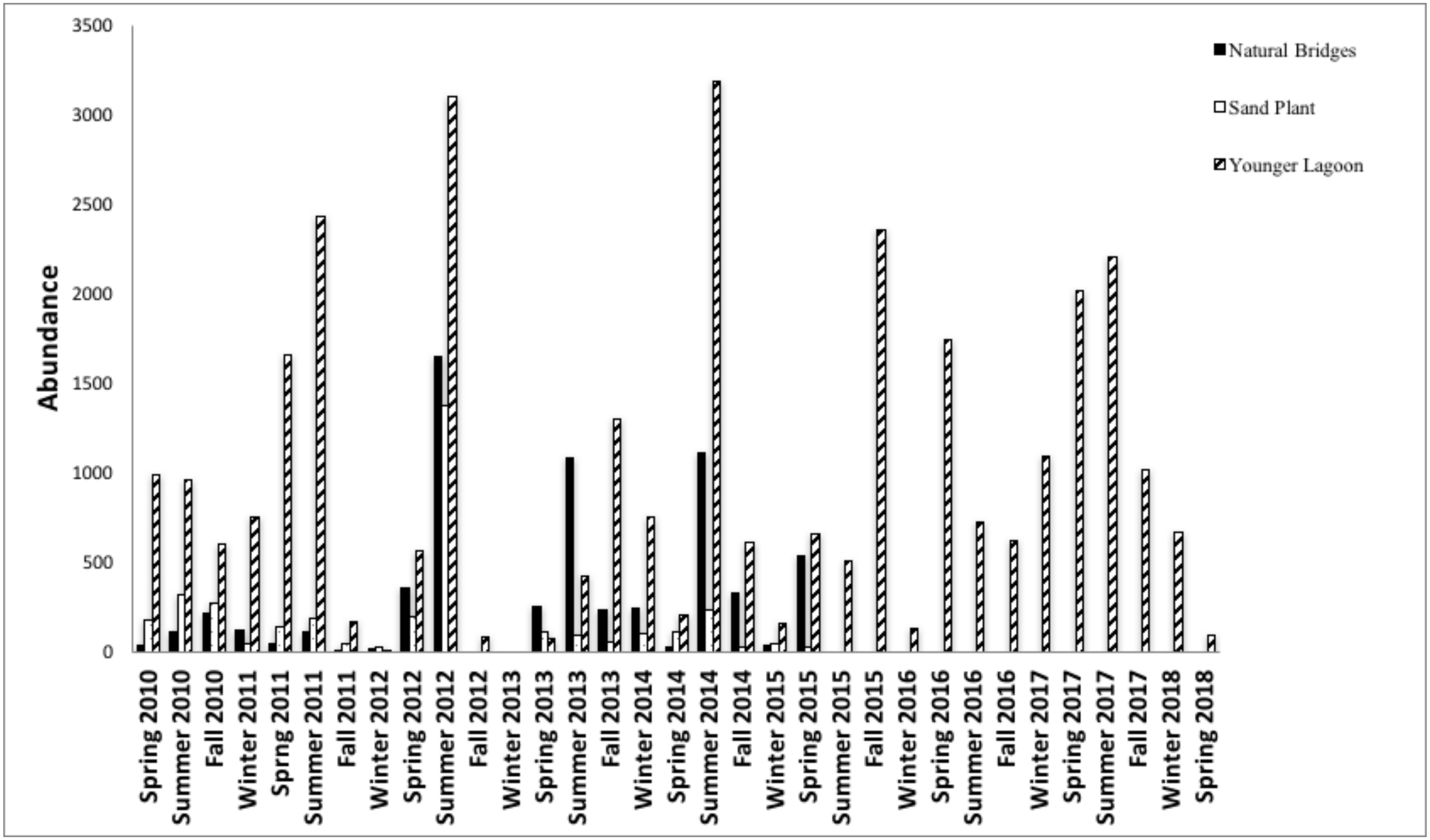

Figure 8. Total abundance of invertebrates at Natural Bridges, Sand Plant Beach, and Younger Lagoon beaches.

Table 10. Summary of bird surveys at Sand Plant Beach, Younger Lagoon, and Natural Bridges beaches.

Site	AMCR	AMPE	BBPL	BCNH	BASW	BLOY	BLPH	BLTU	BRAC	BRBL	BRPE	BUHE	CAGO	CAGU	CLSW	CORA	COOT	DOCO	DUSP	EUST	GCSP	GRHE	GREG	GRTE	HEGU	HOFI
April 24 & 26, 2010																										
Sand Plant																										
Younger Lagoon																										
Natural Bridges										2																
August 11-12, 2010																										
Sand Plant																									1	
Younger Lagoon						2												1		1					2	
Natural Bridges	2									19																
November 15 & 16, 2010																										
Sand Plant																						3				
Younger Lagoon								1			27						2		3	1						
Natural Bridges										1												2	2		24	
February 15 & 16, 2011																										
Sand Plant																										
Younger Lagoon																		5								
Natural Bridges	3									2		1		58												
May 3 & 4, 2011																										
Sand Plant	2										8															
Younger Lagoon																										
Natural Bridges	1						1							3				6					1			
July 22 & 23, 2011																										
Sand Plant					4		1								4										8	
Younger Lagoon																										
Natural Bridges	9				4					6								10							48	
March 29 & 30, 2012																										
Sand Plant														1												
Younger Lagoon										5							3			2						
Natural Bridges								1																2		
May 15 & 16, 2012																										
Sand Plant																										
Younger Lagoon						3				2										2						
Natural Bridges	1									1																
August 25 & 26, 2012																										
Sand Plant														2		2										
Younger Lagoon		1				1	1							4												
Natural Bridges														1												
November 5& 6, 2012																										
Sand Plant																	5									
Younger Lagoon										4							8									
Natural Bridges	2																									
January 13&14, 2013																										
Sand Plant																										
Younger Lagoon						1						1					5									
Natural Bridges																1						1				
May 1 & 2, 2013																										
Sand Plant																										
Younger Lagoon										1			2							2						
Natural Bridges	2																						2			
July 16-17, 2013																										
Sand Plant				1										1		1										
Younger Lagoon				1			2			7				2								1				
Natural Bridges							2			1				1								1			11	
October 22-23, 2013																										
Sand Plant														1		2										
Younger Lagoon			3				3							2				1		1					300	
Natural Bridges	2		1								1			3											3	
February 13-14, 2014																										
Sand Plant													6													
Younger Lagoon																							1			
Natural Bridges	1																									
April 27-28, 2014																										
Sand Plant	3										20															
Younger Lagoon						8					13		2													
Natural Bridges	3					2					11			7	2			8					1			
July 30-31, 2014																										

Site	AMCR	AMPE	BBPL	BCNH	BASW	BLOY	BLPH	BLTU	BRAC	BRBL	BRPE	BUHE	CAGO	CAGU	CLSW	CORA	COOT	DOCO	DUSP	EUST	GCSP	GRHE	GREG	GRTE	HEGU	HOFI
Sand Plant														10									1		10	
Younger Lagoon											18												4			
Natural Bridges											18														15	
November 4-5, 2014																										
Sand Plant																	2								6	
Younger Lagoon							2				5						6									
Natural Bridges	11									2							10						1		9	
January 26-27, 2015																										
Sand Plant							2						2													
Younger Lagoon											6						9									
Natural Bridges	12						1				27					3							1			
April 14-15, 2015																										
Sand Plant							1						2				1									
Younger Lagoon							2										1									
Natural Bridges											6						7									
July 8-9, 2015																										
Younger Lagoon				2	4																					
October 29-30, 2015																										
Younger Lagoon							1				4			2												
February 2-3, 2016																										
Younger Lagoon							1													2						
May 3-4, 2016																										
Younger Lagoon					4		2						2												1	
July 12, 2016																										
Younger Lagoon					3		1			12				2									1			
November 9-10, 2016																										
Younger Lagoon							2				1												1			
March 1-2, 2017																										
Younger Lagoon							1							3									1			
April 25-26, 2017																										
Younger Lagoon	1														6					2						
August 2-3, 2017																										
Younger Lagoon					8	2	2		8														1		2	6
October 25-26, 2017																										
Younger Lagoon							1		6		2															
February 7-8, 2018																										
Younger Lagoon							1		2		2										1				3	
May 2-3, 2018																										
Younger Lagoon					5	2	2		5	1																

Site	KILL	LOCU	MALL	MAGO	MEGU	MODO	NOHA	PECO	PIGR	PIGU	REHA	REPH	RWBB	RODO	SAND	SAPH	SNEG	SPSA	SURF	WEGU	WESA	WHIM	Richness
April 24 & 26, 2010																							
Sand Plant			2																	2			1
Younger Lagoon			3														2			2			3
Natural Bridges	1											2					2						2
August 11-12, 2010																							
Sand Plant																							1
Younger Lagoon	2	1	10														4			32			9
Natural Bridges	1																			3			5
November 15 & 16, 2010																							
Sand Plant																				1			2
Younger Lagoon								15							11			1		4			9
Natural Bridges	4					2									140		1	1		17		1	11
February 15 & 16, 2011																							
Sand Plant			2																	6			2
Younger Lagoon																1							2
Natural Bridges		3	4					47									18			6		19	10
May 3 & 4, 2011																							
Sand Plant			4				2			35										5		1	7
Younger Lagoon																							0
Natural Bridges	7	4	4	1										1						16		7	12
July 22 & 23, 2011																							
Sand Plant										17							1			1			7
Younger Lagoon																							0
Natural Bridges			7							3				2			2			81		1	11
March 29 & 30, 2012																							
Sand Plant			5																				2
Younger Lagoon	1		8					13									2			16		2	9
Natural Bridges			10	3						2					65		2			10		5	9
May 15 & 16, 2012																							
Sand Plant																				4		5	2
Younger Lagoon	3		2					25		5				1			2			15			10
Natural Bridges			6														2						4
August 25 & 26, 2012																							
Sand Plant	3																						3
Younger Lagoon			4					35				8		1			1			7			10
Natural Bridges	5		1															1		5	1		6
November 5& 6, 2012																							
Sand Plant																				1			2
Younger Lagoon	5							14			1			4			2			3		10	9
Natural Bridges	4		9														2	1	2			12	7
January 13&14, 2013																							
Sand Plant																							0
Younger Lagoon								3	1						38	1	1						8
Natural Bridges																	1			11			4
May 1 & 2, 2013																							
Sand Plant										8										2			2
Younger Lagoon			3			2		9												11		2	8
Natural Bridges			4																	23		2	5
July 16-17, 2013																							
Sand Plant										7													4
Younger Lagoon	2		25					8		1							4						10
Natural Bridges	1																			10			7
October 22-23, 2013																							
Sand Plant																							2
Younger Lagoon	4			1				33									3			150		26	13
Natural Bridges			2														4			110		24	8
February 13-14, 2014																							
Sand Plant			2											1						103			4
Younger Lagoon								8									4			7		10	5
Natural Bridges			2														1			19		24	5
April 27-28, 2014																							
Sand Plant			6							4										24		2	6
Younger Lagoon	3		6							8			1							2		2	9
Natural Bridges	1		4																	18		7	11
July 30-31, 2014																							

Site	KILL	LOCU	MALL	MAGO	MEGU	MODO	NOHA	PECO	PIGR	PIGU	REHA	REPH	RWBB	RODO	SAND	SAPH	SNEG	SPSA	SURF	WEGU	WESA	WHIM	Richness
Sand Plant	4									3										25		2	8
Younger Lagoon	2		2							3							3			28		1	8
Natural Bridges	3														7					80		7	6
November 4-5, 2014																							
Sand Plant													2							3			4
Younger Lagoon															11		1			10		8	7
Natural Bridges	4														20		4	1		18			10
January 26-27, 2015																							
Sand Plant			2																	25			4
Younger Lagoon			4										10							27		1	7
Natural Bridges			2										9				2			175		3	10
April 14-15, 2015																							
Sand Plant			2							3										5			6
Younger Lagoon	1												5				2			5			6
Natural Bridges													4				3			21		9	7
July 8-9, 2015																							
Younger Lagoon	2		2							4							2			31			7
October 29-30, 2015																							
Younger Lagoon																				6			4
February 2-3, 2016																							
Younger Lagoon			3							2							3			9		4	7
May 3-4, 2016																							
Younger Lagoon	1		3										1					1		8			10
July 12, 2016																							
Younger Lagoon			3														1			2			7
November 9-10, 2016																							
Younger Lagoon	6												5							6			8
March 1-2, 2017																							
Younger Lagoon								1					6				1			2		1	10
April 25-26, 2017																							
Younger Lagoon			4										2							2		4	8
August 2-3, 2017																							
Younger Lagoon	1																						8
October 25-26, 2017																							
Younger Lagoon	6																1	1		10			7
February 7-8, 2018																							
Younger Lagoon	6												7							3			8
May 2-3, 2018																							
Younger Lagoon	4												9									2	8

Discussion

Data collected indicate that Younger Lagoon Reserve (YLR) supports a wide variety of native flora and fauna, provides habitat for sensitive and threatened species, supports a very unique beach dune community, and is extensively used for research and education.

A parameter that we have mapped, and is evident from visual observation and photo documentation, is the presence of dune hummocks and downed woody material at YLR, both of which are almost entirely absent at Sand Plant Beach and Natural Bridges (Figure 11). It is likely that the hummocks and woody material are absent at Natural Bridges and Little Wilder due to human trampling, collection, and burning. These features provide habitat for plant species such as the succulent plant dudleya, which grow on downed woody material and dune hummocks at YLR, as well as burrowing owls that use burrows in hummocks and seek shelter beneath downed woody material at YLR.

Although Younger Lagoon does experience human use, the intensity and number of users is small. Additionally, users of the YLR beach are educated about the reserve, unique natural features, and are not allowed to collect woody material or trample dune vegetation. The relatively natural state of YLR beach and dune vegetation is unique among the three sites and most pocket beaches in Santa Cruz County and likely represents a glimpse into what many of the pocket beaches in the greater Monterey Bay area looked like prior to significant human disturbance.

Open access to the beach would likely result in the loss of the unique ecological characteristics of the site and certainly reduce its effectiveness as a research area for scientific study. Controlled beach access through the Seymour Center docent led tours, provides an appropriate level of controlled access that enables people to see and learn about the lagoon habitat while limiting impacts to the system. We recommend that this continue.

Figure 9. Younger Lagoon dune map. Survey data and resulting elevation model output shows topographic features on Younger Lagoon Beach.

Literature Cited

Friends of Santa Cruz State Parks. Natural Bridges. Retrieved from http://thatsmypark.org/naturalBridges.php. Accessed December 10, 2010.

Friends of Santa Cruz State Parks. Wilder Ranch. Retrieved from http://thatsmypark.org/wilderRanch.php. Accessed December 10, 2010.

Hyland, Tim. Personal communication December 22, 2010.

University of California at Santa Cruz. 2008. Final Compiled Coastal Long Range Development Plan. Prepared for California Coastal Commission, December 2008.

University of California at Santa Cruz. 2010. Notice of Impending Development 10-1, Beach Access Management Plan. Prepared for California Coastal Commission, March 2010.

Appendix 1. Younger Lagoon Photos.


YLR Beach Photopoint #1. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #1. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #1. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #4. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

Appendix 2. Compliance monitoring report

Compliance Monitoring Report for Coastal Prairie and Coastal Scrub Restoration Sites at Younger Lagoon Reserve
Spring 2018
J. Lesage

Introduction

In keeping with the goals of the restoration plan for the Younger Lagoon Reserve prepared for the California Coastal Commission (UCNRS 2010), reserve employees, interns, and volunteers have continued to perform native plant community restoration activities. This report presents the results of the 2018 monitoring of 2012, 2014, and 2016 coastal prairie habitat plantings, 2014 and 2016 coastal scrub plantings, and 2012 wetland buffer plantings. Restoration efforts at Younger Lagoon Reserve are within target native richness and cover goals for all planted areas measured except the 2012 coastal prairie habitat.

Methods

Planting

Seeds for the coastal prairie planting projects were primarily collected from local reference sites in coastal regions of Santa Cruz and San Mateo Counties. The seeds were typically grown in Ray Leach stubby (SC7) conetainers™ for several weeks in the UCSC greenhouses before being introduced to the site. Site preparation prior to planting typically involved the hand-pulling of large weeds (such as *Carpobrotus edulis*) and/or the application of herbicide and tarping to reduce weed cover. Additionally, a heavy layer of wood chip mulch (~10-15 cm) was applied to all restoration sites prior to planting to suppress subsequent weed emergence. Teams of volunteers, interns, and staff planted the native plugs primarily between December and February using dibblers. Sites received supplemental irrigation during the first year following planting to help ensure their establishment. After the first year, there was no supplemental irrigation. Follow up management included hand-pulling and spot spraying of herbicide for emerging weeds during the first 18-24 months following planting. All sites were mowed twice annually in the years following planting. Fall mowing was intended to reduce thatch, and spring mowing was intended to reduce weed seed set while allowing native perennial species to drop seed.

Sampling

Vegetation sampling followed the protocols described in Holl and Reed (2010). To measure cover in coastal prairie and wetland habitats, a 0.25 × 1-m quadrat was placed on alternating sides of a 50-m transect tape every 5 m, for a total of ten quadrats per 50-m transect. In some areas, 50-m transects did not fit the shape of the restoration area, so transects were split and divided into sections to better fit the site. Cover was measured using a modified Braun-Blanquet class system within each quadrat, with increases in 5% intervals, starting with 0-5%. The midpoint each cover class was used for data analysis (e.g. 2.5%, 7.5%, etc.). Richness was measured using a 2-m belt transect on either side of the 50-m transect tape to visually detect any native species not measured in the cover quadrat sampling. To measure cover in scrub habitats, the area of each species and bare ground under the transect was measured. In some areas, herbaceous cover and scrub were mixed, and both shrub measurements and quadrats were placed, as was appropriate to the location.

The 2012 coastal prairie planting area was measured using three transects of 25, 40, and 45 m, for a total of 22 quadrats (Figure 1). The 2014 coastal prairie was measured using three transects of 40, 45, and 50 m, for a total of 27 quadrats (Figure 2). The 2016 mixed coastal prairie and scrub planting area was measured using three transects of 50 m each, with a total of

28 quadrats and 7.5 m of scrub cover (Figure 1). For analysis, these transects were split into two prairie-identified transects and one scrub-identified transect. The 2014 predominantly scrub plantings were measured using four transects of 25, 25, 45, and 50 m, with a total of 9 herbaceous cover quadrat measurements and 84 m of scrub cover quantified (Figure 2). Finally, the 2012 wetland 6 buffer plantings were measured using two transects of 25 and 30 m transects for a total of 11 quadrats, and the 2016 wetland 6 planting was measured using two transects of 30 m each, for a total of 12 quadrats (Figure 3). For each planted area, cover and richness were averaged across transects/quadrats.

All sites are expected to meet the targets laid out for the California Coastal Commission (UCNRS 2010). The 2012 plantings are expected to meet six-year targets, the 2014 sites should meet four-year targets, and the 2016 sites should meet two-year targets. Targets for all habitat types and year-post-planting are available in Appendix 1.

Results

Native species cover targets were met and surpassed in all but the 2012 coastal prairie sites (Table 1). The 2012 coastal prairie had a native cover of 17.0 ± 5.1%, which does not meet the requirement of ≥ 25% native cover. The 2014 and 2016 coastal prairie sites had observed cover values of 31.3 ± 5.1% and 58.5 ± 6.9%, respectively, surpassing their ≥ 15% and ≥ 5% targets. The 2012 wetland 6 buffer (treated as coastal prairie) had an average native species cover of 44.1 ± 10.0%, exceeding the ≥ 25% native cover target. In the 2014 and 2016 coastal scrub sites, native cover goals were also met. Scrub cover in these sites was 92.3 ± 2.3% and 81.3%, respectively, exceeding the shrub cover goals of ≥ 40% and ≥ 25%. Within these scrub areas, herbaceous cover was also above targets. Finally, wetland 6 had 65.4 ± 8.0% native cover, far exceeding the ≥ 10% native cover requirement.

Native species richness measurements were also at or above defined target levels for all planted areas except the 2012 coastal prairie (Table 2). Transects in the 2012 coastal prairie area had a native species richness of 3.7 ± 0.9 species, which does not meet the requirement of ≥ 8 species. The 2014 and 2016 coastal prairie sites had observed richness values of 8.7 ± 3.2 and 18 ± 2.0, respectively, surpassing their ≥ 6 species targets. The 2012 wetland 6 buffer had 10.0 ± 1.0 native species, meeting the ≥ 8 species target. Both the 2014 and 2016 coastal scrub areas met their ≥ 6 species goals, with 12 ± 1.9 native species per transect and 19 native species respectively. Finally, wetland 6 had 7 native species, meeting the ≥ 4 species target.

All planted areas showed evidence of recruitment for multiple species.

Discussion

All but one restoration area at Younger Lagoon Reserve met or exceeded the restoration targets laid out for the California Coastal Commission for their respective habitats (UCNRS 2010). The 2012 wetland 6 buffer area, 2014 coastal prairie and coastal scrub areas, the 2016 coastal prairie and scrub areas all appear to successfully have restored native species cover and richness. Only the 2012 coastal prairie area did not meet its restoration targets, with both native cover and native species richness targets failing to be met.

The 2012 coastal prairie plantings had a native cover of 17.0 ± 5.1% (target ≥ 25%), and species richness of 3.7 ± 0.9 species (target ≥ 8 species). These low values indicate that follow-up weeding and planting will be necessary for this location in the future. These transects were dominated by non-native forb species, primarily *Medicago polymorpha*, suggesting that a weed-management technique known to reduce forb species may be beneficial at this location. Data should have been collected for these areas in 2014 and 2016, however, due to record keeping error, they were collected in 2015. In 2015, native cover was 31.2 ± 4.1% (target ≥ 25%), and species richness of 6.3 ± 1.2 species (target ≥ 8 species) (Lesage, 2015), demonstrating the difficulty of maintaining native cover and richness at coastal prairie restoration sites.

A comparison of monitoring data from 2016 and 2018 shows interesting trends in the coastal prairie and coastal scrub plantings (Lesage 2016). The 2014 coastal prairie native cover has declined slightly, from 42.3 ± 5.9% in 2016 to 31.3 ± 5.7% in 2018. If this decline continues, the 2014 coastal prairie site may not meet its ≥ 25% native cover 4-year goal. However, the native species richness for the 2014 coastal prairie site has not declined significantly, going from 9.3 ± 0.9 species in 2016 to 8.7 ± 3.2 species this year. In the coastal scrub, we see the opposite trend. It is more difficult to compare the 2014 coastal scrub plantings, as they were measured differently in 2016 and 2018. In 2016, these plantings achieved a native cover of 59.4 ± 7.2%. The shrub cover measured this year was 92.3 ± 2.3%, with herbaceous cover of 29.7 ± 8.1% between the shrub plantings. Measuring purely the shrub cover, we see 77.1 m of native shrubs over 145 m of transect, for a native cover value of 53.2%. This indicates that shrub cover has not declined significantly since 2016. The native species richness in this habitat continues to exceed goals, going from 7.0 ± 0.6 native species per transect in 2016 to 12 ± 1.9 native species per transect in 2018. Overall, these findings suggest that coastal prairie habitat may be difficult to maintain into the future without more intensive management, whereas restored coastal scrub sites are more likely to thrive.

Generally, the restoration efforts at Younger Lagoon Reserve are meeting their target goals. Management strategies, such as irrigation during the first year, hand-weeding of sites, and seasonal mowing, are maintaining native cover and richness in restored coastal prairie, coastal scrub, wetland buffer and wetland habitats. Only the 2012 coastal prairie planting did not meet their targets, suggesting that additional planting or weed management in this area will be necessary in the future.

Tables and Figures

Figure 1. Map of locations for the 2012 coastal prairie transects and planting areas (orange lines in green shaded area) and 2016 coastal prairie and scrub plantings (orange lines in purple shaded area). Note that some transects were split to fit the sites or to address changes in vegetation type.

Figure 2. Map of locations for the 2014 coastal prairie transects (orange lines) and 2014 coastal scrub transects (blue lines) within the 2014 planting areas (pink outline). Note that some transects are split to fit the sites.

Figure 3. Map of locations for the 2012 wetland 6 buffer transects and planting area (orange lines in green shaded area) and 2016 wetland 6 transects (orange lines in the purple shaded area). Note that some transects are split to fit the sites.

Table 1. Table of native species cover and richness targets and observed values (± SE) in the 2012, 2014, and 2016 coastal prairie, 2014 and 2016 coastal scrub, 2016 wetland 6, and 2012 wetland 6 buffer restoration areas at Younger Lagoon Reserve.

Restoration Area	Observed Native Cover (%)	Target Native Cover (%)	Observed Native Richness (# species/transect)	Target Native Richness (# species/transect)
2012 Wetland 6 Buffer	44.1 ± 10.0	≥ 25	10.0 ± 1.0	≥ 6
2012 Coastal Prairie	17.0 ± 5.	≥ 25	3.7 ± 0.9	≥ 6
2014 Coastal Prairie	31.3 ± 5.7	≥ 15	8.7 ± 3.2	≥ 6
2016 Coastal Prairie	58.5 ± 6.9	≥ 5	18 ± 2.0	≥ 6
2014 Coastal Scrub				
Shrub Cover	92.3 ± 2.3	≥ 40	12 ± 1.9	≥ 6
Herb Cover	29.7 ± 8.1	≥ 15		
2016 Coastal Scrub				
Shrub Cover	81.3	≥ 25	19	≥ 6
Herb Cover	33.0 ± 9.4	≥ 5		
2016 Wetland 6	65.4 ± 8.0	≥ 10	7	≥ 4

Table 2. Table of the native species observed in the 2012, 2014, and 2016 coastal prairie, 2014 and 2016 coastal scrub, 2016 wetland 6, and 2012 wetland 6 buffer restoration areas at Younger Lagoon Reserve. Chart shows species found in at least one transect for each site. Growth forms abbreviated (AF=Annual Forb, PF=Perennial Forb, PG=Perennial Grass, PGRM=Perennial Graminoid, S=Shrub, T=Tree).

Scientific Name	**Common name**	**Growth Form**	**2012 W6 Buffer**	**2012 Coastal Prairie**	**2014 Coastal Prairie**	**2016 Coastal Prairie**	**2014 Scrub**	**2016 Scrub**	**2016 W6**
Cardamine oligosperma	western bittercress	AF	X		X		X		
Lupinus nanus	sky lupine	AF				X			
Achillea millefolium	yarrow	PF	X	X	X	X	X	X	
Baccharis glutinosa	marsh baccharis	PF				X	X	X	
Chlorogalum pomeridianum	soaproot	PF	X			X	X	X	
Clinopodium douglasii	yerba buena	PF					X		
Eriophyllum staechadifolium	lizard tail	PF				X	X	X	
Eschscholzia californica	California poppy	PF				X		X	
Fragaria chiloensis	beach strawberry	PF						X	
Grindelia stricta	gumweed	PF				X	X	X	
Potentilla anserina	Pacific silverweed	PF							X
Prunella vulgaris	selfheal	PF				X		X	X
Pseudogna-phalium sp.	cudweed	PF		X	X				
Ranunculus californica	California buttercup	PF		X	X				
Scrophularia californica	California bee plant	PF					X		
Sidalcea malviflora	checker-bloom	PF					X		
Sisyrinchium bellum	western blue-eyed grass	PF				X		X	
Symphyotrichum chilense	Pacific aster	PF	X	X	X	X	X	X	X
Bromus carinatus	California brome	PG		X		X			
Danthonia californica	California oatgrass	PG				X			

Table 2, continued

Scientific Name	Common name	Growth Form	2012 W6 Buffer	2012 Coastal Prairie	2014 Coastal Prairie	2016 Coastal Prairie	2014 Scrub	2016 Scrub	2016 W6
Elymus glaucus	blue wild rye	PG		X	X	X	X	X	
Elymus triticoides	creeping wild rye	PG	X	X	X	X		X	X
Hordeum brachyantherum	meadow barley	PG	X	X	X	X	X		X
Horkelia californica	California horkelia	PG			X	X	X	X	X
Stipa pulchra	purple needle grass	PG		X		X	X		
Carex hartfordii	Monterey sedge	PGRM			X	X			X
Juncus mexicanus	Mexican rush	PGRM	X			X			X
Juncus patens	spreading rush	PGRM	X		X	X	X	X	X
Artemisia californica	California sagebrush	S			X	X	X	X	
Baccharis pilularis	coyote brush	S	X		X	X	X	X	
Lupinus variicolor	varied lupine	S				X			
Mimulus aurantiacus	sticky monkey flower	S			X		X	X	
Ribes sanguineum	flowering currant	S			X		X		
Rosa californica	California wild rose	S			X		X		
Rubus ursinus	pacific blackberry	S	X		X	X	X	X	
Salix lasiolepis	arroyo willow	T	X						
Observed Native Species Richness:			11	9	17	24	21	18	9
Target Native Species Richness:			≥ 6	≥ 6	≥ 6	≥ 6	≥ 6	≥ 6	≥ 4

Table 3. Rainfall for Santa Cruz for rainfall years starting with the 2011-2012 rain year. Rainfall years are measured from October to September of the following year. Data from the California Department of Water Resources.

Rainfall Year	Total Precipitation
100 Year Average	75.8 cm
2011-2012	52.6 cm
2012-2013	45.8 cm
2013-2014	36.6 cm
2014-2015	55.1 cm
2015-2016	82.7 cm
2016-2017	129.7 cm

Works Cited

California Department of Water Resources. 2016. California Data Exchange Center: Santa Cruz "CRZ" precipitation data. Retrieved from http://cdec.water.ca.gov/cgi-progs/staMeta?station_id=CRZ

Holl, K. D., and Reed, L. K. 2010. Reference and Baseline Vegetation Sampling for Younger Lagoon Natural Reserve. Report to the Coastal Commission.

Lesage, Josie. 2016. Compliance Monitoring Report for Five Restored Habitat Patches at Younger Lagoon Reserve, Spring 2016. Monitoring Report Prepared for the California Coastal Commission.

UCSC Natural Reserves Staff and the Younger Lagoon Reserve Scientific Advisory Committee (UCNRS). 2010. Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve. Plan prepared for the California Coastal Commission.

Appendix 1 – Relevant Compliance Monitoring Standards for YLR Restoration Efforts

Excerpted from: *UCSC Natural Reserves Staff and the Younger Lagoon Reserve Scientific Advisory Committee (UCNRS). 2010. Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve. Plan prepared for the California Coastal Commission.*

Grassland / Coastal Prairie
Performance Standard: 8 native plant species appropriate for habitat established in planted areas to comprise 25% cover.

Years Post Planting	Goal
2 years after planting	6 or more native plant species established comprising > 5% cover and evidence of natural recruitment present
4 years after planting	6 or more native plant species established comprising > 15% cover and evidence of natural recruitment present
6 years after planting and every 5 years after that	8 or more native plant species established comprising > 25% cover and evidence of natural recruitment present

Scrub
Performance Standard: 8 native plant species appropriate for habitat established in planted areas to comprise 40% cover.

Years Post Planting	Goal
2 years after planting	6 or more native plant species established comprising > 10% cover and evidence of natural recruitment present
4 years after planting	6 or more native plant species established comprising > 25% cover and evidence of natural recruitment present
6 years after planting and every 5 years after that	8 or more native plant species established comprising >40 % cover and evidence of natural recruitment present

Wetlands (except W1/2)

Performance Standard: 4 native plant species appropriate for habitat established in planted areas to comprise 30% cover.

Years Post Planting	Goal
2 years after planting	4 or more native plant species established comprising > 10% cover and evidence of natural recruitment present

4 years after planting	4 or more native plant species established comprising > 20% cover and evidence of natural recruitment present
6 years after planting and every 5 years after that	4 or more native plant species established comprising > 30% cover and evidence of natural recruitment present

Appendix 3. Student intern reports

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

MIXED EFFECTS OF MULTI-YEAR STORAGE ON GERMINATION OF CALIFORNIA NATIVE SPECIES

A Senior Thesis submitted in partial satisfaction
Of the requirements for the degree of

BACHELOR OF ARTS

in
ENVIRONMENTAL STUDIES/BIOLOGY COMBINED

by
Madison Ginn

June 2018

ADVISOR(S): Karen D. Holl, Environmental Studies

ABSTRACT: Successful restoration of California coastal prairie and sage scrub ecosystems relies on a properly stored native seed stock. This study quantifies the percent germination of 25 native plant species collected coastally near Santa Cruz, CA for restoration at the Younger Lagoon Reserve (YLR). The purpose of this study is to inform seed management at YLR and beyond, and to understand how multi-year storage affects the percent germination and time to germination of a subset of these species. One hundred seeds from each collection year of the 25-study species were sown into four repetition containers equally in a 5 × 5 seed grid and monitored weekly for germination. Results showed mixed effects of seed age on percent germination and time to germination, with over half of all study species demonstrating a decrease in germination and half showing an increase in time to germination with increasing age. Germination of the remaining species either did not vary with seed age or showed some interannual variation but with no obvious directional trend. Eighteen of the 25 species showed at least 30% mean germination without complicated germination triggers. These species-specific results indicate a necessity to test all available seed stock when possible to ensure best seed management and increase restoration success. If this is not feasible, seed should be used within a couple years post collection, as a majority of the California native species tested show a decrease in percent germination over time.

KEYWORDS: Restoration, seed longevity, California native species, coastal prairie, sage scrub

6/7/18

Introduction

Coastal sage scrub and prairie ecosystems are critically threatened in California (Hoekstra et al. 2005). Non-native invasive species have proliferated through grassland and sage scrub habitats leading to detrimental ecological impacts (Vasey & Holl 2007). The long-term recovery of California native ecosystems will depend on developing best management strategies for their restoration, which are currently being developed throughout the state (Dorner 2002). Planting and propagating native seed for restoration ensures conservation of biodiversity and genetic diversity at the project site and increases site resistance to invasive species (Vasey & Holl 2007). This being said, seed germination rates and seed longevity data for the huge variety of California native species are largely unexplored. Species-specific data for these characteristics will help inform restorationists about seed collection and seed management practices.

Seed longevity and resulting germination rates are determined by many variables including species-specific biology and dormancy mechanisms, seed collection practices, storage conditions, and interannual variation in the health of the parent population (Baskin, 1988, Rajjou et al. 2008). Previous studies have shown that interannual variability in microclimatic conditions and other maternal environmental factors can explain substantial variation in germination rates, making it essential from a restoration point of view to collect seeds in bulk over many years (Barton, 2016; Tielbörger and Martina Petrů 2010; Gulmon, S. L. 1990). Although I found few studies on seed longevity for California native species, studies outside California have used primarily field-based studies to analyze seed longevity. The overwhelming majority of these studies have found reduced seed longevity with both greater soil moisture content and temperature (Dickie et al. 1989, Brown & Briggs 1991, Nguyen et al. 2012). Furthermore, seed dormancy and seed longevity have been shown to be negatively correlated, with reduced seed longevity correlating with deep seed dormancy. (Nguyen et al. 2012, Schwienbacher et al. 2010).

Plants endemic to California's Mediterranean climate have adapted seed longevity in response to microclimatic conditions and disturbances that have made optimal germination conditions rare. (Baskin 1998). Drought events common to California, for example, make long dormancy periods necessary for survival. Regardless of this relationship, proper seed storage practices are required for long-term seed viability (Brown & Briggs 1991). Best seed collection protocol by the Millenium Seed Bank at Kew Gardens, the world's leader in seed banking, dictates that seeds of all sizes and across environmental gradients should be collected to ensure the greatest genetic diversity possible, and the required maturity of the seed at time of collection depends largely on life-form and species-specific requirements (Brown and Briggs 1991; Emery 1988; Table 5).

There is limited information on whether interannual variation in seed quality or seed longevity has a stronger influence on germination rates. Dara Emery's book, *Seed Propagation of Native California Plants,* supplies information on the germination requirements of hundreds of native California species. However, it lacks information on species-specific germination rates or seed longevity. Consolidated information on species-specific seed attributes and germination patterns will better enable restorationists to collect and store high quality seed, and in turn reduce project costs and increase plant establishment. (Barton, 2016).

The purpose of this study is to: (1) quantify the percent germination of 25 native California grassland and shrubland species commonly used in coastal scrub and prairie restoration along the central coast of California and (2) quantify how time since collection (1-6 years) affects the germination of a subset of these species to help inform seed management in ecological restoration at the Younger Lagoon Reserve (YLR) located in central California, and beyond. I tested the hypotheses that percent germination decreases with seed age and that time to germination increases with seed age, which could occur as a result of genetic or physiological storage potential, deterioration events during storage, and/or environmental factors pre-storage or post sowing (Rajjou et al. 2008, Emery 1988).

Materials and Methods

Site Description. Seeds for this study were collected along State Route 1 at Año Nuevo State Park (37.1193° N, -122.3076° W), Wilder Ranch State Park (36.9608° N, -122.0834° W), Coast Dairies State Park (36.9843° N, -122.1557° W), Scaroni Farms (36.978002, -122.138153), 4 Mile Beach (36.966331, -122.122721), and on the University of California at Santa Cruz (UCSC) campus at West Marshall Field (37.030242° N, -122.061015° W). All of the above sites are either near or in Santa Cruz, California, and were collected for the Younger Lagoon Reserve (YLR) restoration project. YLR is a 29 ha area of protected land (36.5791159° N, -122.35546° W) that belongs to the University of California Natural Reserve System (UCNRS). Heavy agricultural use of the lands in Brussels sprout farming and cattle production for over 150 years caused proliferation of non-native species into the ecosystem and dramatic native habitat destruction (Stern 2013, Holl et al. 2014). As a result, the property supported minimal existing native seed bank aside from *Baccharis pilularis* and *Baccharis douglasiana* upon the start of a 20-year restoration project that began on site in 2008 (Stern 2013).

The primary goals of the YLR restoration project are to restore the pre-agricultural coastal prairie, scrub, and wetland ecosystems and their associated seedbanks, and to increase native coverage. YLR staff, with the help of undergraduate interns from UCSC, have provided a continued workforce to complete the restoration project through collection and storage of native seeds, preparation of the site for planting, and eventual transplanting and monitoring of native propagules to the site. After collection and cleaning, seeds are dried for 1-2 years and then stored either on site at YLR or at the Thimann Greenhouse located on the upper campus of UCSC, approximately 5 km away (T. Brown, pers. comm. May 22, 2018). All seed germination testing for this study took place at Thimann Greenhouse.

Rainfall in California's Mediterranean climate falls primarily during the winter months from November through April, with a prolonged dry season from May through October. Seeds for the YLR project were collected during this dry period. Rainfall data were obtained from the Younger Lagoon Reserve, California Weather Station, and each rainfall year (mm) was measured from October 1st of the prior year through September 30th of the following year.

Species description. Twenty-five native California species that are commonly used for the YLR restoration project were selected for this study. Species and collection years reflected the seed collections collected annually by YLR interns and staff. All seed collections were stored with desiccant packets either in plastic bags at the Thimann greenhouse, where some species were stored at ambient temperature and some at -2°C, or stored on site at YLR in glass containers or paper bags at room temperature. Sixteen of the total species selected were tested in chronosequence. The 16 chronosequence collections range from 2010 to 2016, and each species has seed collections for ≥ 3 years in chronosequence (Table 1). The remaining five were tested for germination percentage in 2-3 collection years and include supplemental germination testing that occurred in 2017 of 15 YLR native species from multiple collection years. (Table 1).

Experimental Design and Data Collection. For each species × collection year combination, 100 seeds were equally divided into four containers. The sowing took place over a period of three days from January 11th-13th, 2018 and on February 3rd, 2017 for earlier tests. Pro-mix HP Mycorrhizae soil was used in all 10.16 × 10.16 × 15.24-cm pots. In each repetition, 25 seeds were individually placed into a 5 × 5 seed grid, avoiding aggregation that could affect germination results. Once placed, a light covering of soil approximately 1.5x the seed length was placed over the seeds. All pots were misted twice daily by the greenhouse irrigation system and watered additionally when the soil surface was dry to the touch, monitored weekly. I counted germination weekly and removed all visible germinants from the soil with forceps. Because germinants were removed once visible to the naked eye, time to germination numbers may be longer than they were in actuality when radicles were present. In 2017, stratification of all seed was recommended for several weeks prior to sowing by greenhouse staff. However, since this method seemed to slow germination, no mechanisms for breaking seed dormancy were used in 2018 except on *Sisyrinchium bellum,* which was stratified in the greenhouse refrigerator at 2.78°C for 6 weeks pre-sowing (Emery, 1988).

Statistical analysis. ANOVA was used to determine which chronosequence species showed an effect of seed age/collection year on percent germination and on time to germination. When seed age was significant, Tukey's multiple comparison procedures were conducted to determine which years differed significantly. I visually inspected the residuals from the analyses, which met the assumption of normality and heterogeneity of variance without transformation. Additionally, I performed a multiple linear regression to analyze whether rainfall in the prior year explained a significant amount of variation in percent germination beyond that explained by seed age. Tests were performed for all species with ≥ 4 collection years where species showed a directional time effect.

Results

Germination rates varied greatly across species and seed age with 18 of the 25 (72%) species exhibiting at least 30% germination in one or more collection years with no additional treatments used to stimulate germination (Figure 1, Table 2). Of the species tested in 2018, *Artemisia californica, Frangula californica,* and *Sisyrinchium bellum* showed very low or no germination in every collection year. Germination percentages for species tested in 2017 were much lower overall, with *Carex gynodynama, Cirsium quercetorum, Danthonia californica, Erigeron glaucus,* and *Symphyotrichum chilense* all exhibiting very low or no germination in every collection year as well.

Of the 13 chronosequence species that germinated, over half (7/13, 54%) showed a decrease in germination with seed age, and six of these showed an increase in time to germination with seed age. Only *Elymus glaucus* showed the opposite trend (Table 3). For 3 species (*Horkelia californica, Prunella vulgaris,* and *Hordeum brachyantherum*), percent germination varied significantly across seed collection years, but with no obvious directional trend. The remaining three species (23%) showed no effect of seed age on germination (Figure 1). Collections including frozen stored seed at -2°C had the highest F values associated with effects of seed age on germination percentage (*Elymus glaucus* $F = 85.0$, $p < 0.0001$) aside from *Frangula californica*, which did not germinate.

The effect of rainfall year on germination percentage was significant for two out of six cases where more than three collection years were tested in chronosequence and the species also showed a directional time effect of seed age on germination. The amount of rainfall in the prior year showed a counterintuitive negative effect on *Bromus carinatus* and *Navarretia squarrosa* germination, both with chronosequences ranging from 2011-2015 and 2013-2017, respectively (Table 4).

Discussion

Central coast California natives showed species-specific responses to multi-year storage. Consistent with my hypothesis, a slight majority of species showed a decrease in germination percentage and an increase in time taken for germination to occur as seeds aged. Decreasing germination and increasing time to germination with seed age observed here is supported by previous studies indicating that during time in storage, seeds become less tolerant to stresses during germination, lose vigor, and deteriorate (Nguyen et al. 2012, Rajjou et al. 2008). My results that *Bromus carinatus* and *Elymus glaucus* seeds are short lived when stored at room temperature, are consistent with (Dremmen 2003) who reported seeds of those species only last around three years (Dremmen 2003). Asteraceae is the only other family in this study tested with more than two species, all of which showed a decrease in germination overtime aside from *Artemisia californica*. I found little research on seed longevity of native California Asteraceae species, but restorationist Justin Luong suggested that other Asteraceae species used for restoration at the University of California, Santa Barbara are similarly short-lived (J. Luong pers. comm. May 21, 2017). It could be that *Artemisia californica* seed used for this study, which was between three and five years old, was not viable.

Three species showed a time effect but with no obvious directional trend, suggesting that for these species, interannual variation in seed quality has a stronger effect on germination percentage than seed longevity, at least within the first few years post collection. Past studies have shown that the rate of seed germination depends on initial seed quality and health of the parent population upon collection, which inevitably varies annually (Nguyen et al. 2012, Rajjou et al. 2008). Cox and Allen (2011) reported that yearly precipitation levels influenced percent cover of both grasses and forbs in southern California (Cox and Allen 2011), and a study by Kochanek (2011) indicated that pre-zygotic environments resulted in parental responses that were passed to offspring seeds, changing their longevity dramatically. Several studies have indicated that although previous rainfall year does show an effect on germination in the field, other maternal environmental factors better explain variation in germination (Tielbörger and Martina Petrů 2010; Gulmon, S. L. 1990) This could help to explain why only *Bromus carinatus* and *Navarretia squarrosa* indicated any significant effect of prior rainfall year on resulting germination. For both species, the effect of seed age on germination percentage explained more variation than prior rainfall year, though rainfall year also had a significant effect. However, the results were contradictory to what I would have expected, with lower germination percentages for seed collections collected after wetter rainfall years. Seeds collected after heavier rainfall years may be more likely to harbor fungal infections, which may have led to this result (T. Brown pers. Obs.)

It is important to note that I measured seed germination and not seed viability, so some of the seed that did not germinate may be viable and require overcoming complex dormancy mechanisms to initiate germination. A lack of appropriate germination triggers was likely the cause of little to no germination observed for *Sisyrinchium bellum* and *Frangula californica* in all chronosequence years, and possibly for *Artemisia californica* as well. Emery's book *Seed Propagation of Native California Plants* suggests that several years or more may be necessary to break dormancy of some species. *Sisyrinchium bellum* has been observed to take two or more years to germinate in the field, suggesting necessary after-ripening to allow for gas exchange, water penetration, and neutralization of inhibitory chemicals to initiate germination events (K. Holl pers. comm. May 16, 2018; Emery 1988). Emery (1988) suggests 1.5 months stratification for newer seeds and no treatment for 3-6 year old seeds for *Sisyrinchium bellum*, whereas Luong (pers. comm.) recommends grinding seeds with a mortar and pestle, pouring boiling hot water over the seeds, allowing them to soak for a week in the shade, and then sowing immediately.

Stored *Frangula californica* seeds are said to require at least three months of stratification (Emery 1988).

Two other factors that could explain, in part, the mixed trends of this are YLR seed collection and storage practices and differences in experimental methods. YLR seed collections from different locations are originally kept separate, but are often later pooled into one collection container to conserve space and labeled only with the collection year. Therefore, site-specific interannual variation in collections cannot be determined and collections could have been from more than one site. Furthermore, the majority of seeds for YLR restoration are stored in dry conditions at ambient temperature. Orthodox seed collections from Kew Millenium Seed Bank state that storage life approximately doubles for each 5ºC decrease in storage temperature, and thus germination percentage may have been higher for species had they been stored at lower temperatures rather than at room temperature. Seeds that were frozen at the Thimann greenhouse were stored at -2ºC, whereas Kew Gardens recommends a seed storage temperature of -4ºC or less (Linington and Manger, 2014). Part of the reason that germination percentages overall were lower in 2017 is that seeds of all species were stratified for a prolonged period, which may have caused a decrease in the observed germination rates of some of the species (Emery 1988). Lastly, the Thimann Greenhouses were only available for use for a period of four months. Had the study been allowed to run for longer, more seeds may have germinated, affecting overall results.

Recommendations

In light of species-specific, mixed-effect results, restorationists should, whenever possible, test all available seed stock to ensure best seed management and increase restoration success. Where this is not feasible, seeds should be planted on site within a couple years post collection to avoid potential loss of seed germination vigor due to seed aging and to avoid prolonged external environmental effects such as rainfall, disease, and herbivory that are exposed to slower germinating, older seed collections (Brown et al. 1991). Seed collection and seed storage protocols developed for the Millennium Seed Bank at Kew Botanical Garden (summarized in Table 4) should be followed to the extent possible to improve seed longevity when seeds are stored for multiple years. To date, most of the knowledge of seed germination triggers and longevity for California native species amassed by horticulturalists and restoration practitioners have not been documented. Written documentation and communication of successful strategies implemented by restorationists in seed collection, storage, and sowing practices will help increase the success of native plant restoration at Younger Lagoon Reserve and elsewhere.

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Works Cited

Barton, M. L., Medel, I. D., Johnston, K. K., Whitcraft, C. R. (2016). Seed Collection and Germination Strategies for Common Wetland and Coastal Sage Scrub Species in Southern California. *Bulletin, Southern California Academy of Sciences.* 115(1):41-71. Retrieved from https://doi.org/10.3160/soca-115-01-41-71.1

Baskin, C. C., Baskin, J. M. (1998). *Seeds: Ecology, Biogeography, and Evolution of Dormancy and Germination.* San Diego, CA: Elsevier Inc.

Brown, A.H.D., Briggs, J.D., 1991. Sampling strategies for genetic variation in ex situ collections of endangered plant species. In: Falk, D.A., Holsinger, K.E. (Eds.), Genetics and Conservation of Rare Plants. Oxford University Press, New York, pp. 99–119.

Dickie, J. B., Ellis, R. H., Kraakj, H. L., Ryder, K., Tompsett, P. B. (1989). Temperature and Seed Storage Longevity. *Annals of Botany.* 65: 197-204

Dorner, J. (2002). *An introduction to using native plants in restoration projects.* Prepared for Plant Conservation Alliance Bureau of Land Management, US Department of Interior U.S. Environmental Protection Agency. Retrieved from https://www.fs.fed.us/wildflowers/Native_Plant_Materials/documents/intronatplant.pdf

Dremmen, C. (2003). Observations on *Bromus carinatus* and *Elymus glaucus*: Seed Storage and Longevity. *Native Plants.* 4(1): 61-64.

Emery, D. E. (1988). Seed Propagation of Native California Plants. Santa Barbara Botanic Garden: Library of Congress Cataloging-in-Publication Data.

Gulmon, S. L. (1990). Patterns of seed germination in Californian serpentine grassland species. *Oecologia.* 89:27-31.

Hoekstra, J. M., T. M. Boucher, T. H. Ricketts, and C. Roberts. (2005). Confronting a biome crisis: global disparities of habitat loss and protection. *Ecology Letters.* 8:23-29.

Holl, K. D., Howard, E. A., Brown, T. M., Chan, R. G. Silva. T. S., Tyler Mann, E., Russel, J. A., Spangler, W. H. (2014). Efficacy of Exotic Control Strategies for Restoring Coastal Prairie Grasses. *Invasive Plant Science and Management. 7*: 590-598.

Kochanek, J., Steadman, K. J., Probert, R. J., Adkins, S. W. (2011). Parental effects modulate seed longevity: exploring parental and offspring phenotypes to elucidate pre-zygotic environmental influences. *New Phytologist.* 191: 223-233.

Linington, S., Manger, K. (2014). Seed bank design: cold rooms for seed storage. Royal Botanic Gardens at Kew. Retrieved from https://www.kew.org/sites/default/files/12-Cold-room-design.pdf

Rajjou, L., Lovingny, Y., Groot, S. P. C., Belghazi, M., Job, C., Job, D. (2008). Proteome-Wide Characterization of Seed Aging in Arabidopsis: A Comparison between Artificial and Natural Aging Protocols. *Plant Physiology.* 148: 620-541.

Schwienbacher, E., Marcante, S., Erschbamer, B. (2010). Alpine species seed longevity in the soil in relation to seed size and shape - A 5-year burial experiment in the Central Alps. *Flora. 205*(1): 19-25.

Stern, Naomi.(2013). *Background to Younger Lagoon Reserve: A Socio-political Perspective.*

Nguyen, T. Keizer, P., Eeuwijk, F, Smeekens, S., Bentsink, L. (2012). Natural Variation and Seed Dormancy Are Negatively Correlated in Arabidopsis. *Plant Physiology. 160*(4): 2083-2092.

Tielbörger and Martina Petrů. (2010). An experimental test for effects of the maternal environment on delayed germination. *Journal of Ecology. 98*(5): 1216 - 1223.

Tischew, S., Youtie, B., Kirmer, A., Shaw, N. (2011). Farming for Restoration: Building Bridges for Native Seeds. E*cological Restoration.* 29(3): 219-222.

Nguyen, T., Keizer, P., Eeuwijk, F., Smeekens, S., Bentsink, L. (2012). Natural Variation for Seed Longevity and Seed Dormancy Are Negatively Correlated in Arabidopsis. *Plant Physiology.* 160: 2083-2092.

Vasey, M. C., Holl, K. D. (2007). Ecological Restoration in California: Challenges and Prospects. *Madroño.* 54(3): 215-224.

Vitt, P, K Havens, AT Kramer, D Sollenberger, and E Yates. 2010. "Assisted migration of plants: Changes in latitudes, changes in attitudes." Biological Conservation 143:18-27.

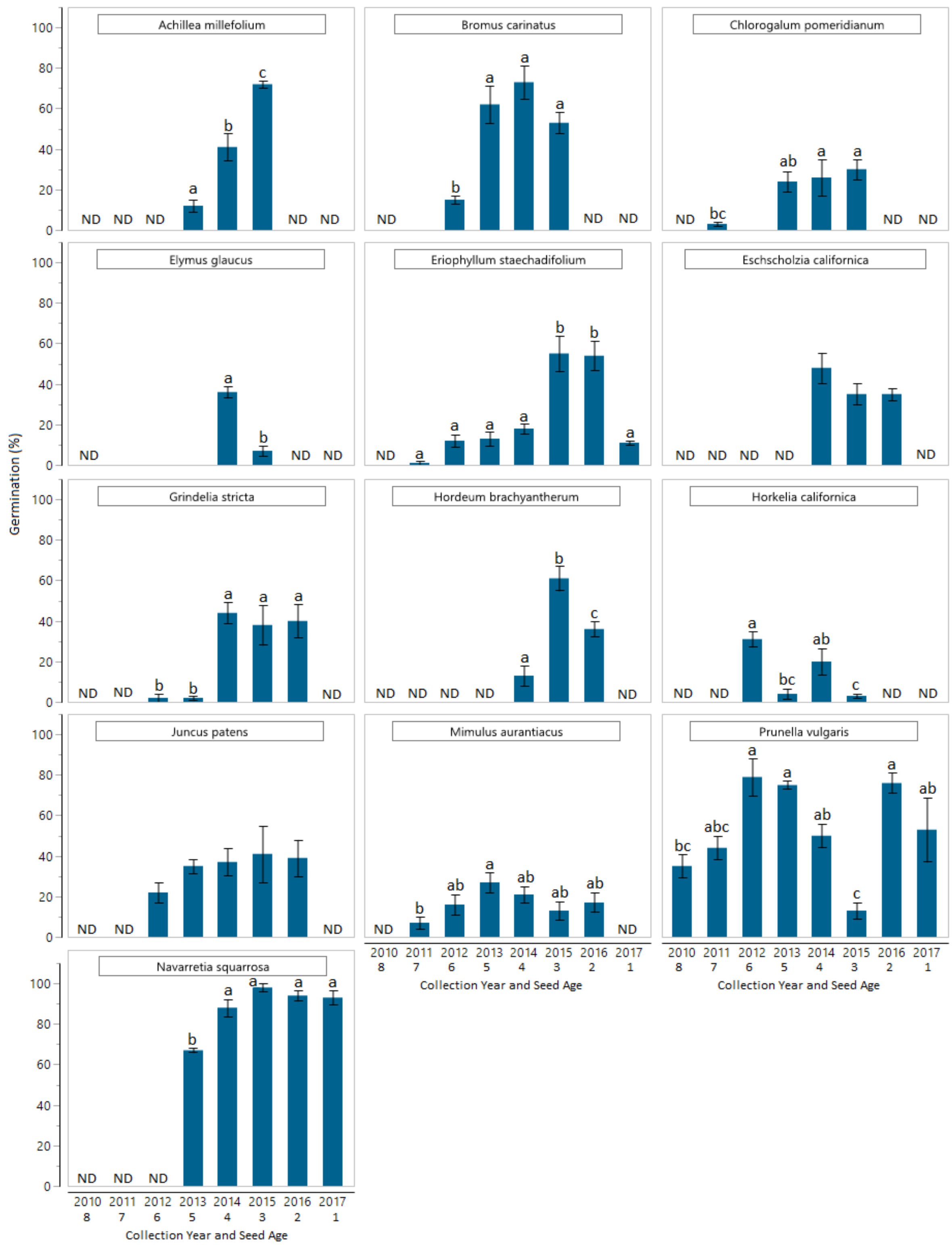

Figure 1. Percent germination of species tested in 2018 in chronosequence. Error bars indicate 1 SE. When ANOVA (Table 1) indicated a significant effect of seed age on percent germination, differences in means using Tukey's mean separation procedure are indicated with lower case letters. ND = no data for that year.

Table 1. Complete list of all species included in both 2017 and 2018 germination tests. Species marked with "C" were tested in chronosequence.

Latin Name	Common Name	Growth Form	2018 Collections	2017 Collections	Frozen/Dry Storage
Bromus carinatus	California Brome	perennial graminoid	2011 - 2015, C	2012, 2015	2011-2014 frozen, 2015 dry
Carex gynodynama	Olney's Hairy Sedge	perennial graminoid	2015, 2016		dry
Danthonia californica	California Oatgrass	perennial graminoid		2016	dry
Elymus glaucus	Blue Wild Rye	perennial graminoid	2011 - 2015, C	2012, 2015	frozen
Hordeum brachyantherum	Meadow Barley	perennial graminoid	2014 - 2016, C	2012, 2014, 2016	2012 frozen, 2014-2016 dry
Juncus mexicanus	Mexican Rush	perennial graminoid	2015, 2016		dry
Juncus patens	California Grey Rush	perennial graminoid	2012 - 2016, C	2012, 2015	dry
Stipa pulchra	Purple Needlegrass	perennial graminoid		2011, 2015	dry
Eschscholzia californica	California Poppy	annual/perennial forb	2014 - 2016, C		dry
Achillea millefolium	Common Yarrow	perennial forb	2013 - 2015, C	2011, 2015	frozen
Chlorogalum pomeridianum	California Soaproot	perennial forb	2011 - 2015, C		dry
Cirsium quercetorum	Brownie Thistle	perennial forb	2016, 2017		dry
Erigeron glaucus	Seaside Daisy	perennial forb	2015, 2016		dry
Grindelia stricta	Oregon Gumplant	perennial forb	2012 - 2016, C	2012, 2015	dry
Horkelia californica	California Horkelia	perennial forb	2012 - 2015, C		dry
Navarretia squarrosa	Skunkweed	perennial forb	2013 - 2017, C		dry
Prunella vulgaris	Self-Heal	perennial forb	2010 - 2017, C	2012, 2015	dry
Scrophularia californica	California Bee Plant	perennial forb		2012, 2015	dry
Sisyrinchium bellum	Blue-Eyed Grass	perennial forb	2013 - 2016, C	2012, 2015	dry
Symphyotrichum chilense	California Aster	perennial forb		2015, 2016	dry
Artemisia californica	California Sagebrush	shrub	2013 - 2015, C	2011, 2015	dry
Eriophyllum staechadifolium	Lizard Tail	shrub	2011 - 2017, C	2012, 2015	dry
Frangula californica	California Coffeeberry	shrub	2013 - 2016, C		frozen
Lupinus variicolor	Manycolored Lupine	shrub	2013, 2015		dry
Mimulus aurantiacus	Sticky Monkeyflower	shrub	2011 - 2016, C	2012, 2015	dry

Table 2. Germination percentages for all species not included in Chronosequence. These include both seeds sown in 2017 and in 2018 studies. Values are means ± 1 SE.

Species	Test Year	Growth Form	Seed Age	Germination (%)
Danthonia californica	2017	perennial graminoid	1	1.0 ± 2.0
Juncus mexicanus	2018	perennial graminoid	2	32.0 ± 10.3
			3	34.0 ± 9.5
Stipa pulchra	2017	perennial graminoid	2	23.0 ± 8.2
			6	47.0 ± 11.9
Cirsium quercetorum	2018	perennial forb	1	53.0 ± 11.0
			2	3.0 ± 3.8
Erigeron glaucus	2017	perennial forb	2	7.0 ± 3.8
			3	18.0 ± 8.3
Grindelia stricta	2017	perennial forb	2	50.0 ± 30.4
			5	6.0 ± 9.5
Scrophularia californica	2017	perennial forb	2	57.0 ± 30.2
			5	74.0 ± 0.0
Lupinus variicolor	2018	shrub	3	51.0 ± 10.0
			5	50.0 ± 5.2

Table 3. Results indicating mixed effects of seed age on germination percentage and of seed age on time to germination for all 2018 chronosequences.

	Seed Age on Germ (%)		Seed Age on Time to Germ	
Variable	F	P	F	P
Species				
Achillea millefolium	49.7	<.0001*	3.7	0.0676
Bromus carinatus	28.3	<.0001*	41.2	<.0001*
Chlorogalum pomeridianum	7.6	0.0015*	0.7	0.5644
Elymus glaucus	85.0	<.0001*	542.2	<.0001*
Eriophyllum staechadifolium	21.4	<.0001*	4.4	0.0063*
Prunella vulgaris	8.8	<.0001*	2.7	0.0358*
Grindelia stricta	11.6	0.0002*	4.9	0.0196*
Hordeum brachyantherum	23.4	0.0003*	6.2	0.0235*
Horkelia californica	12.0	0.0006*	0.1	0.9493
Navarretia squarrosa	19.9	<.0001*	8.6	0.0008*
Eschscholzia californica	1.8	0.2163	1.0	0.4053
Juncus patens	0.8	0.5482	1.4	0.2896
Mimulus aurantiacus	2.4	0.0791	0.7	0.5352

Table 4. Results of seed age on germination percentage tested with previous rainfall year on germination percentage. Tests were included for all species showing a directional time effect trend with ≥ 4 collection years tested in chronosequence.

	Seed Age on Germ (%)		Rainfall Year on Germ (%)	
Variable	F	P	F	P
Species				
Bromus carinatus	13.7	0.0018*	6.5	0.0206*
Chlorogalum pomeridianum	15.8	0.001*	0.0	0.8335
Elymus glaucus	2.2	0.1523	2.2	0.2915
Eriophyllum staechadifolium	8.2	0.0082*	0.7	0.4104
Grindelia stricta	21.8	0.0003*	3.8	0.0678
Navarretia squarrosa	19.4	0.0004*	7.1	0.0164*

Table 5. This table was modified from a synthesis of seed collection and seed storage protocols for the Millenium Seed Bank by Brown and Briggs, 1991; Vitt and Havens, 2004, and from Linington, S, Manger, K. (2014) from Kew.

1. Collect from a minimum of 50 maternal plants to capture 95% of the genetic diversity
2. Collect no more than 10-20% available seed any given day, to ensure that collection efforts do not impact vital rates of the target populations
3. Collect across any obvious environmental gradients
4. Collect both from within the center of population density AND from the periphery to ensure the greatest genetic diversity and to ensure collection from individuals that may perform better in marginal portions of the habitat
5. Search out and collect even the smallest plants because they may contain quantitative trait variation that would pre-adapt them to an alternate site
6. In general, collections are bulked within a population, but maternal lines may be stored separately in some target species
    i. To facilitate research efforts
    ii. In species with naturally low fecundity
    iii. To ensure equalization of founders
    iv. When collecting from small or marinal populations
7. Collect a minimum of 3000 seeds
    i. Consider maternal-line collections versus bulked
    ii. Separate years should be accessioned individually
8. Collect across years in the same populations
9. Collect at peak seed maturity, recognizing that some phenotypes (and sites) will be excluded, or collect on multiple days
10. Collect information on exact GPS location, habitat, plant population, related vegetation, etc. to store with seed
11. Store seeds in dry room where possible, or else store individual seed collections with dessicant packets
12. Store seeds at -4° or colder for longest possible longevity

University of California

Non-Chemical Methods to Control Exotic Ground Cover and Restore Coastal Prairie Ecosystems

A Senior Thesis submitted in partial satisfaction

of the requirement for the degree of

BACHELOR OF ARTS

In

ENVIRONMENTAL STUDIES

by

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ABSTRACT: Due to increasing restrictions on common synthetic herbicides, non-chemical methods of controlling exotic ground cover are needed, particularly to restore California grasslands. I examined the impact and cost effectiveness of three mechanical methods of controlling exotic grasses and forbs, in conjunction with the planting of native species from three functional groups: grasses, forbs, and shrubs. These mechanical methods included tarping (application of a black plastic tarp to shade out germinating seedlings), as well as applying a layer of paper or cardboard prior to depositing of a wood mulch layer and planting. There were four replicates of each treatment with twelve different native species planted in each plot. I monitored native species survivorship and cover, as well as cover of vegetation guilds in spring 2018, the second growing season of the experiment. There was no significant treatment effect on survivorship of individual planted native species or on cover of any of the plant guilds. Cover of two planted species, *Elymus glaucus* and *Horkelia californica* were higher in cardboard than the other two treatments. Given no treatment effect on survivorship and cover, paper and wood mulch is a cost-effective and relatively environmentally friendly method for exotic species control in coastal prairie ecosystems.

KEYWORDS: Non-chemical exotic control, coastal grassland, mulch, tarping, paper, cardboard.

Non-Chemical Methods to Control Exotic Ground Cover

and Restore Coastal Prairie Ecosystems

Introduction:

Native perennial grasslands are one of the most endangered ecosystems in the United States (Stromberg et al. 2001). Grasslands make up a substantial component of the ecosystems of California, and large portions of these communities are now dominated by exotic Mediterranean annual grasses (Holl et al. 2014, Stromberg et al. 1996), which in some cases account for >80% of ground cover (Stromberg et al. 2001). The dynamic mosaic of coastal grassland and coastal scrub habitats in central California house a disproportionately high biodiversity, but are at risk due to demand for both urban and agricultural development (Holl et al. 2010). Despite the extent of exotic invasion and human development, however, some grasslands still contain a rich patchwork of rare and endemic flora (Stromberg et al. 2007), making them valuable from a conservation standpoint. Thus, there is a need for feasible and cost-effective methods to control exotic ground cover in order to restore coastal prairie ecosystems.

Methods for the control of exotic grasses and forbs vary in their efficacy and practicality. Application of herbicides generally is regarded as the most cost-effective method (Holl et al. 2014). But concerns about herbicides affecting human health in some cases can eliminate herbicides as a permissible treatment (Solomon 2016, Williams et al. 2016), and in 2017 California listed glyphosate, the most commonly used herbicide for exotic plant control in California, as a carcinogen under Proposition 65. Many of California's grasslands are fire-adapted so fire can be used as a management tool, but maintaining a controlled burn regime can also be impractical (Stromberg et al. 2007), primarily due to concerns about air quality and proximity to infrastructure. Other options such as hand-weeding (Kimball et al. 2013), topsoil removal (Buisson et al. 2006), and grazing (Gilhaus et al. 2015) are effective in specific cases, but their practicality depends on the scale, accessibility, and ownership of the site. In the case of the University of California Younger Lagoon Reserve near Santa Cruz, the presence of federally recognized wetlands, proximity to residential housing, and restrictions on herbicide use further limit restoration techniques to non-chemical methods of exotic species control.

Tarping and wood mulch (layers applied over a seed bank to suppress germination) have shown promise as exotic control methods at an intermediate level of cost and efficacy (Holl et al. 2014). Application of wood mulch can have numerous beneficial effects, including improved soil moisture, maintenance of soil temperature, reduced soil erosion, and increased soil fertility (Chalker-Scott 2007). Holl et al. (2014) found tarping to be similarly effective to herbicide application for exotic plant control in coastal prairie habitats, but more research is needed. However, a drawback of tarping is that it is relatively labor intensive, particularly in patchy habitats and also requires precise timing and removal for maximum effectiveness. One alternative is the application of biodegradable layers under the wood mulch, such as paper and cardboard. These methods decrease the overall amount of time required, as paper or cardboard, wood mulch, and seedlings can all be deposited simultaneously.

I studied the effect of three mechanical treatment methods on the survivorship and cover of 12 native species planted as seedlings, as well as on percent cover of exotic grasses, exotic forbs, mulch, and thatch. The treatments included tarping, application of paper, and application of cardboard prior to mulching. Three UCSC undergraduates, Andrew Filous, Taylor Ramos, and Steven Wertheimer collected data for the first year and saw few significant differences in plant survival and cover across treatments. Shrub and grass survivorship was slightly higher in cardboard plots than the other treatments, while forb survivorship was higher in paper plots. There was no significant effect of treatment type on exotic ground cover. I collected data during the second growing season. I anticipated that the cardboard plots would show a continuing or increasing trend of outperforming tarp and paper due to the greater thickness and lower rate of decomposition.

Methods:

Site Description: This experiment was conducted at the University of California, Santa Cruz Younger Lagoon Reserve (YLR) adjacent to the Long Marine Laboratory (36°57’11.59”N, 122°3’55.46”W). The 29-hectare coastal terrace was a Brussels sprouts farm before it was donated to the UCSC Natural Reserves System in 1973. It is now a patchwork of restoration sites composed primarily of coastal prairie, coastal scrub, and seasonal wetland habitat types. The reserve is surrounded by agricultural land to the west and north, De Anza Mobile Home Park to the east, and the Pacific Ocean to the south.

Experimental Design: Two UCSC undergraduates, Andrew Filous and Taylor Ramos set up twelve 36-m^2 test plots in November 2016, with four plots for each treatment type: paper, cardboard, and plastic tarp (Figure 1). The tarp treatment plots were covered with a black plastic tarp in November following the first rains and left for a period of 6 weeks before the tarp was removed, and the layer of wood mulch was deposited. The paper and cardboard plots were covered evenly with a single layer of paper or cardboard at the time of outplanting in January, and then covered with a layer of wood mulch 5-10 cm thick immediately prior to planting. The paper was purchased from Sunshine Paper Company at $79.99 per 1.2 m-wide × 152-m long ×0.28-mm thick roll. The cardboard was acquired for free from a local bike shop and had varying dimensions, typically about 1-cm thick; staples and tape were removed before placing it in the field. The mulch was comprised primarily of redwood, oak, and bay laurel wood chips and was obtained from the UCSC Grounds Department.

The Younger Lagoon Reserve Manager purchased the paper in bulk, paying $2142.02 for twenty 185.3 m^2 rolls. This comes out to 58¢/m^2, or $21.51 per plot. He purchased the tarp rolls individually from Home Depot at $117.91 per 223 m^2, with a cost of 53¢/m^2, or $19.68 per plot. Filous and Ramos acquired the cardboard for free, but with the added labor of hauling it, and manually removing staples, tape, and other packaging elements.

Twelve native plant species were selected, with four native species each from three different guilds: shrubs, forbs, and grasses (Table 1). The seedlings planted in the research plots were grown from seed collected at local reference sites and propagated at the UCSC Greenhouse. Seedlings were planted mid-January in rows running north to south, with each guild grouped together. Color-coded flags were placed at the end of each row of species in each plot to facilitate relocating the seedlings. Rows were separated by 46 cm with a buffer zone of 53 cm at the plot edges. In February 2017, plots were inspected and early seedling mortality was re-planted.

Data Collection: Andrew Filous collected native species survivorship and cover data in April 2017, and I collected the same data in April 2018. I took cover data of individual planted native plants and recorded cover in dm^2 using cover squares as a reference. Additionally, I used rectangular PVC quadrats (0.25 × 1 m) to estimate percent cover of all native species, exotic grasses, exotic forbs, mulch, thatch, and bare ground in 5% cover classes (e.g. 0-5%, 5-10%, 10-15%). Each plot was divided into a grid of six vertical (1 m) columns, and 24 (0.25 m) rows, and I used a random number generator to select two cells per vertical row, for a total of 12 quadrats per plot, to estimate cover of plant guild.

Data Analysis: Survivorship and cover measurements from individual plants and vegetation quadrats were averaged across each plot prior to analysis using the JMP Pro (Version 14) to perform statistical analysis. First, I used a two-way ANOVA to examine the effect of species, treatment, and a species × treatment interaction on both individual survivorship and cover values. When there was a significant interaction, I then used a one-way ANOVA to examine the effect of each treatment on individual species. If there was a significant treatment effect, I then used Tukey's multiple comparison procedure to test for differences between plots of the same treatment. I compared cover plant guilds across treatments using a one-way ANOVA. One of the plots, Cardboard-4, experienced substantial flooding due to water from nearby landscaping in the first year (Filous pers. obs.). However, removal of this plot from data analysis had little effect.

Table 1. Latin and common names of planted native species, grouped by guild. Values are means ± SE.

Latin Name	Common Name	Guild	Survivorship (%)	Tukey's HSD
Artemisia californica (ARCA)	California sagebrush	Shrubs	85.4 ± 8.9	A B
Ericameria ericoides (ERER)	California goldenbrush	Shrubs	70.8 ± 9.8	A B
Mimulus aurantiacus (MIAU)	Sticky monkey flower	Shrubs	81.9 ± 7.5	A B
Scrophularia californica (SCCA)	California bee plant	Shrubs	59.0 ± 9.0	A B
Clinopodium douglasii (CLDO)	Yerba buena	Forbs	20.8 ± 6.9	C D
Horkelia californica (HOCA)	California horkelia	Forbs	90.3 ± 2.7	A
Prunella vulgaris (PRVU)	Common selfheal	Forbs	52.8 ± 10.0	B C
Symphyotrichum chilense (SYCH)	Pacific aster	Forbs	82.6 ± 5.2	A B
Danthonia californica (DACA)	California oatgrass	Grasses	9.0 ± 6.3	D
Elymus glaucus (ELGL)	Blue wild rye	Grasses	13.2 ± 4.9	D
Hordeum brachyantherum (HOBR)	Meadow barley	Grasses	15.3 ± 7.4	D
Stipa pulchra (STPU)	Purple needle grass	Grasses	7.6 ± 5.1	D

Results:

Overall, there was a substantial decrease in survivorship of grasses and forbs between the first and second years of the experiment (Table 2). The flooded Cardboard-4 plot exhibited the opposite trend, with much higher survivorship and cover of grasses, some forbs, and minimal shrub survival (4.15%).

By the second year of data collection, there were few significant treatment effects. Survivorship varied significantly across species (Table 1), but there was no significant treatment or treatment × species interaction. Shrubs consistently had the highest survivorship across all treatments (74.3%). Cover values for *Elymus glaucus* and *Horkelia californica* were significant (Table 3). Removal of the Cardboard-4 plot from analysis did not influence survivorship values significantly, but had some impact on individual cover. *H. californica* was no longer significant (P = 0.0697, but *Mimulus aurantiacus* was (P = 0.0154). The P value for *E. glaucus* decreased to P = 0.0242). Tukey's multiple comparison procedure indicated that cardboard was significantly better than tarp or paper for *E. glaucus* when the C4 plot was included, but when it was excluded, only cardboard and tarp were significantly different.

Background vegetation cover showed no significant treatment effect. This includes examination of values for native cover, mulch, thatch, exotic grasses, exotic forbs, and overall exotic cover. (Table 4).

Table 2. Comparison of guild survivorship across treatments. Values are means ± SE for n = 4 for each treatment.

		Survivorship (%)	
Guild	Treatment	2017	2018
Shrubs	Cardboard	75.0% ± 23.7	63.0% ± 21.0
	Paper	83.9% ± 12.4	78.1% ± 14.6
	Tarp	92.2% ± 3.5	81.8% ± 7.3
Forbs	Cardboard	80.2% ± 7.8	62.5% ± 8.5
	Paper	88.0% ± 4.7	68.2% ± 10.9
	Tarp	73.4% ± 6.0	54.2% ± 10.9
Grasses	Cardboard	97.4% ± 2.0	26.0% ± 14.2
	Paper	92.7% ± 5.4	4.2% ± 4.2
	Tarp	52.1% ± 14.6	3.6% ± 3.6

Table 3. Mean cover values ± SE (n = 4) measured in dm^2. Significant values ($p < 0.05$) are marked with an *. Values with the same letter are not significantly different according to Tukey's multiple comparison procedure.

	Mean Cover (square decimeter) by Species				
	Mean ± SD				
Species	Cardboard	Paper	Tarp	*F*	P
ARCA	21.0 ± 1.1	19.9 ± 1.2	17.7 ± 1.5	0.1	0.8995
ERER	3.9 ± 0.5	3.0 ± 0.6	2.0 ± 0.2	0.6	0.5457
MIAU	10.5 ± 2.0	5.4 ± 0.9	5.9 ± 0.6	2.8	0.1128
SCCA	5.1 ± 1.0	5.5 ± 0.7	5.9 ± 2.4	0.02	0.9824
CLDO	0.9 ± 0.3	0.6 ± 0.6	1.0 ± 0.0	1.3	0.3184
HOCA	13.3 ± 1.7 A	9.0 ± 1.0 AB	7.7 ± 0.7 B	6.1	0.0215*
PRVU	2.7 ± 0.8	2.0 ± 1.3	1.8 ± 0.2	0.2	0.8206
SYCH	14.1 ± 2.6	10.7 ± 1.2	7.7 ± 2.5	1.3	0.3309
DACA	0.7 ± 0.0	0.0 ± 0.0	0.1 ± 0.0	1.6	0.2561
ELGL	1.0 ± 0.6 A	0.3 ± 0.0 B	0.0 ± 0.0 B	8.3	0.0089*
HOBR	0.8 ± 0.8	0.2 ± 0.0	0.1 ± 0.0	1.7	0.2438
STPU	0.7 ± 0.4	0.0 ± 0.0	0.0 ± 0.0	1.2	0.3549

Table 4. Mean background cover ± SE measured by % cover classes (e.g. 0-5%, 5-10%, 10-15%).

	Cover (%) by Treatment				
	Mean ± SD				
Cover Type	Cardboard	Paper	Tarp	*F*	P
Exotic Grass	26.8 ± 4.9	34.8 ± 4.1	31.8 ± 9.6	0.4	0.6986
Exotic Forb	11 ± 3.3	7.3 ± 1.6	14.7 ± 4.0	1.4	0.2979
Exotic Cover	37.8 ± 8.0	42.1 ± 4.7	46.6 ± 7.9	0.4	0.6823
Native Cover	18 ± 2.9	22.5 ± 3.3	15.6 ± 6.8	1.7	0.2377
Mulch	25.7 ± 9.8	18 ± 6.8	17.5 ± 4.7	0.4	0.6925
Thatch	8.8 ± 2.3	7.2 ± 2.0	5.9 ± 1.5	0.5	0.6016

Discussion:

Overall, there were minimal treatment effects on native species survivorship and native and exotic cover in the second year. The only difference was higher cover of two native species in the cardboard plots. It is possible that the application of wood mulch is overriding the effectiveness of each individual treatment. Holl et al. (2014) found that the effects of mulching × tarping converged substantially within 3 years, but in this case, treatment effects had converged almost completely by the second growing season. A masking effect by the wood mulch could explain this. Additionally, the low number of replicates (n = 4) doubtlessly impacted the soundness of the results.

There is a strong trend of reduced native species survivorship between years, particularly among grasses (Table 2.) Many of the plots experienced significant gopher activity, which disrupts the integrity of treatment layers and could allow for easier recolonization by invasive forbs and grasses. These effects would compound over time. Another explanation for the overall decrease in native species survivorship between years is variation in annual precipitation. Winter of 2016 was an exceptionally wet year for Younger Lagoon (104.4 mm/ mo. from Aug. 2016 - Jul. 2017), followed by a comparatively dry year in 2017 (38.4 mm/ mo. from Aug. 2017 - Jul. 2018). Such substantial yearly variation may have a confounding effect on determination of successful methods (Cox and Allen 2008), especially in precipitation-dependent regions such as coastal California.

Trends seen in survivorship across species are consistent with predictions of reserve managers, with shrub and forb survivorship being substantially higher than that of grasses.

There are a several explanations for the trends and variation seen. Of the twelve planted species, only five are not listed as wetland associated species by the U.S. ACE National Wetland Plant List - ARCA, ERER, HOCA, MIAU, and STPU. With the exception of STPU, all of these species had >70% survivorship, which suggests that species' tolerance for differing soil types and hydrology has some effect, and further supports the idea that 2017's unusually arid winter likely had an effect. Growth and life history strategy certainly plays a significant role (Chu et al. 2013; Silvertown et al. 1993) as the three species with the highest individual mean cover values also had the highest survivorship (ARCA, HOCA, SYCH). Overall mean survivorship and cover of forbs was heavily impacted by values for CLDO (20.8% survivorship), which is more commonly an understory species.

This lack of significant persistent treatment effect leads to the conclusion that the most practical and inexpensive treatment method is the best for land managers. The cardboard was acquired for free, but was highly cumbersome and labor intensive to source and prepare in large quantities, since all tape and staples had to be removed by hand, and pieces had to be torn and fitted to the plots. Therefore, while cardboard is less expensive it is highly unfeasible at larger scales. Costs per meter for tarp (53¢/m^2) and paper (58¢/m^2) were relatively similar. Paper has some logistic and environmental advantages over tarping, primarily that paper is biodegradable and does not need to be removed later in the season. Considering the minimal treatment differences, both paper and tarp seem to be equally viable for larger scale restoration, with paper as the slightly more efficient and environmentally-friendly option.

In summary, there is no silver bullet for coastal grassland restoration. Treatment effects are not persistent, and the high rate of invasion of exotic annual grasses means that without continuous maintenance, some functional groups will be unable to compete, and composition will approach that of non-restored sites. It may be useful for a future study to compare the effectiveness of paper, tarp, and wood mulch individually. Additionally, reserve staff have begun using a corrugated paper/cardboard hybrid in the restoration site for the 2018 year, which is less expensive than the paper rolls used in this study and easier to prepare and apply than cardboard. Decisions between paper, tarp, cardboard, and wood mulch as methods for exotic ground cover should be made on a case-by-case basis depending on the scale and composition targets of the restoration effort.

Literature Cited:

Buisson, E., Holl, K. D., Anderson, S., Corcket, E., Hayes, G. F., Torre, F., . . . Dutoit, T. (2006). Effect of Seed Source, Topsoil Removal, and Plant Neighbor Removal on Restoring California Coastal Prairies. *Restoration Ecology,14* (4), 569-577. doi:10.1111/j.1526-100x.2006.00168.x

Chalker-Scott, Linda. (2007). Impact of Mulches on Landscape Plants and the Environment — A Review. *Journal of Environmental Horticulture:* December 2007, Vol. 25, No. 4, pp. 239-249. Doi: 10.24266/0738-2898-25.4.239.

Cox, R. D., & Allen, E. B. (2008). Stability of exotic annual grasses following restoration efforts in southern California coastal sage scrub. *Journal of Applied Ecology,45*(2), 495-504. doi:10.1111/j.1365-2664.2007.01437.x

Chu, C., Havstad, K. M., Kaplan, N., Lauenroth, W. K., Mcclaran, M. P., Peters, D. P., . . .

Adler, P. B. (2013). Life form influences survivorship patterns for 109 herbaceous perennials from six semi-arid ecosystems. *Journal of Vegetation Science, 25*(4), 947-954. doi:10.1111/jvs.12106

Filous, Andrew. (2017). Non-chemical Methods to Reduce Exotic Cover and Facilitate Native Coastal Prairie and Scrub Plant Survival and Growth. *Bachelor of Arts Thesis,* June 2017. University of California, Santa Cruz; Santa Cruz, CA

Gilhaus, Kristin, et al. (2015). “Restoration of Sand Grasslands by Topsoil Removal and Self-Greening.” *Applied Vegetation Science*, vol. 18, no. 4, 2015, pp. 661–673., doi:10.1111/avsc.12176.

Holl, K. D. and L. K. Reed. (2010). Reference and baseline vegetation sampling for Younger Lagoon natural reserve. Report for the California Coastal Commission.

Holl, K.D., Howard, E.A., Brown, T.M., Chan, R.G., de Silva, T.S., Mann, E.T., Russell, J.A. and Spangler, W.H. (2014). 'Efficacy of Exotic Control Strategies for Restoring Coastal Prairie Grasses', *Invasive Plant Science and Management*, 7(4), pp. 590–598. doi: 10.1614/IPSM-D-14-00031.1.

Kimball, Sarah, et al. "Establishment and Management of Native Functional Groups in Restoration." *Restoration Ecology*, vol. 22, no. 1, 2013, pp. 81–88., doi:10.1111/rec.12022.

Silvertown, J., Franco, M., Pisanty, I. & Mendoza, A. 1993. Comparative plant demography – relative importance of life-cycle components to the finite rate of increase in woody and herbaceous perennials. *Journal of Ecology* 81: 465–476.

Solomon, Keith R. "Glyphosate in the General Population and in Applicators: a Critical Review of Studies on Exposures." *Critical Reviews in Toxicology*, vol. 46, no. sup1, 2016, pp. 21–27., doi:10.1080/10408444.2016.1214678.

Stromberg, Mark R., and James R. Griffin. "Long-Term Patterns in Coastal California Grasslands in Relation to Cultivation, Gophers, and Grazing." *Ecological Applications*, vol. 6, no. 4, 1996, pp. 1189–1211., doi:10.2307/2269601.

Stromberg, Mark R., Kephart, Paul., Yadon, Vern. "Composition, Invasibility, and Diversity in Coastal California Grasslands." *Madroño*, vol. 48, no. 4, 2001, pp. 236-252

Stromberg, Mark. R,. (2007). "California Grassland Restoration." *California Grasslands: Ecology and Management*, by Mark R. Stromberg, University of California Press, 2007.

Williams, Gary M., et al. "A Review of the Carcinogenic Potential of Glyphosate by Four Independent Expert Panels and Comparison to the IARC Assessment." *Critical Reviews in Toxicology*, vol. 46, no. sup1, 2016, pp. 3–20., doi:10.1080/10408444.2016.1214677.

Appendix 4. Photo monitoring

YLR Beach Photopoint #1. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

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YLR Beach Photopoint #4. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Terrace Photopoint #1. May 15, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

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Appendix 5. NOID 9 (18-1)

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ADOPTED

Th12a

Prepared August 29, 2018 (for September 13, 2018 hearing)

To: Coastal Commissioners and Interested Persons

From: Susan Craig, Central Coast District Manager
Sarah Carvill, Coastal Planner

Subject: UCSC Marine Science Campus Coastal Long Range Development Plan (CLRDP) Notice of Impending Development Number 9 (SCZ-NOID-0004-18) (Younger Lagoon Reserve Beach Area Public Access Plan). Coastal Commission consideration of UCSC's notice regarding its intent to implement its updated beach area public access management plan within Younger Lagoon Reserve pursuant to the certified CLRDP.

SUMMARY OF STAFF RECOMMENDATION

The University of California at Santa Cruz's (UCSC's) Marine Science Campus (Campus) Coastal Long Range Development Plan (CLRDP) was certified by the Commission on January 7, 2009. UCSC is now pursuing its ninth project pursuant to the CLRDP, has submitted the above-referenced notice of impending development (NOID) to the Commission, and is requesting that the Commission concur that the proposed project is consistent with the certified CLRDP.

This NOID affects Younger Lagoon Beach, a relatively small pocket beach with a back-beach lagoon system within which UCSC's research and resource protective efforts are focused (through the UC Reserve System's Younger Lagoon Reserve program). Although historically a popular beach for general public access, Younger Lagoon Beach has been off-limits to such general use since 1981 when the Commission authorized a CDP for a temporary beach closure to protect UCSC's Long Marine Lab research program in the lagoon area inland of the sandy beach itself, as well as coastal resource values in the lagoon/beach area overall. That original beach closure was only allowed by the Commission based on a required periodic reevaluation, which ultimately occurred in 2001 when the Commission again allowed for continued beach closure for similar reasons. Subsequently, in 2009, the periodic beach access reevaluation tool was codified into the certified CLRDP. Consequently, the CLRDP requires that the amount and level of intensity of beach access be revaluated every five years via authorization of a Younger Lagoon Beach Public Access Management Plan through the NOID process. That reauthorization process is designed to allow UCSC and the Commission to reassess the context and conditions associated with the level of public beach access at Younger Lagoon Beach, and to potentially make changes in the degree of public beach access provided to the beach area (i.e., to increase it, decrease it, or leave it as is) for the next five years.

CLRDP Implementation Measure (IM) 3.6.3 requires that the public have "supervised access" to Younger Lagoon Beach, but does not specify the level of supervision. Rather, this question is subject to the periodic reevaluation identified above. IM 3.6.3 also requires that a monitoring program be implemented to document the condition of native flora and fauna within Younger Lagoon and the back beach area at five-year intervals, and that UCSC prepare a report at the end of each five-year period that presents the results of the monitoring and includes a discussion of the potential effects of sandy beach public access on Younger Lagoon resources, and whether beach access changes should be implemented. At the end of each five-year period, UCSC must submit a NOID to the Commission to implement a beach access plan for the next five years.

In March 2010, the Commission approved UCSC's NOID 2 to implement a beach access management plan through 2015 that allowed for supervised access to Younger Lagoon Beach through a docent-led beach tour program and implemented a five-year monitoring program, as required by IM 3.6.3. UCSC began implementing the beach access plan and monitoring program in spring of 2010, and submitted the report on the results of the monitoring to the Commission in February of 2016. In 2017, UCSC submitted their required beach access NOID (to cover the period between 2015 and 2020), which described a plan to continue the beach access program that had been in place under NOID 2 for the next five-year period (i.e., through 2020). That NOID was presented to the Commission at its July 2017 meeting, but UCSC withdrew it prior to any Commission action in order to consider and incorporate feedback from Commissioners regarding the adequacy of its proposed public access parameters. UCSC now proposes a revised beach access management plan in the current NOID.

This revised NOID again proposes to keep the beach closed to general public access, and to continue the existing docent-led beach tour program as the allowed form of public beach access through 2020, with some changes (relative to the previous program) designed to provide additional opportunities for the public to access the beach and to reduce the cost of access for younger visitors. Specifically, UCSC now proposes to offer public beach tours four times a month during the spring and summer season (March through September), and twice monthly during other times of the year, thus increasing the number of beach tours offered during that summer season compared to the twice per month beach tours provided year-round under the previous program. UCSC also proposes to increase the number of participants allowed on each beach tour from 12 to 14, and to allow those under the age of 16 to participate in the beach tours for free. All others will be required to pay admission to the Seymour Marine Discovery Center (SMDC)[1] for a tour, where current admission prices are $9 for those over 16.[2] UCSC has also identified a suite of advertising outlets that it indicates are currently being used to promote the tours, including press releases, local papers and event calendars, social media, and new and

[1] SMDC is a Campus marine science education center located adjacent to Long Marine Laboratory on the bluff downcoast of Younger Lagoon Beach. SMDC offers daily tours of its own facility and the laboratory in addition to the tours of Younger Lagoon Beach that are the focus of this NOID.

[2] Currently, admission to the Discovery Center is $9 for adults, $7 for children between the ages of 3-16, and free for children younger than 3.

existing interpretive signage on Campus.

As under the previous beach access program, tours would be led by SMDC docents, and would include a narrative history of the UC Natural Reserve System, a discussion of the lagoon and its habitats, a walk through a restored coastal scrub habitat with opportunities to view the rear dune, and would culminate with a walk on the sand at Younger Lagoon Beach. As set forth in this proposed NOID, UCSC would also continue to monitor for potential coastal resource and research impacts as required by, and described in, IM 3.6.3, and would continue to submit a NOID to the Commission every five years that reports on the previous five years of the docent-led beach access program, includes a monitoring report that evaluates beach conditions, and proposes beach access parameters for the next five years. The next NOID to implement a Younger Lagoon Beach Access Plan will be due in 2020.[3]

Staff believes that the proposed project needs to be modified in order for it to be found CLRDP consistent. <u>First</u>, in order to meet the CLRDP's free public access requirements (which allow only "modest fees" to be charged to visitors on Campus, and only when the fees are for "access to the Seymour Marine Discovery Center and similar University facilities"), **Condition 1** requires that beach tours be free for all who sign up, whether one pays for SMDC access or not. **Condition 1** also requires UCSC to track the number of tour requests that are denied due to lack of tour availability in order to help identify the optimum number of tours and participants moving forward. <u>Second</u>, although UCSC has identified a suite of measures to promote the beach tour program, UCSC has not actually committed to any specific frequencies of use for those measures. In order to ensure that the proposed measures are adequately utilized to inform the public of the availability of beach tours, **Condition 2** requires that UCSC provide a schedule for each type of outreach, with the goal of reaching as many potential audiences as possible, including audiences that might not be reached through traditional local means (e.g., inland communities). <u>Third</u>, to ensure that users who are already onsite are informed of the beach tours, **Condition 3** also requires that UCSC provide signage at Campus overlooks and outside and inside of the SMDC that describe tour availability, including "day of" signs to ensure maximum notice is provided. <u>Fourth</u>, while UCSC has proposed a goal of continuing to offer four beach tours per month from March to September and two beach tours per month for the remainder of the year, resulting in 38 beach tours per year overall, it has not committed to actually offering 38 beach tours per year. **Condition 4** commits UCSC to this tour schedule as a minimum. Additionally, in order to assess the effectiveness of outreach pursuant to **Condition 2** and ensure that future decisions regarding access to Younger Lagoon Beach are based on complete information about utilization of the tour program, **Condition 4** requires UCSC to prepare and submit a report regarding compliance with these conditions (including outreach activities, tour subscription, and data collected on the number of persons turned away) and recommendations regarding how the tour program might be best modified to better meet public demand. <u>Finally</u>, in order to ensure that UCSC meets the CLRDP requirement for five-year review of beach access at Younger Lagoon Beach on the original time schedule required by the Commission through the

[3] NOID 2 covered the five-year period from 2010 to 2015, and no NOID for the next five-year period (2016 to 2020) has thus far been approved. If the Commission finds this NOID consistent with the CLRDP, UCSC will have obtained approval through the 2020 period. A new NOID must be submitted and approved for the 2021 to 2025 period to meet the CLRDP requirement that the beach access parameters and a Beach Access Plan be reviewed and authorized every five years.

CLRDP (and in order to avoid a situation in which the program that has been operative since 2015 is not covered by CLRDP authorization, as is the case currently), **Condition 5** specifies that this NOID is effective through December 31, 2020 only, and requires UCSC to submit a NOID for the January 1, 2021 to December 31, 2025 period by July 1, 2020.

In this case, and for similar reasons as the Commission has found in the past with respect to beach access at Younger Lagoon Beach, staff believes that the proposed program as conditioned can be found CLRDP consistent, and further believes that the balance being struck here (i.e., between research and resource protection on the one hand, and general beach public access on the other) through the docent-led beach tour program is appropriate in this case. Staff notes that the beach access situation at Younger Lagoon Beach is an anomaly in coastal California, including inasmuch as public beach access is of critical importance, and ensuring it is maximized and provided to all is a critical component of the Commission's coastal program under the Coastal Act. It is only because of the historical context here, namely the Commission's involvement in setting access limits for this particular pocket beach as part of UCSC's research program dating back to 1981, that limitations on general public beach access in this location can be found appropriate given that larger context. It is incumbent on UCSC to recognize that same dynamic in terms of the type of access program it provides to the general beach going public *in return for* that concession on the part of the Commission on behalf of those beachgoers, and staff believes that conditions are necessary to push UCSC's program towards being more accommodating to the general public. Public beach access is the cornerstone of the Commission's access program, and regulations on its use are not to be taken lightly. The conditions applied here will help to better provide such access, in staff's view, and staff intends to continue to work with UCSC to improve the program for the public moving forward, both to inform this iteration of the program as well as future beach access plans and NOIDs.

Staff therefore recommends that the Commission determine that the NOID project, as conditioned, is consistent with the certified CLRDP. The necessary motion and resolution to find the proposed development consistent with the certified CLRDP are found on page 5 below.

Staff Note - NOID Action Deadline: This NOID was filed as complete on August 24, 2018. The 30-working-day hearing deadline is October 8, 2018. Thus, unless UCSC agrees to extend the hearing deadline (as allowed by CLRDP Section 8.4.2[4]), the Commission must take action on the NOID by October 8, 2018 or it will be deemed consistent with the CLRDP.

[4] CLRDP Section 8.4.2 provides that the hearing deadline may be extended if, on or before the deadline, the Director of Campus Planning waives UCSC's right to a hearing within 30 working days, and agrees to an extension to a date certain that is no later than three months from the hearing deadline (in this case, no later than January 8, 2019).

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I. MOTION AND RESOLUTION

Staff recommends a **YES** vote on the motion below. Passage of this motion will result in a determination that the development described in the UCSC NOID 9 (SCZ-NOID-0004-18) is consistent with the certified UCSC CLRDP as conditioned, and adoption of the following resolution and findings. The motion passes only by affirmative vote of a majority of the Commissioners present.

> ***Motion:*** *I move that the Commission determine that the development described in UCSC Notice of Impending Development Number 9, if conditioned as identified in this report, is consistent with the certified University of California at Santa Cruz Coastal Long Range Development Plan, and I recommend a yes vote.*
>
> ***Resolution:*** *The Commission hereby determines that the development described in UCSC Notice of Impending Development Number 9, as conditioned as identified in this report, is consistent with the certified University of California at Santa Cruz Coastal Long Range Development Plan for the reasons discussed in the findings herein.*

II. CONDITIONS

1. **Free Beach Tours.** All beach tours shall be offered for free, and UCSC shall not require that beach tour users pay any separate admission fee to any other facility in order to take the beach tour. This condition shall not be construed as affecting existing already allowed admission fees for UCSC's Seymour Marine Discovery Center. Beach tour signups may be provided online (e.g., at UCSC Marine Science Campus and Seymour Marine Discovery Center websites) but shall at a minimum be made available by phone and at the Seymour Marine Discovery Center front desk. UCSC shall also identify and implement a mechanism for tracking the number of tour requests that are denied due to lack of tour availability or because tours are fully booked. All UCSC materials referencing the beach at Younger Lagoon and/or beach tours shall be required to be modified as necessary to clearly identify that access to the beach is available for free via beach tours. Within 30 days of this approval (i.e., by October 13, 2018), UCSC shall provide evidence to the Executive Director identifying the manner in which (1) free beach tour signups are made available, (2) tour request denials are quantified and recorded, and (3) UCSC materials have been modified to reflect that beach access is available for free via beach tours, all consistent with this condition.

2. **Beach Tour Outreach Plan.** Within 30 days of this approval (i.e., by October 13, 2018), UCSC shall submit two copies of an Outreach Plan for Executive Director review and approval, where such Plan shall identify all measures and venues to be used to advertise and increase awareness of the free beach tours (e.g., UCSC Marine Science Campus and Seymour Marine Discovery Center websites, press releases, calendar listings with UCSC Events and local media (e.g., *Good Times* newspaper), ads on radio (e.g., public radio station KAZU), print ads, social media (including Facebook, Twitter, and Instagram), etc.). The Plan shall identify the language to be used in describing the free beach tours (where said language shall be required to be consistent with the terms and conditions of this approval), and shall provide a schedule for each type of outreach, with the goal being to reach as many potential free beach tour audiences as possible, including audiences that might not normally be reached through traditional and local means (e.g., inland communities). UCSC shall implement the approved Outreach Plan as directed by the Executive Director.

3. **Beach Tour Signs.** Within 30 days of this approval (i.e., by October 13, 2018), UCSC shall submit two copies of a Beach Tour Sign Plan for Executive Director review and approval, where such Plan shall provide for installation of signage outside of the Seymour Marine Discovery Center and inside at its front desk, at Campus overlooks, and at other appropriate public access locations on the Marine Science Campus that describe free beach tour availability, including "day of" signs for each day beach tours are offered to ensure maximum notice is provided. All such signs shall be sited and designed to be visually compatible with the area, shall be consistent with the Campus sign program (and CLRDP sign requirements), and shall provide clear information in a way that minimizes public view impacts. UCSC shall implement the approved Beach Tour Sign Plan as directed by the Executive Director.

4. **Beach Tour Availability and Monitoring.** UCSC shall offer at least four beach tours per month (of which at least one per month is a weekday tour and at least two per month are

weekend tours) from March 1st through September 30th each year, and shall provide at least two beach tours per month (of which at least one per month is a weekday tour and at least one per month is a weekend tour) otherwise (a minimum of 38 total beach tours per year). UCSC may limit the number of beach tour participants to 14 persons per tour, but this number may be exceeded per tour on a case by case basis, and beach tours shall not require any minimum number of participants to be provided (i.e., if at least one person signs up, the tour shall be provided). UCSC shall document the date/time and number of participants for each beach tour, as well as the number of tour requests that are denied due to lack of tour availability or because tours are fully booked (see also **Condition 1**).

At least every six months (i.e., by June 30th and December 31st each year), UCSC shall submit two copies of a Beach Tour Monitoring Report for Executive Director review and approval, where the Report shall at a minimum provide information regarding compliance with these conditions of approval, including a section identifying UCSC's activities under the approved Beach Tour Outreach Plan (see **Condition 2**), as well as the required information described in the previous paragraph. Each such Monitoring Report shall include a section that identifies recommendations about whether user data suggests that beach tours should be increased in terms of frequency of tours and/or number of tour attendees, or otherwise modified to better respond to user demand, including the potential to offer a more limited beach area tour (e.g., designed to allow participants to access just the sandy beach area itself in a shorter amount of time) as a means of offsetting demand. UCSC shall implement any Executive Director-approved recommendations from each Beach Tour Monitoring Report.

5. **Beach Access Management Plan Duration.** This approval for UCSC's public beach access management plan at Younger Lagoon Beach shall be effective through December 31, 2020. UCSC shall submit a complete NOID, consistent with all CLRDP requirements, to implement its next public beach access management plan at Younger Lagoon Beach (for the period from January 1, 2021 to December 31, 2025) no later than July 1, 2020. Such complete NOID shall at a minimum summarize the results of the Beach Tour Monitoring Reports (see **Condition 4**), and shall identify the manner in which UCSC's proposed management plan responds to such data, including with respect to opportunities to increase public access to the beach area (when considered in light of potential impacts to UCSC research and coastal resources). If such complete NOID has not been submitted by July 1, 2020, then UCSC shall allow supervised (via beach and trail monitors only) general public access to Younger Lagoon Beach during daylight hours (i.e., one hour-before sunrise to one-hour after sunset) until such NOID has been submitted.

III. FINDINGS AND DECLARATIONS

A. UCSC CLRDP

General CLRDP Background

As an alternative to project-by-project coastal permit review, Coastal Act Section 30605 allows for, among other things, universities to develop long-range development plans for Commission certification. Once certified, each university is the primary entity responsible for ensuring that future development on the site is consistent with the certified coastal long range development plan (CLRDP), subject to ongoing Commission oversight.

UCSC's Marine Science Campus

The University of California at Santa Cruz (UCSC) Marine Science Campus (Campus) site is located directly adjacent to the Monterey Bay National Marine Sanctuary just within the western border of the City of Santa Cruz in Santa Cruz County (see **Exhibit 1** for a location map).[5] Agricultural land extends to the west (upcoast) along the coast beyond the Younger Lagoon Reserve and the western Campus boundary. To the north (inland) are the Santa Cruz Branch Line rail corridor, the Raytek industrial facility, a City of Santa Cruz corporation yard, and Highway One. To the south (seaward) lies the Sanctuary and the Pacific Ocean, and to the east (downcoast) is Antonelli Pond (north of Delaware Avenue) and the densely packed De Anza Mobile Home Park (south of Delaware Avenue), beyond which is Natural Bridges State Park and, past that, West Cliff Drive in the City of Santa Cruz.

The Campus site is primarily made up of a relatively flat terrace area (roughly 73 acres) sloping gently from north to south (to the ocean) with the remainder occupied by a large arroyo feature (roughly 25 acres) on the west of the site, at the base of which lies Younger Lagoon, an estuarine lagoon that connects (at times) to the ocean. A sandy beach area fronts Younger Lagoon below the terrace. The lagoon, the pocket beach, the arroyo and a portion of the terrace make up Younger Lagoon Reserve, a component of the UC Reserve System. The terrace portion of the site includes within it a NOAA Fisheries Lab and related development on a 2.5 acre federally-owned parcel that is completely surrounded by UCSC property. Altogether, the Campus (including the federal in-holding and the Younger Lagoon Reserve) is about 100 acres.[6]

UCSC'S Marine Science Campus CLRDP

The CLRDP was certified by the Commission on January 7, 2009. The CLRDP provides a blueprint for future development of the site, including a maximum increase of about 600,000 square feet of new Campus facilities (including outdoor research and support areas), mostly within four distinct development zones (occupying about one-third of the terrace area). The CLRDP provides for roughly 340,000 gross square feet of potential new facilities within the four

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[5] The main UCSC campus is located roughly two miles inland of the Marine Science Campus, in the rolling foothills northwest of downtown Santa Cruz. The main campus is located almost entirely outside of the coastal zone.

[6] As required by the CLRDP, the terrace areas located outside of the allowed development footprint on the Marine Science Campus were added to Younger Lagoon Reserve in 2009. Thus, when added to the original 25-acre Reserve area, Younger Lagoon Reserve now occupies 72 acres of the almost 100-acre Marine Science Campus.

development zones in new one- and two-story buildings up to 36 feet tall,[7] with the remainder in outdoor research and support areas. The CLRDP also accounts for additional areas of roads, and natural drainage features and related water quality BMPs that extend outside of the four development nodes. Overall, and at full buildout, the CLRDP allows for the Campus to grow by about three times its size at the time of CLDRP certification in 2009. In addition to the building program, the CLRDP also provides for an expanded public access trail system and natural habitat restoration in the roughly 47 acres of wetlands and open space on the terrace that are not part of the proposed development zones (and which have been added to Younger Lagoon Reserve per the CLRDP). UCSC recently completed several large construction projects, including installation of the CLRDP-required Campus-wide access trail system and the Campus-wide system of natural drainage features. See **Exhibit 2** for Campus area photos, including of Younger Lagoon Beach.

B. UCSC NOID 9

Notices of Impending Development

Under a certified CLRDP, university development of specific projects contained in a CLRDP can proceed without a coastal permit, provided UCSC sends a Notice of Impending Development (NOID) to the Commission and other interested parties prior to undertaking development, and either the Commission deems the identified development project consistent with the CLRDP (with or without conditions to make it so) within 30 working days after the NOID is filed with the Commission. The development is deemed consistent if the Commission fails to act upon the NOID in a timely manner.[8] Pursuant to Coastal Act Sections 30605 to 30607 and Section 13550(d) of Title 14 of the California Code of Regulations (CCR), the Commission may impose conditions on such development project proposals, but only in order to ensure consistency with the Coastal Act and the certified CLRDP.

Younger Lagoon Beach Access

Younger Lagoon Beach is not unlike other sandy pocket beaches along the northern Santa Cruz County coast that include inland lagoon and brackish features, and it was a popular and well-used area for general beach activities for many years before UCSC acquired the property in the 1970s. The beach was closed to general public access on a temporary basis in 1981 in order to protect UCSC research as well as Younger Lagoon and related habitat resources, and to provide UCSC marine lab security more generally.[9] Although some unauthorized access continued to

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[7] Several new buildings were recently completed pursuant to NOID 6.

[8] Coastal Act Section 30606 requires that universities provide a NOID at least 30 working days prior to pursuing the development. Title 14 of the California Code of Regulations (CCR) Section 13549(b) provides that a NOID is only deemed filed following Executive Director review of the NOID and any supporting materials to ensure there is sufficient information for making the consistency determination, where such filing review must be completed within ten working days after receiving the NOID submittal. CCR Section 13548 requires that the Commission take action on the notice within 30 working days of filing of the NOID or else the development is deemed consistent with the CLRDP. In sum, if the Commission does not take action within 30 working days of filing of the NOID, the identified development project is deemed consistent and can proceed. In the case of the UCSC CLRDP, the action deadline may be extended by UCSC for up to three months (per CLRDP Section 8.4.2).

[9] This general public beach access closure was only allowed by the Commission on a temporary basis in 1981, and that approval required periodic reevaluation, which ultimately occurred in 2001 when the Commission again allowed for continued beach closure for similar reasons. The temporary nature of the closure was based on the

occur (i.e., primarily, surfing and skim-boarding use across the wet sandy fore-beach), the general beach access closure remained in effect, limiting beach access to UCSC researchers and personnel only between 1981 to 2010, or for nearly three decades. As indicated, the initial closure in 1981 was conditioned by Commission CDP for periodic reevaluation, and that reevaluation mechanism was ultimately built into the CLRDP when it was certified in 2009. The CLRDP Younger Lagoon Beach Access Plan is structured to be reevaluated every five years, and the reauthorization process is designed to allow UCSC and the Commission to reassess the context and conditions associated with the level of public beach access at Younger Lagoon Beach, and to potentially make changes in the degree of public beach access provided to the beach area (i.e., to increase it, decrease it, or leave it as is) for the next five years.

NOID 9 – Younger Lagoon Reserve (YLR) Beach Public Access Management Plan

In March 2010, the Commission approved the UCSC's initial NOID as required by Implementation Measure 3.6.3 (NOID 2). NOID 2 provided for the public to access the beach via docent-led tours only (consistent with the initial CLRDP when it was certified in 2009) for the first five-year period (i.e., through the end of 2015). These docent-led tours provided the first opportunities for the general public to physically access the beach in nearly thirty years. UCSC began implementing the Beach Access Plan and its associated monitoring program in the spring of 2010, and provided the results of the monitoring program to the Commission in February of 2016 as part of the CLRDP-required Younger Lagoon Annual Report. UCSC submitted their required beach access NOID (to cover the period between 2016 and 2020) in 2017, which described a plan to continue the beach access program that had been in place under NOID 2 for the next five-year period (i.e., through 2020). That proposal was presented to the Commission at its July 2017 meeting, but UCSC ultimately withdrew the NOID before the Commission took any action in order to consider and incorporate feedback from Commissioners regarding the adequacy of its proposed public access parameters. This resubmitted NOID (i.e., NOID 9) is UCSC's revised and modified proposal for public access at Younger Lagoon Beach, and the associated monitoring program, through 2020.

Current Tour Background and Monitoring Report Results

Currently, docent-led public beach tours of Younger Lagoon Beach are provided through the Seymour Marine Discovery Center (SMDC)[10] and are included with the cost of admission to the SMDC (i.e., tours are not available unless one purchases admission into the SMDC).[11] These tours began in the spring of 2010, and until 2017 they were offered twice monthly, including one

premise that the Commission would continue to reevaluate the beach access issue on a regular basis in order to ensure that the balance being struck and the trade-offs (i.e., between research and resource protection on the one hand, and general beach public access on the other) remained appropriate under the Coastal Act.

[10] SMDC is a marine science education center located on the UCSC Marine Science Campus, adjacent to Long Marine Laboratory on the bluff downcoast of Younger Lagoon Beach. SMDC offers daily tours of its own facility and the marine laboratory in addition to the tours of Younger Lagoon Beach that are the focus of this NOID.

[11] Admission to SMDC is currently $9 for adults, $7 for children between the ages of 3-16, and free for children younger than 3. Thus, since UCSC currently requires tour-goers to purchase SMDC admission regardless of whether or not they intend to enter the SMDC, the de facto cost of a beach tour is $7-$9 (for those above 3 years old), depending on the age of the participant.

tour on a weekday and one on a weekend.[12] UCSC indicates that tours were advertised on the SMDC website,[13] and via press releases, calendar listings, print and public radio ads, and social media postings. Members of the public may only book spaces on the tours by phone. Tours are limited to 12 persons and are advertised as being best suited for adults in good physical condition and children over 10 years of age. The SMDC allocates spaces on the tours and keeps track of all participant data.

UCSC indicates that the beach tours are designed to provide an interpretive experience for visitors. They are led by SMDC docents trained in the natural history and ecology of the YLR, who can give visitors detailed information about flora, fauna, geology, and the UC Natural Reserve System (UCNRS). The tour curriculum focuses on the ecology of Younger Lagoon and its fronting beach. While walking to the beach, participants are provided with a narrative history of the UCNRS and a discussion of the lagoon and its habitats. The tour proceeds through restored coastal scrub habitat, and participants are given opportunities to view the rear dune. The tour culminates with a walk on the sandy beach. The extent of the beach area that may be accessed during the tours varies depending on tidal conditions and the location of plants, because foot traffic is only permitted seaward of the dune vegetation. Thus, the exact beach access area may vary slightly from the areas depicted in Figure 1 of the NOID based on on-the-ground conditions (see **Exhibit 3**, p. 12, and **Exhibit 4 (**CLRDP Figures 3-11 and 5-6).

Members of the public who enter YLR are required to adhere to the UCNRS use guidelines. Because beach tours are limited to groups with trained docents who interpret the natural history of the YLR and ensure that visitors remain in areas authorized for access, installation of additional signage and fences has not been necessary in the Reserve. The trail consists of a simple dirt/mulch path with steps that lead down the bluff to the beach and dune area, and is maintained by clipping overgrown vegetation and maintaining the earthen path and timber steps as needed.

In addition to monitoring Younger Lagoon Beach as required under the CLRDP, UCSC also voluntarily monitored nearby beaches that allow for varying intensities of use (i.e., Natural Bridges State Beach and Sand Plant Beach) during the five-year period starting in 2010 in order to examine differences in the flora, fauna, and human use among the three sites. According to UCSC, this effort required hundreds of hours of their staff and student time, as well as coordination with State Parks staff. The annual survey results were included in the CLRDP-required Younger Lagoon Reserve annual reports submitted to the Commission from 2011 to 2016. The Younger Lagoon Natural Reserve Beach Monitoring Report (Monitoring Report) describes the monitoring program in detail and presents the results of the entire beach monitoring program (**Exhibit 3**, pp. 37-96).[14]

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[12] In addition, all of the docent-led daily tours run by the SMDC (i.e., other SMDC facility tours that do not stop at the beach) include an informational stop regarding the YLR.

[13] Information on the tour program is provided on a page titled “Behind-The-Scenes Tours” (http://seymourcenter.ucsc.edu/visit/behind-the-scenes-tours), which can be accessed by clicking on a link under the “visit” tab on the main SMDC page.

[14] UCSC discontinued monitoring on Natural Bridges State Beach and Sand Plant Beach after the 2015 monitoring season; however, data from the 2010-2015 monitoring seasons (including all three beaches) are included in the NOID 9 monitoring report.

Data from the monitoring reports indicate that Younger Lagoon Beach supports a variety of native flora and fauna, provides habitat for sensitive and threatened species, supports a back-beach dune community, and is frequently used for teaching and research. In general, native plant species richness was greatest at Younger Lagoon and Natural Bridges Beaches compared to Sand Plant Beach; however, there was significant annual variation among the sites. A parameter that was quantified in 2012, which is also evident from visual observation and photo documentation, is the presence of dune hummocks and downed woody material at Younger Lagoon Beach, both of which are almost entirely absent at other local beaches due to human use according to UCSC. These features provide habitat for plant species such as the native succulent plant *Dudleya sp.*, which grows on downed woody material and dune hummocks, as well animal species such as the burrowing owl (*Athene cunicularia*), which uses burrows in the dune hummocks and seeks shelter beneath downed woody material. The relatively natural state of Younger Lagoon Beach and its associated dune vegetation is unique among most pocket beaches in Santa Cruz County and likely represents a glimpse into what many of the pocket beaches in the greater Monterey Bay area looked like prior to significant human disturbance. Again, general public access to Younger Lagoon Beach was discontinued in 1981, and the beach area has been subject to only limited UCSC researcher and other authorized use since then. Broadly, the results of the monitoring program suggest that allowing general public access to the beach at Younger Lagoon (as allowed at Natural Bridges State Beach and Sand Plant Beach) could result in damage to the ecological characteristics of the beach area, which could reduce its effectiveness as a research area for scientific study, and could have a negative impact on sensitive species and habitats.

NOID 9 - Proposed Tour Changes

NOID 9 again proposes to keep the beach closed to general public access, and to continue the existing docent-led beach tour program as the allowed form of public beach access through 2020, with some changes relative to the previous program designed to provide additional opportunities for the public to access the beach and reduce the cost of access for younger visitors. Specifically, UCSC is proposing to continue the docent-led Younger Lagoon beach tour program with the following changes:

- The maximum number of persons per beach tour would be increased from 12 to 14.

- UCSC proposes to increase the number of beach tours offered in the spring and summer seasons (March through September) from two to four tours per month, while twice-monthly tours would remain the standard from October through February. UCSC has set a goal of maintaining tours at this level for the term of this Beach Access Plan, weather and docent availability permitting. Weekday and weekend tours would be offered in each month.

- Children under the age of 16 may participate in the beach tour program without paying the SMDC admission fee (though a fee will still be charged for anyone under the age of 16 who wishes to enter the SMDC in addition to taking a beach tour, and adults will continue to be charged the SMDC admission fee to participate in the Younger Lagoon Beach tour).

UCSC will also continue to monitor the beach and lagoon area, and to submit beach access

NOIDs to the Commission at five-year intervals[15] that report on the previous five years' of beach access management, including (in each NOID) the required monitoring report that evaluates beach conditions and all necessary supporting information for a development project to implement the next five-year beach access management plan, as outlined in the CLRDP.

See **Exhibit 1** for a location map and a site plan; see **Exhibit 2** for photos of the Campus, including Younger Lagoon Beach; and see **Exhibit 3** for the complete NOID and supporting materials.

C. CLRDP Consistency Analysis

Applicable CLRDP Provisions

The CLRDP includes multiple provisions that regulate YLR in general, as well as public beach access specifically. IM 3.6.3 governs public beach access within YLR and provides as follows:

> ***Implementation Measure 3.6.3 - Public Beach Access within YLR (Original YLR).*** *Supervised beach access to Younger Lagoon beach shall be provided to the general public consistent with and pursuant to a management plan for such access that is based on the best possible assessment of the capacity of the beach area to sustain use and the level of intensity of such use when considered in light of the fragility of the beach area and adjacent resources and ongoing research. Within six months of CLRDP certification, and at five-year intervals post-certification after that, the University shall submit a Notice of Impending Development to the Coastal Commission with all necessary supporting information for a development project to implement such a beach access management plan for the next five years. Each such management plan shall at a minimum include:*
>
> - *A regular schedule of guided, educational tours to the beach area that is coordinated with and similar to other Marine Science Campus education and docent programs and designed to introduce visitors to the special aspects of beach ecology without causing deterioration of that ecology or loss of opportunity for feeding or breeding of beach dependent species. These tours may be weekly weather permitting, but shall be offered a minimum of two times per month.*

[15] The original NOID covered the five-year period from 2010 to 2015, and no NOID for the next five-year period (2016 to 2020) has thus far been approved. If the Commission finds this NOID consistent with the CLRDP, UCSC will have obtained approval through 2020. A new NOID must be submitted and approved for the 2021 to 2025 period to meet the CLRDP requirement that the Beach Access Plan be reviewed and authorized every five years.

- *Identification of all parameters for beach access, including a clear depiction of the area within which such access is allowed, and a clear description of all related implementing measures (e.g., trail alignments, trail design, barriers/fencing, signage, timing restrictions, supervision requirements, etc.). Access shall be by way of controlled access trails shown on Figure 5.6. Trails shall be maintained, marked, and signed for safety and interpretation of YLR ecology.*

- *A monitoring program that evaluates trends in beach area conditions, where at a minimum such program shall include: user data (including identification of all user types and specific data on size and composition of beach tour groups); a selected set of repeatable photo points to be taken seasonally to show all major areas of the beach; presence/absence of tidewater goby and evidence of breeding activity; species composition and coverage of beach dune vegetation from the lowest (nearest to the mean high tide line) occurring terrestrial plant to 10 meters inland into the strand vegetation; evidence of seed production by beach strand species in this zone; species composition and abundance of animal tracks (vertebrate and invertebrate) on the beach and adjacent beach dune area; and regular counts of feeding shorebirds on the beach.*

- *An assessment of beach area resources and the effect of beach area use and activities (including authorized and unauthorized uses, research use, YLR activities, etc.) on such resources in the time since the last five-year review and overall in the time since at least CLRDP certification;*

- *A description of existing public access opportunities on the Campus, and the way in which such opportunities relate to the amount and type of supervised access provided to the beach area.*

Policy 6.1 Public Access to the Marine Science Campus
Maximum public access to the coastal resources of the Marine Science Campus and the adjacent shoreline and coastal area shall be provided consistent with public safety, fragile coastal resources, implementation of the educational and research missions of the Campus, and security of sensitive facilities and research activities on the site.

Implementation Measure 6.1.1 – Free Public Access for Visitors
Free public visitor access to the Marine Science Campus shall be provided during at least daylight hours (i.e., one hour before sunrise until one-hour after sunset). Modest fees may be charged only for access to the Seymour Marine Discovery Center and similar University facilities with developed educational and/or visitor-oriented programs.

Consistency Analysis
UCSC is proposing to continue to keep the beach closed to general public access, and to continue the docent-led beach tour program as the allowed form of public beach access through 2020, with some changes relative to the prior program (as described above). Additionally, the NOID includes new information on the means by which UCSC has been promoting and advertising the beach tour program. No changes are proposed for the substance of the tours; they would still be

led by SMDC docents, and would include a narrative history of the UCNRS, a discussion of the lagoon and its habitats, and a walk through a restored coastal scrub habitat with opportunities to view the rear dune, and would conclude on the sandy beach itself.

In an effort to respond to Commissioner comments at the July 12, 2017 hearing regarding the potential for increased beach tour availability and reduced fees, UCSC analyzed historic beach tour data and determined that tour availability met or exceeded public demand in the slower fall and winter months (October through February), but that demand for tours was higher in the spring and summer months. Based on these observations, in 2018 SMDC began offering four beach tours per month during the March through September season, increasing the overall number of annual tours from 24 to 38. UCSC has proposed that SMDC will continue to offer beach tours between two and four times per month (a minimum of four times per month during the March through September season, and a minimum of two times per month otherwise) with the goal of offering 38 tours per year, weather and docent availability permitting. To ensure UCSC is accountable for its proposal, this NOID is conditioned to make that number (i.e., 38 tours per year) the annual *minimum* number of tours (see **Condition 4**). SMDC will also continue to ensure that weekday and weekend beach tours are offered each month. In addition, **Condition 4** requires that at least two beach tours will be offered on weekends in months when four beach tours are offered, while maintaining UCSC's commitment to offering at least one weekday tour each month. This modification ensures that the public has opportunities to access the beach on both weekdays and weekends, while also ensuring that at least half of all beach tours are offered on weekend days when more people may be available to take them. UCSC also proposes to increase the maximum number of persons per beach tour from 12 to 14. Subject to the following discussion, these changes are generally appropriate in light of the information gathered from the Monitoring Report for the initial five-year period, and should increase beach access availability while ensuring adequate protection of coastal resources consistent with the CLRDP, including IM 3.6.3.

With respect to beach tour fees, UCSC has eliminated them for users age 16 and under, but has otherwise not modified its fee proposal from that presented to the Commission in July 2017.[16] IM 3.6.3 does not reference potential fees, and the CLRDP is clear that general public access to the Campus is meant to be free, other than for access to developed facilities (see also below). As indicated above, the beach access program as operated between 2010 and 2016 required that tour users pay for the cost of admission to the SMDC (ranging up to $9 per adult) in order to access the beach via docent tour, even if beach visitors did not actually go to the SMDC. Under the proposed plan, children ages 16 and under will be allowed to take the beach tour without paying for SMDC admission. Tours would therefore be free to those ages 16 and under, but those older than 16 would be required to pay the $9 SMDC adult admission in order to access the beach. Of course, that admission would allow the user access to the SMDC in addition to the beach, but the fee of $9 would be required for beach access even if the user does not want to enter the SMDC.

UCSC has not to date agreed to allow visitors over 16 to take beach tours for free if they do not also want to access the SMDC. As is, a $9 per person beach tour fee for individuals over 16 is

[16] SMDC admission fees have increased since the beach access program was last considered by the Commission, however. The current rates for adults and children 16 and under are $1 higher than they were in July of 2017.

relatively expensive, particularly for those least able to afford such fees. Given the concessions that the public is already required to make with respect to beach access here (i.e., limited supervised access to allow protection of Younger Lagoon-area research and ecology), it appears clear that a different fee structure for the beach tour program would be more consistent with CLRDP IM 6.1.1. In addition, IM 6.1.1 only allows for "modest fees," and only when the fees are for "access to the Seymour Marine Discovery Center and similar University facilities." The sandy beach at issue in this case is not a "facility" (which connotes a human-made edifice[17]), but rather a natural area under University control and management. As such, it is not clear that fees for beach access are even allowed by the CLRDP. Thus, this NOID is conditioned to allow for free beach access tours for all who sign up, whether one pays for SMDC access or not (see **Condition 1**). Beach tour participants who drive to Campus may still need to pay parking fees, however.[18]

UCSC indicates that in recent years it has raised awareness of the beach tour program via press releases, calendar listings with UCSC Events and the *Good Times* (a local weekly newspaper), ads on public radio station KAZU, print ads, and social media (including Facebook, Twitter, and Instagram). UCSC proposes to continue to engage in this suite of outreach and advertising activities, though the proposed plan does not make any commitments with respect to how or how often the tour program would be promoted on each platform. UCSC indicates that the tours would also be advertised on a "Behind-the-Scenes Tours" page on the SMDC website and on interpretive signage in public areas on Campus, consistent with how they have been promoted in those venues in the past. In order to ensure that these measures are adequately utilized to inform the public of the availability of beach tours, this NOID is conditioned to require that UCSC prepare an Outreach Plan for Executive Director review and approval that describes the language that will be used to promote the beach tour program and how often each type of outreach will be used. The Plan shall be prepared with the goal of reaching as many possible audiences as possible, including audiences that might not normally be reached through traditional local means (e.g., inland communities) (see **Condition 2**). Furthermore, to ensure that users that are already onsite are informed of the beach tours, **Condition 3** requires that UCSC provide signage at Campus overlooks and inside and outside of the SMDC that describe tour availability, including "day of" signs to ensure maximum notice is provided.[19] Together, **Conditions 2 and 3** ensure

[17] For example, the Merriam-Webster Dictionary defines "facility" as "something (such as a hospital) that is built, installed, or established to serve a particular purpose." (See definition 4.b at https://www.merriam-webster.com/dictionary/facility.)

[18] Currently, paying SMDC visitors may have their parking validated to avoid the $1.50 per hour parking fee for public spaces in the Campus parking lot just north of SMDC (Lot 201). That fee, which was approved as part of NOID 6 in 2013, applies between 8 a.m. and 5 p.m. on non-holiday weekdays. Parking in Lot 201 is free on weekends, State holidays, and during weekday daylight hours before 8 a.m. and after 5 p.m. Free parking is also available in the new lot at the Campus' entrance (Lot 207) and along Delaware Avenue west of the Campus entrance. Beach tour participants who do not wish to pay admission to SMDC may pay the $1.50 per hour fee to park in Lot 201 (during the hours when fees are in effect) or utilize alternative, free parking in Lot 207 or off-Campus. A beach tour typically takes 1-1.5 hours, so the cost of onsite parking for Younger Lagoon Beach tour participants would not be expected to exceed $3.

[19] UCSC already provides this information on at least some Campus overlooks and access areas, but it is not clear how many of the available overlooks and access areas currently offer tour information, and UCSC does not provide and has thus far not committed to providing "day of" signs (whether in the SMDC or otherwise)

that the tour program will be implemented successfully, including as structured under **Condition 4** (see below), by ensuring adequate public notice of the tour program.

It is expected that with increased awareness and eliminated fees for the beach tours, including via the conditions identified above, demand for access to the beach tours will likely increase. To assess changes in demand for beach tours and provide a mechanism for responding to any increases, this approval is conditioned to require UCSC to prepare and submit, on a semiannual basis, a report regarding compliance with these conditions, including outreach activities, beach tours offered, the number of people who sign up for each beach tour, and the number of persons turned away for lack of available spaces.[20] The report must also contain recommendations based on user data regarding whether beach tours should be increased (in terms of frequency of tours and/or number of tour attendees) or otherwise modified to better respond to user demand, and consider the potential to offer a more limited beach area tour (e.g., designed to allow participants to access just the sandy beach area itself in a shorter amount of time) as a means of offsetting demand. UCSC will be required to implement any such recommendations that the Executive Director approves (see **Condition 4**). Finally, in order to ensure that UCSC meets the CLRDP requirement for five-year review of beach access at Younger Lagoon Beach on the original time schedule required by the Commission through the CLRDP (and in order to avoid a situation in which the program that has been operative between 2015 and the present is not actually covered by CLRDP authorization, as is the case currently), **Condition 5** specifies that this NOID is effective through December 31, 2020 only, and requires UCSC to submit a NOID for the January 1, 2021 to December 31, 2025 period by July 1, 2020.

In addition to the beach tour components, UCSC proposes to continue to provide visual access into YLR and the beach via CLRDP-required overlooks. Specifically, the Commission required three overlooks into Younger Lagoon and the beach as part of the offsetting mitigation package built into the CLRDP to address UCSC building program impacts. Overlook C is the main campus overlook that provides views into the Campus' marine mammal pools (on the one side) and YLR and the sandy beach (on the other). This overlook is elevated atop the Younger Lagoon protective berm and it provides the best view to the beach area from the terrace portion of the Campus. Overlook C is accessible only through docent-led tours, and it is the main overlook visited on such tours through the SMDC.[21] Overlook D is located further inland and just north of the Campus Ocean Health Building on the Younger Lagoon side of the protective berm, and is developed with a partially enclosed observation blind that gives a more inland view of YLR, including a more distant view of the beach and ocean. As with Overlook C, Overlook D can only be accessed via docent-led tours. Finally, Overlook E is located even further inland and provides a view of the more interior parts of Younger Lagoon from a partially enclosed smaller space near the protective berm. Overlook E was completed recently and is open to the public; participation

indicating that space is available in an upcoming tour. **Condition 3** requires submittal of a sign plan to ensure that UCSC provides adequate informational signage, including the provision of "day of" signs.

[20] UCSC does not currently track the number of individuals who are denied access to the beach because tours are not offered at the times they are sought or because the tours that are offered are booked. **Condition 1** requires UCSC to develop and implement a mechanism for gathering such data so that unmet demand for tours can be quantified and addressed.

[21] UCSC estimates that nearly 15,000 visitors took the general SMDC tour to Overlook C in 2017.

in a tour is not required to access the site. The updated Beach Access Plan includes continuing visual beach access through these overlook offerings, which is appropriate, as views are required to be made available in these ways per the CLRDP.

UCSC also notes that it has complementary public programs that help offset the lack of general access to the Younger Lagoon Beach. For example, in April 2018 UCSC hosted its third annual "Bioblitz" (i.e., a period of rapid, intensive biological surveying intended to develop an inventory of the living organisms found in a particular place, usually conducted by a wide variety of people, including those with formal training and "citizen scientists") in the lagoon and beach area. The most recent Younger Lagoon Reserve Bioblitz was held during UCSC's Alumni weekend, but UCSC indicates that it was also open to the public at large. Events like the BioBlitz are part of the suite of ongoing public educational activities that bring as many as 50,000 people to the SMDC each year. One of these programs, Watsonville Area Teens Conserving Habitats (WATCH), allows pre-college-age students to access the YLR; however, most youth programming at the Campus is based in the SMDC and at Long Marine Laboratory.

As required by the CLRDP, UCSC is also proposing to continue preparation of the Younger Lagoon Public Access Plan and Beach Monitoring Report, which complies with parameters set forth in IM 3.6.3, including by providing: (1) a regular schedule of guided, educational tours; (**Exhibit 3**, pp. 43-44); (2) identification of all parameters for beach access (**Exhibit 3**, p. 44; see also p. 12); (3) a monitoring program that evaluates trends in beach area conditions (**Exhibit 3**, pp. 46-52); (4) an assessment of beach area resources and the effect of beach area use and activities (**Exhibit 3**, pp. 52-86; and (5) a description of existing public access opportunities on the Campus, and the way in which such opportunities relate to the amount and type of supervised access provided to the beach area (**Exhibit 3**, pp. 44-45).

In addition, as set forth in the NOID, UCSC will also continue to monitor Younger Lagoon and the beach area as required by, and described in, IM 3.6.3; however, UCSC will no longer conduct monitoring at Natural Bridges State Beach or Sand Plant Beach (which is not required by IM 3.6.3) on the basis that the original five years of data collection have provided adequate information to help assess differences in beach resources. Going forward, the goal of the monitoring program will be to help document the presence and distribution of flora and fauna within YLR and evaluate changes in distribution and density over time in order to understand how any observed changes relate to changes in human use of the area. Specific details regarding the proposed monitoring program are set forth in the NOID (see **Exhibit 3**, pp. 7-8). UCSC will also continue to submit a NOID to the Commission at five-year intervals that (1) reports on the previous five years of beach access management, (2) includes a monitoring report that evaluates beach conditions, and (3) includes all necessary supporting information for a development project to implement a beach access management plan for the next five years as outlined in the CLRDP. Importantly, as indicated above, these every-five-year reevaluations represent the time when UCSC and the Commission are required by the CLRDP to assess whether more or less beach access is appropriate, building upon the Commission's pre-CLRDP CDP history, as well as its certification of the CLRDP itself, during which process the Commission concluded that a permanent beach access ban or permanent set of beach access criteria were not appropriate and the level and intensity of beach access needed to be periodically reevaluated over time.

In this case, and for similar reasons as the Commission has found in the past with respect to public access at Younger Lagoon Beach, the docent-led tour program can be found CLRDP consistent provided it is modified as identified above. With these conditions in place, the NOID strikes an appropriate balance (i.e., between research and resource protection on the one hand, and general beach public access on the other) through the docent-led beach tour program. In making such finding, however, the Commission notes that the beach access situation here at Younger Lagoon Beach is an anomaly in coastal California, including inasmuch as public beach access is of critical importance, and ensuring it is maximized and provided to all is a critical component of the Commission's coastal program under the Coastal Act. It is only because of the historical context here, namely the Commission's involvement in restricting public access to this particular pocket beach as part of UCSC's research program dating back to 1981, that such limitations on general public beach access here can be found appropriate in that larger context. The Commission notes that it is incumbent on UCSC to recognize that same dynamic in terms of what type of access program it provides to the general beach going public *in return for* that concession on the part of the Commission on behalf of those beachgoers, and the Commission finds that conditions are necessary to push UCSC's program towards being more accommodating to the general public. Public beach access is the cornerstone of the Commission's access program, and regulations on its use are not to be taken lightly. The conditions applied here will help to better provide such access, including in terms of continued reassessment through monitoring of program provisions, both to inform this iteration of the program as well as future beach access plans and NOIDs. Thus, the Commission finds the proposed beach access management plan, as conditioned, consistent with the certified CLRDP.

D. CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

Section 13096(a) of Title 14 of the California Code of Regulations requires the Commission to make a specific finding that a permit application is consistent with any applicable requirements of CEQA. This requirement also applies to the Commission's review of NOIDs, based on Section 13550(d) of the Regulations (incorporating by reference Coastal Act section 30607). Section 21080.5(d)(2)(A) of CEQA prohibits a proposed development from being approved if there are feasible alternatives or feasible mitigation measures available which would substantially lessen any significant adverse effect which the activity may have on the environment.

UCSC, as the lead agency under CEQA, certified a Final EIR (FEIR) for the CLRDP in September 2004. In November 2006, UCSC certified an addendum to the FEIR to respond to changes in the CLRDP in the time since the original FEIR certification, including changes stemming from Commission review of the CLRDP prior to certification. Following UCSC certification of the FEIR and Commission certification of the CLRDP under the Coastal Act, UCSC subsequently found this proposed beach access management plan categorically exempt from further CEQA review.

The Coastal Commission's review and analysis of land use proposals, including NOIDs, has been certified by the Secretary of the Natural Resources Agency as being the functional equivalent of environmental review under CEQA (14 CCR Section 15251(c)). The preceding CLRDP consistency findings discuss the relevant CLRDP coastal resource issues with the proposal, and the NOID conditions identify appropriate modifications to avoid and/or lessen any potential for adverse impacts to said resources and to be able to find CLRDP consistency. The Commission finds that the proposed project, as conditioned, will avoid significant adverse effects on the environment, within the meaning of CEQA. As such, there are no additional feasible alternatives or feasible mitigation measures available which would substantially lessen any significant adverse environmental effects that conditioned approval of the proposed project would have on the environment within the meaning of CEQA. The proposed project, as conditioned, will not result in any significant environmental effects for which feasible mitigation measures have not been employed consistent with CEQA Section 21080.5(d)(2)(A).

APPENDIX A – SUBSTANTIVE FILE DOCUMENTS[22]

- UCSC CLRDP
- University of California at Santa Cruz Marine Science Campus Coastal Long Range Development Plan Final Environmental Impact Report (September 2004), and Addendum (November 2006).

[22] These documents are available for review in the Commission's Central Coast District office.

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Th12a

SCZ-NOID-0004-18 (YOUNGER LAGOON BEACH ACCESS PLAN)

SEPTEMBER 13, 2018 HEARING

EXHIBITS

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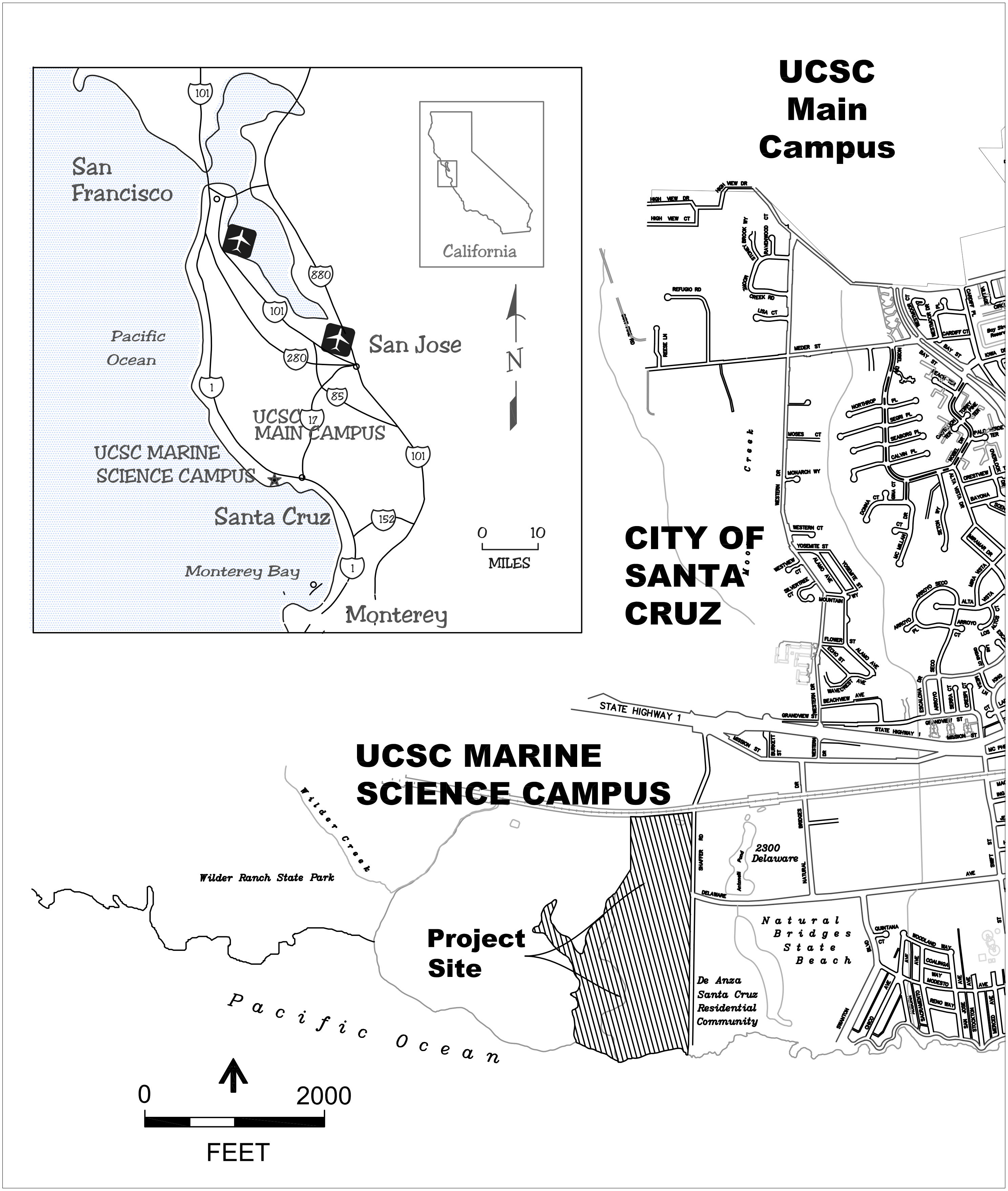

Exhibit 1
SCZ-NOID-0004-18
Page 1 of 1

Aerial View of Younger Lagoon Beach and the Marine Science Campus

Note: All photopoint locations are approximate.

Photopoint #1

All photos from May 2018, courtesy of UCSC

Looking down to the beach and upcoast (west) from the Long Marine Lab area

Looking down to the beach and inland (north) from the Long Marine Lab area

Photopoint #2

Looking upcoast (west) over the beach from the downcoast bluff (site of Long Marine Lab)

Looking upcoast (west) and slightly inland over the rear dune area of the beach from the downcoast bluff

Photopoint #3

Looking seaward from Younger Lagoon Beach

Looking upcoast (west) toward the upcoast bluff; the most seaward portion of the Lagoon is visible at the base of the bluff.

Photopoint #3

Looking upcoast (west) and slightly inland toward the upcoast bluff; the most seaward portion of the Lagoon is visible at the base of the bluff.

Looking inland (north) toward vegetated dunes

Photopoint #3

Looking northeast (inland/downcoast) toward the downcoast bluff.

Looking east (downcoast) toward the seaward edge of the downcoast bluff (Seymour Marine Discovery Center and Long Marine Lab are behind the blufftop berm)

Photopoint #4 Looking inland (north) toward the Lagoon from the upcoast (western) bluff.

Notice of Impending Development 9 18-1

A Notice of Impending Development (NOID) provides notice to the public and the California Coastal Commission of UC Santa Cruz' intention to undertake a development project at its Coastal Science Campus (CSC, formerly the Marine Science Campus). In order for a project to be implemented, it must be contemplated by and within the parameters of the Marine Science Campus Coastal Long Range Development Plan (CLRDP). The CLRDP is available at UCSC's McHenry Library, the Santa Cruz Public Library and at: https://lrdp.ucsc.edu/final-clrdp.shtml.

The California Coastal Commission will review the project that is the subject of this NOID and determine if it is consistent with the CLRDP. The California Coastal Commission will provide advanced public notice of the date of the hearing.

Project Summary for NOID 9 18-1
Public Access to and Within Younger Lagoon Natural Reserve

The project is a beach access management plan for the next five years.

Supporting Information, which includes more details about this project is available at: http://ppc.ucsc.edu/planning/EnvDoc.html. A hard copy is available for review at UC Santa Cruz Office of Physical Planning, Development and Operations, 1156 High Street, Barn G, Santa Cruz, CA 95064.

University Approval Date **January 2010**
see CLRDP 8.1.4 (5)

NOID Posting Date **8/14/18**
see CLRDP 8.2.4

Environmental Compliance (CEQA/NEPA) Date October 2009
see CLRDP 8.1.4 (5)

X	CEQA	Categorical Exemption CEQA document
__	NEPA	____________________ NEPA document

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Notice of Impending Development 9 18-1

Public Access to and within Younger Lagoon Natural Reserve

Supporting Information

see CLRDP 8.2.5

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1. Project Report

1a. NOID 9 18-1 Project Description

PUBLIC ACCESS TO AND WITHIN YOUNGER LAGOON NATURAL RESERVE (IMPLEMENTATION MEASURE 3.6.3)

Overview

CLRDP Implementation Measure (IM) 3.6.3 requires that the public have access to Younger Lagoon Reserve beach through controlled visits, and that a monitoring program be created to document the condition of native flora and fauna within Younger Lagoon and its beach over a five-year period. IM 3.6.3 also requires that the campus prepare a report at the end of the five-year period which presents the results of the monitoring and a discussion of the potential effect of controlled beach access on flora and fauna at Younger Lagoon. At the end of each five-year period, the University must submit a NOID to the Coastal Commission to implement a beach access plan for the next five years.

In March 2010, the California Coastal Commission (CCC) approved the University of California's first NOID for Implementation Measure 3.6.3 of (NOID 10-1). The campus began implementing the public access plan and monitoring program in spring 2010, and submitted the report on the results of the monitoring to the Coastal Commission in February of 2016 as part of the Younger Lagoon Annual Report. The 2017 monitoring report is attached to this NOID (Section 5)

The campus submitted NOID 9 (16-2) *Public Access to and Within Younger Lagoon Reserve* to the California Coastal Commission (CCC) in December 2016. At the request of local coastal staff, the campus withdrew NOID 9 (16-2) resubmitted it as NOID 9 (17-1) in June 2017. The campus presented NOID 9 (17-1) at the July 2017 CCC and although CCC staff found the NOID consistent with the CLRDP, Commissioner Brownsey requested the University consider providing significantly more tours to the beach and allow children to attend free of charge. We are resubmitting it here with changes to the beach tour program as NOID 9 (18-1).

The current NOID 9 (18-1) describes the University's plan for continuing the public access program (which was initiated in 2010) but with modifications that meet Commissioner Brownsey's request. Specifically, we have significantly increased the number of beach tours and provided tours free of charge for children under 16.

Background

Fifty years ago, the University of California Natural Reserve System (UCNRS) began to assemble, for scientific study, a system of protected sites that would broadly represent California's rich ecological diversity. Today the UC Natural Reserve System is composed of 39 reserves that encompass approximately 750,000 acres of protected natural land available for university-level instruction, research, and outreach. The University of California Natural Reserve System supports research and education through its mission of contributing *"to the understanding and wise management of the Earth and its natural systems by supporting university-level teaching, research, and public service at protected natural areas throughout California."* By creating this system of outdoor classrooms and living laboratories, and making it available specifically for long-term study and education, the NRS supports a variety of disciplines that require fieldwork in wildland ecosystems. UC Santa Cruz administers four UC Natural Reserves: Younger Lagoon, Año Nuevo

Island Reserve, Landels-Hill Big Creek Reserve, and Fort Ord Natural Reserve as well as a 400-acre campus reserve.

History of Public Access to Younger Lagoon Beach

This summary provides a coarse overview of the major events that affected beach access at Younger Lagoon. Prior to 1972, Younger Beach was privately owned and closed to the public. The owners (Donald and Marion Younger) actively patrolled for, and removed, trespassers from their property, including the beach. In 1972, the Younger Family donated approximately 40 acres of their property to the University of California for the study and protection of the marine and coastal environment. These lands included Younger Lagoon and Beach (approximately 25 acres), and an adjoining parcel of land (approximately 15 acres) which became the site of the original Long Marine Laboratory (LML). At the time of their donation, Donald and Marion Younger intended that the lagoon, beach and surrounding slopes be protected in perpetuity by the University as a bird sanctuary.

In the years between the donation of the property and the start of LML construction (1976), the University leased the future LML site back to farmers who had been farming the property for the Younger family prior to the donation. During those years, the same no-trespassing rules for the beach were enforced as when the property was owned by the Younger family.

Once construction of Long Marine Lab began in 1976, the land was no longer under the watch of the farmers, and public pressure on the beach began to increase. Many Santa Cruz locals remember the next several years at Younger Beach fondly as it became a popular nude beach. The increased public access had a noticeable impact on the flora and fauna of the beach, and was not in accordance with the intention of the original donation by the Younger family. By 1978 discussions had begun between the University and the California Coastal Commission regarding the impact of uncontrolled public access to the beach. In 1981, it was decided that the impacts to Younger Beach were significant and the California Coastal Commission, under coastal permit P-1859, closed uncontrolled access to the beach.

After the approval of coastal permit P-1859, the University began actively to patrol the beach for trespass and to educate the public about the closure. After YLR was incorporated into the UCNRS in 1986, users were required to fill out applications or contact NRS staff for specific research, education, or outreach efforts. As the LML campus grew, a protective berm and fencing were constructed around the perimeter of the lagoon, and informational ‘beach closed’ signs were posted on the cliffs above the beach. Over time, trespass decreased and the reduced public access had a noticeable positive impact on flora fauna as well as beach/dune habitat.

Public access to YLR beach came to the forefront again during the CLRDP negotiation process (2000-2008). At the time negotiations began, YLR supported a rich composition of plant and animal species despite being surrounded by agricultural and urban development. Reserve staff were concerned that any increase in public access could threaten the already heavily impacted habitat and impact ongoing and future research efforts. After CLRDP certification (2009), a Beach Access Management Plan was implemented as outlined in NOID 10-1. Under the Beach Access Management Plan, the YLR beach remained closed to unsupervised public access and the reserve has implemented a management and monitoring plan that is consistent with other UC Reserves and includes public access through docent-guided tours. Although infrequent, unauthorized uses including trespass and vandalism of the YLR beach continue and put research equipment and sensitive resources at risk. Reserve staff will continue to work hard to protect sensitive resources and maintain the YLR beach as an important outdoor classroom and living laboratory.

Implementation of NOID-10-1

Docent Led Tours

From 2010 - 2017, docent-led beach tours were offered twice monthly through the Seymour Marine Discovery Center (Seymour Center). In addition, all of the docent led daily tours run by the Seymour Center (approximately 1,500 tours annually) include an informational stop about YLR that includes visual access to the beach. In October 2017, in an effort to meet Commissioner requests to increase the number of tours, Younger Lagoon Reserve staff met with Seymour Center staff to discuss the potential of providing more tours. Seymour Center staff analyzed historic tour data and identified those months during which tour demand had been met or exceeded (October-February), and those months during which there was higher demand (March-September). Based on these data, beginning in January 2018, we conducted a pilot program with the Seymour Center and began offering tours twice a month during the slower fall and winter months (October-February), and four times a month during the busier spring and summer months (March-September). The total number of tours offered in 2018 was increased from 24 to 38 (offering approximately 60% more tours). Moving forward, the Seymour Center will continue to offer tours between two and four times per month (depending on the season and demand), with the goal of continuing to offer at least 38 tours per year (depending on weather, docent availability, etc.), including tours on weekdays and on weekends.

The extent of the beach access area varies depending on tidal conditions and the location of plants, as foot traffic is only permitted seaward of the dune vegetation. Thus, the exact access area may vary slightly from the areas depicted in Figure 2 below and Figure 3.11 of the CLRDP. The trail provides an interpretive experience for visitors that begins with a narrative history of the UC Natural Reserve System (UCNRS), an overview of the lagoon, a walk through a restored coastal scrub habitat with opportunities to view the rear dune, and ends on the beach. Tours are led by Seymour Center docents trained in the natural history and ecology of YLR and provide detailed information about flora, fauna, geology, and the UCNRS. Tour curriculum, which was first presented to the Seymour Center docents during the regular winter docent-training program in 2010, focuses on the unique ecology of the YLR beach.

In addition to the docent-guided beach tours, visual access to the lagoon and back dune is provided to the public via a newly constructed overlook along McAllister Way (Figure 1). This overlook (Overlook E) is open to the public and includes interpretative signage that provides information on how to sign-up for the beach tour. Visual access to the Younger Lagoon beach and information about Younger Lagoon Reserve is also provided to all visitors taking the Seymour Center's docent-guided Reserved and Daily Tours via the Overlook C (Figure 1). Last year, nearly 15,000 visitors took these tours.

The YLR beach access tours are part of broader public education and outreach programming on the Coastal Science Campus offered through the Seymour Center.

Every year, nearly 50,000 people visit the Seymour Center. The Seymour Center provides marine science education to hundreds of classes, comprised of thousands of students, teachers, and adult chaperones from across the country. Many of the classes served come from schools classified as Title 1—schools with high numbers of students from low-income families. Scholarships are made available to Title 1 schools, making it possible for students to participate who would not otherwise have the opportunity to experience a marine research center. Teachers often incorporate the Seymour Center into their weeklong marine science field study courses.

In FY 2017-2018, The Seymour Center, Younger Lagoon Reserve and the Monterey Bay Aquarium continued their partnership supporting high school students in the Watsonville Area Teens

Conserving Habitats (WATCH) program. WATCH students from Aptos High School designed and carried out field-based research projects in Younger Lagoon Reserve on topics including endangered fish, aquatic invertebrates, and birds. These students made repeated visits to the Reserve throughout the year. Find out more at: https://www.montereybayaquarium.org/education/teen-programs/watsonville-area-teens-conserving-habitats-watch

In April 2018, Younger Lagoon Reserve and the California Academy of Sciences partnered to host the third annual Younger Lagoon Reserve Bioblitz. A bioblitz is a community event that brings together a wide variety of people – citizen scientists - to rapidly inventory the living organisms found in a particular place. The Younger Lagoon Reserve Bioblitz was held during UCSC's Alumni Weekend, and was open to both alumni and members of the public. Participants explored the lagoon and beach areas as part of this event. A link to the page advertising this community event can be found here: https://www.inaturalist.org/projects/younger-lagoon-reserve-bioblitz-2018

Every year, dozens of children ages 7-14, enroll in weeklong summer science sessions known as Ocean Explorers. Students actively learn about and participate in marine research at the Seymour Center, and our associated Long Marine Laboratory, where participants work alongside marine mammal researchers and trainers. Participants gain experience with the scientific process, focusing on honing their observation and questioning skills. Ocean Explorers also investigate the coastal environment at field sites around Monterey Bay, including rivers and watersheds, sandy beaches, rocky intertidal areas, and kelp forests by kayak. Young participants generally come from Santa Cruz, Santa Clara, and San Mateo Counties. Full and partial scholarships are extended to low-income participants.

The Seymour Center actively promotes its activities with press releases and calendar listings throughout the region. Every year, traditional print ads are placed in newspaper and magazines. The Seymour Center's activities are also often covered in the local newspaper, the Santa Cruz Sentinel. Public radio ads run throughout the year on the NPR-affiliate, KAZU.

Coupons for discounted admissions are available in various formats. The most highly used program is through the many Bay Area municipal libraries. Called Discover and Go, hundreds of families from across the region utilize these discount coupons. The Seymour Center connects with the public through Facebook, Twitter, Instagram, Pinterest, Flickr, and bi-monthly e-blasts.

While part of UC Santa Cruz, the Seymour Center must raise its ~$1.25 million budget annually (including all operating costs, salaries, and benefits). Earned revenue—admissions, program fees, facility rentals, and the Ocean Discovery Shop—makes up approximately half of its general operating requirements.

YLR Beach tours are advertised via press releases, calendar listings, print ads, public radio ads, social media, and the Seymour Center website: http://seymourcenter.ucsc.edu/visit/behind-the-scenes-tours/. YLR Beach tours are filled via phone reservation: (831) 459-3800. The Seymour Center allocates tour spaces and keeps track of all user data. Tours are now limited to 14 persons (this has been increased from 12 persons, with the goal to turn no one away), and are best suited for adults in good physical condition and children over 10 years of age. Children under 16 years of age may take the tour without paying admission to the Seymour Center.

Public members entering YLR are required to adhere to the UCNRS Reserve Use guidelines. Because beach tours are limited to groups with trained docents no additional signage or fences have been required. The beach trail consists of a simple dirt/mulch path that was already in place. The trail is maintained by clipping overgrown vegetation and maintaining the earthen path and timber steps as needed.

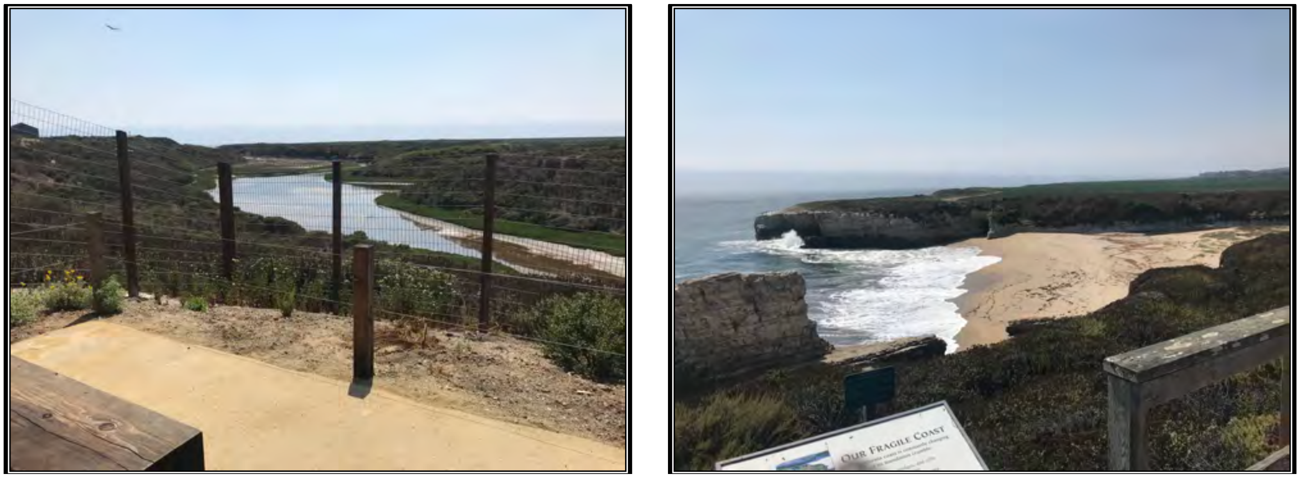

Figure 1. Younger Lagoon Overlooks. Left panel shows the view from the Overlook E located along McAllister Way. Overlook E is open to the public and includes interpretative signage that provides information on how to sign-up for the beach tour. Right panel shows the view from the Overlook C. Approximately 15,000 people visit Overlook C annually as part of the Seymour Center's docent guided tour programs.

Monitoring Program

Although Implementation Measure 3.6.3 (IM 3.6.3) of the CLRDP only requires monitoring of the YLR beach, YLR staff, faculty, and a Scientific Advisory Committee (that was jointly appointed by Executive Director, Peter Douglas and Chancellor George Blumenthal) decided to monitor nearby beaches with varying levels of use (Natural Bridges and Sand Plant Beach) during the five-year period starting in 2010 in order to examine differences in the flora, fauna and human use among the three sites. This effort required hundreds of hours of staff and student time, as well as coordination with State Parks staff. The annual survey results were included in annual reports submitted to the Coastal Commission over the past seven years. The Younger Lagoon Natural Reserve Beach Monitoring Report 2017 included in this NOID (Section 5) describes the monitoring program in detail and presents the results of the entire beach monitoring program (Section 5).

Data collected during the first five years of resource monitoring indicated that Younger Lagoon supports a wide variety of native flora and fauna, provides habitat for sensitive and threatened species, supports a unique beach dune community, and is frequently used for teaching and research. In general, native plant species richness was greatest at YLR and Natural Bridges compared to Sand Plant Beach; however, there was quite a bit of annual variation among the sites. A parameter that we quantified in 2012, and is evident from visual observation and photo documentation, is the presence of dune hummocks and downed woody material at YLR, both of which are almost entirely absent at local beaches due to human use. These features provide habitat for plant species such as the succulent plant dudleya, which grow on downed woody material and dune hummocks, as well as burrowing owl that use burrows in hummocks and seek shelter beneath downed woody material. The relatively natural state of YLR beach and dune vegetation is unique among most pocket beaches in Santa Cruz County and likely represents a glimpse into what many of the pocket beaches in the greater Monterey Bay area looked like prior to significant human disturbance.

Species lists for birds, mammals, plants, reptiles, amphibians, and fish are included as Appendices I-IV. These lists provide an overview of the flora and fauna that have been recorded at Younger Lagoon over the years. Although there have been numerous surveys of the area, to the best of our knowledge the monitoring project outlined in NOID 10-1 and undertaken over the last five years provided the most extensive survey effort for flora and fauna on the Reserve, resulting in numerous additions to the Reserve's species lists. Younger Lagoon provides important habitat for numerous animals and supports a rich composition of plant species. The lack of disturbance and low human activity are likely the primary factors that maintain the high diversity in the Lagoon. Track survey and camera trap work have documented bobcat, coyote, deer, and numerous other mammals on the beach; many of these species are likely residents within the Reserve. Track survey results also indicate that several of these mammals are residing (at least occasionally) in the Reserve and use the area as hunting grounds. For example, bobcat sign indicates that this species successfully hunts for roosting pelagic birds within the Reserve boundaries. These observations suggest that although Younger Lagoon is a relatively small area, amidst agriculture and development, this relic habitat is still functioning at a level beyond most developed beaches and lagoons in the region.

The results of the monitoring program indicate that open access to the beach would result in the loss of the unique ecological characteristics of the site, reduce its effectiveness as a research area for scientific study, and likely have a negative impact on sensitive and protected species.

Proposed Project

Docent-Led Tours

The University is proposing to continue the docent-led beach tour program initiated in spring 2010 for an additional five years. No changes to the tour access area are proposed (see Figure 1). Tours will now be offered two to four times per month (depending on demand and seasonality), with the goal of continuing to offer at least 38 tours per year (depending on weather, docent availability, etc.), and will continue to include tours on weekdays and on weekends. The tours will continue to be led by Seymour Center docents, and will include a narrative history of the UC Natural Reserve System (UCNRS), an overview of the lagoon, a walk through a restored coastal scrub habitat with opportunities to view the rear dune, and end on the beach. Children under 16 will now be able to take the tour without paying admission to the Seymour Center. YLR Beach tours will continue to be advertised via press releases, calendar listings (Good Times, UCSC Events), print ads, public radio ads (KAZU), social media (Facebook, Twitter, Instagram, Pinterest, Flickr), interpretative signage on the Coastal Science Campus, and on the Seymour Center website: http://seymourcenter.ucsc.edu/visit/behind-the-scenes-tours/ and filled via phone reservation: (831) 459-3800. Because beach tours are limited to groups with trained docents no additional signage or fences will be required. Maintenance of the trail by clipping overgrown vegetation and maintaining the earthen path and timber steps will be continued.

Monitoring Program

We will continue to monitor YLR Beach as required by, and described in, IM 3.6.3; however, we stopped monitoring at Natural Bridges State Beach or Sand Plant Beach in 2015 as the past five years of data collection have provided us with adequate information to assess differences in beach resources. The goal of the monitoring program is to document the presence and distribution of flora and fauna within YLR and to evaluate changes in distribution and density over time.

Biological Monitoring

Variables that will be monitored include: user data, changes as observable in photo documentation, tidewater goby surveys, species composition and seed production of beach dune vegetation, species composition of animals, and abundance of feeding shore birds. Details for each of the aforementioned parameters are described below.

User Data— User data from tours and other outreach and education programming conducted by the Seymour Center, as well as research and education use of YLR, will be recorded and maintained by Seymour Center and YLR Staff.

Human Beach Use— We will use remote cameras to quantify human use of YLR Beach. A camera will be placed along the western edge of Younger Lagoon quarterly with each separate sampling events each consisting of two days. Cameras will be set to automatically take photos at 15 minute intervals. Number of people will be quantified for 15 minute intervals during the day (camera time will vary across sampling periods due to day length and position; however, we will standardize within each sampling period).

Photo Documentation—Photo point locations have been established at three locations within YLR (Figure 2). These locations were chosen to ensure coverage of all major areas of the beach. Photos will continue to be taken annually during late spring to early summer (May – July). Photos will be taken at these photo points in order to ensure repeatability over time. At each photo point we will collect the following monitoring information:

- Photo point number
- Date
- Name of photographer
- Bearing
- Camera and lens size
- Coordinates
- Other comments

In addition to these three points, a permanent camera has been installed on the west side of the lagoon (Figure 3)

Tidewater Goby Surveys— Tidewater goby surveys will be conducted at YLR Beach quarterly each year. Surveys will be conducted using a 4.5 ft x 9 ft beach seine with 1/8 inch mesh. The objectives of the surveys are to document tidewater goby presence and evidence of breeding activity (determined by the presence of multiple size/age classes). All fish will be identified to species and counted. When individuals exceed ~50 per seine haul, counts will be estimated. Sampling will be conducted with the goal of surveying the various habitats at the lagoon (e.g. sand, sedge, willow, pickleweed, deep, shallow, etc.).

Species Composition and Coverage of Beach Dune Vegetation—Implementation Measure 3.6.3 requires that dune vegetation "*from the lowest (nearest to the mean high tide line) occurring terrestrial plant to 10 meters inland into the strand vegetation*" be surveyed to document species composition, cover, and seed production. Figure 3 shows a potential survey area for dune vegetation; however, the exact location and extent of survey area will vary annually depending upon the location of the "lowest" plant detected each year. Within the survey area we will establish a 50-m east-west transect across the dune vegetation and measure the distance from the estimated mean high tide line to the "lowest" plant on the beach. Herbaceous species composition will be measured by visual estimation of absolute cover for each species in ten 0.25 m^2 quadrats along the transect. Quadrats will be placed every 5 m on alternating sides of the transect starting at a randomly selected point between 1 and 5 meters (a total of 10 quadrats per transect). A clear plastic card with squares representing 1, 5, and 10% of the sampling frame will be used to help guide visual cover estimations.

Species cover (native and exotic), bare ground, and litter will be estimated at 5% intervals. Litter will be specifically defined as residue from previous year's growth while any senescent material that is recognizable as growth from earlier in the current growing season will be counted as cover for that species. After all cover estimates have been made, we will conduct surveys within 2 m of either side of the transect (a 4 × 50 m belt). In the belt transects, individual species will be recorded as either seedlings or greater than 1 year old. The presence of flowers and seeds will also also noted.

Non-avian Vertebrate Monitoring
Tracks— Vertebrate tracks will be measured using raked sand plots quarterly throughout the study period. Tracking stations will be placed throughout the beach area in constriction zones where vegetation is absent. The objective of these surveys will be simply to detect what species use the beach habitat. As such, plot size will vary depending upon the amount of available open sandy area at each location. Track stations will be raked each evening and checked for tracks in the morning. Stations will remain open for two days during each monitoring bout. Tracks will be identified to species when possible. Species composition will be summarized; however, abundance will not be quantified due to the fact that most often tracks cannot be used to identify individual animals (e.g. a single individual could walk across the plot multiple times).

Small Mammals—Sherman live traps will be placed on beach habitat for two nights every quarter of the study period. A total of 30 traps will be placed at each site and sampled for a period of two evenings (60 trap nights per sampling bout). Traps will be set at dusk and collected at dawn. Each trap will be baited with rolled oats and piece of synthetic bedding material will be placed in each trap to ensure animals do not get too cold. Individuals will be identified to species, marked with a unique ear tag, and released at the site of capture.

Invertebrate Monitoring—Terrestrial invertebrates on beach habitat will be monitored by placing one 12 oz plastic container (pit fall traps) at each tracking station (one at each plot) during "non-avian vertebrate monitoring" efforts. Traps will be buried to the lip of the container; terrestrial vertebrates fall into the trap passively. Traps will be checked each morning and all individuals will be identified and counted.

Avian Monitoring—Ocular surveys of birds on the beach, lagoon, and cliff habitats will be conducted at each site. Survey locations will be selected along one edge of the beach on the cliff. The entire beach area, fore portion of the lagoon, and western cliff will be surveyed from the eastern edge of the lagoon. The top and western face of the rock stack that is located at the beach/ocean edge will also surveyed. Counts will be recorded quarterly throughout the study. Surveys will be conducted in the dawn or dusk hours within approximately 2 hours of sunrise or sunset and of one another. Data from the two days during each sampling effort will be combined and individuals will be identified and counted.

Reporting
IM 3.6.3 requires that at five-year intervals post-certification, the University shall submit a Notice of Impending Development (NOID) to the Coastal Commission that both reports on the previous five years of beach access management, and includes all necessary supporting information for a development project to implement a beach access management plan for the next five years. A summary report was submitted in February 2016. We will continue to submit a NOID to the Coastal Commission each 5th year that both reports on the previous five years of beach access management, and includes all necessary supporting information for a development project to implement a beach access management plan for the next five years as outlined in the CLRDP.

Figure 2. Overview of beach tour route. Visitors on docent led tours will have beach access within the "Beach Access Area." The extent of the beach access area will vary from year to year dependent upon the location of plants (i.e. foot traffic will be seaward of the dune vegetation). The above depiction represents the approximate location of plants in the spring of 2009.

Figure 3. Locations of monitoring points, plots, and regions for YLR beach. The beach monitoring area, survey points, and track stations will vary between years depending upon the high water mark. Dune plant surveys will occur within 10 m of the high water mark as per the CLRDP guidelines.

Appendix I. Younger Lagoon Bird List

Birds of Younger Lagoon

LOONS
Red-throated Loon
Pacific Loon
Common Loon

GREBES
Pied-billed Grebe
Horned Grebe
Red-necked Grebe
Eared Grebe
Western Grebe
Clark's Grebe

FULMARS and SHEARWATERS
Northern Fulmar
Pink-footed Shearwater
Buller's Shearwater
Sooty Shearwater
Black-vented Shearwater

PELICANS and CORMORANTS
Brown Pelican
Double-crested Cormorant
Brandt's Cormorant
Pelagic Cormorant

FRIGATEBIRDS
Magnificent Frigatebird

HERONS and EGRETS
American Bittern
Great Blue Heron
Great Egret
Snowy Egret
Cattle Egret
Green Heron
Green-backed Heron
Black-crowned Night Heron

WATERFOWL
Tundra Swan

OWLS
Barn Owl
Great Horned Owl
Burrowing Owl
Short-eared Owl

SWIFTS
Black Swift
Vaux's Swift
White-throated Swift

HUMMINGBIRDS
Anna's Hummingbird

Rufous Hummingbird
Allen's Hummingbird

KINGFISHERS
Belted Kingfisher

WOODPECKERS

Downy Woodpecker
Northern Flicker
(Common Flicker)

FLYCATCHERS and KINGBIRDS
Western Wood Pewee
Willow Flycatcher
Pacific-slope Flycatcher
Black Phoebe
Say's Phoebe
Ash-throated Flycatcher
Tropical Kingbird
Western Kingbird

LARKS
Horned Lark

SWALLOWS
Tree Swallow
Violet-green Swallow
Northern

Birds of Younger Lagoon

Mute Swan
Snow Goose
Brant
Canada Goose
Green-winged Teal
Mallard
Northern Pintail
Cinnamon Teal
Northern Shoveler
Gadwall
Eurasian Wigeon
American Wigeon
Ring-necked Duck
Greater Scaup
Lesser Scaup
Harlequin Duck
Black Scoter
Surf Scoter
White-winged Scotter
Common Goldeneye
Bufflehead
Hooded Merganser
Red-breasted Duck
Ruddy Duck

VULTURES, HAWKS, and EAGLES

Turkey Vulture
Osprey
White-tailed Hawk
(Black
Northern Harrier
Sharp-shinned Hawk
Cooper's Hawk
Red-shouldered Hawk
Red-tailed Hawk
Ferruginous Hawk
Rough
Golden Eagle
American Kestrel
Merlin
Peregrine Falcon

QUAILS and PHEASANTS

Ring-necked Phaesant

Rough-winged Swallow
Cliff Swallow
Barn Swallow

JAYS and CROWS

Western Scrub
American Crow
Common Raven

CHICKADEES and BUSHTITS

Chestnut-backed Chickadee
Chickadee
Bushtit

WRENS

Bewick's Wren
House Wren
Marsh Wren

KINGLETS

Golden-crowned Kinglet
Ruby-crowned Kinglet

THRUSHES

Swainson's Thrush

Hermit Thrush
American Robin

WRENTITS

Wrentit

MOCKINGBIRDS and THRASHERS

Northern Mockingbird
Sage Thrasher

WAGTAILS and PIPITS

Yellow Wagtail
American Pipit (Water Pipit)

WAXWINGS and SHRIKES

Cedar Waxwing
Loggerhead Shrike

STARLINGS

Birds of Younger Lagoon

California Quail

RAILS and COOTS

Virginia Rail
Sora
Common Moorhen
American Coot

SHOREBIRDS

Black -bellied Plover
Snowy Plover
Semipalmated Plover
Killdeer
American Oystercatcher
(American Black
Oystercatcher
Black-necked Stilt
American Avocet
Greater Yellowlegs
Lesser Yellowlegs
Willet
Wandering Tattler
Spotted Sandpiper
Whimbrel
Long-billed Curlew
Marbled Godwit
Ruddy Turnstone
Black Turnstone
Surfbird
Sanderling
Western Sandpiper
Least Sandpiper
Baird's Sandpiper
Pectoral Sandpiper
Dunlin
Short-billed Dowitcher
Long-billed Dowitcher
Wilson's Snipe
Common Snipe

PHALARONES

Red-necked Phalarope
Red Phalarope

European Starling

VIREOS

Warbling Vireo

WARBLERS

Orange-crowned Warbler
Yellow Warbler
Yellow-rumped Warbler
Townsend's Warbler
Palm Warbler
Northern Waterthrush
MacGillivray's Warbler
Common Yellowthroat
Wilson's Warbler

BUNTINGS and GROSBEAKS

Indigo Bunting
Dickcissel

TOWHEES and SPARROWS

Spotted Towhee
Canyon Towhee
Chipping Sparrow
Clay-colored Sparrow
Vesper Sparrow
Lark Sparrow
Savannah Sparrow
Fox Sparrow
Song Sparrow
Lincoln's Sparrow
Swamp Sparrow
White-throated Sparrow
Golden-crowned Sparrow
White-crowned Sparrow

JUNCOS and LONGSPURS

Dark-eyed Junco
Lapland Longspur

BLACKBIRDS, MEADOWLARKS, and ORIOLES

Bobolink
Red-winged Blackbird
Tricolored Blackbird

Birds of Younger Lagoon

JAEGERS
Pomarine Jaeger
Parasitic Jaeger

GULLS
Bonaparte's Gull
Heermann's Gull
Mew Gull
Ring-billed Gull
California Gull
Herring Gull
Thayer's Gull
Western Gull
Glaucous-winged Gull
Black-legged Kittiwake
Sabine's Gull

TERNS
Caspian Tern
Elegant Tern
Common Tern
Arctic Tern
Forster's Tern

ALCIDS
Common Murre
Pigeon Guillemot
Marbled Murrelet
Ancient Murrelet
Rhinoceros Auklet

DOVES and PIGEONS
Rock Pigeon
Band-tailed Pigeon
Mourning Dove

Western Meadowlark
Rusty Blackbird
Brewer's Blackbird
Brown-headed Cowbird
Hooded Oriole
Scott's Oriole

FINCHES
House Finch
Pine Siskin
Lesser Goldfinch
Lawrence's Goldfinch
American Goldfinch

WEAVER FINCHES
House Sparrow

Appendix II: Younger Lagoon Mammal List

Mammals of Younger Lagoon
DIDELPHIDAE
Virginia Opossum *Didelphis virginiana*

SORICIDAE
Vagrant Shrew *Sorex sp.*

LEPORIDAE
Brush Rabbit *Sylvilagus bachmani*

SCIURIDAE
California Ground Squirrel *Spermophilus beecheyi*

GEOMYIDAE
Botta's Pocket Gopher *Thomomys bottae*

CRICETIDAE
Western Harvest Mouse *Reithrodontomys megalotis*
Deer Mouse *Peromyscus maniculatus*
Pinyon Mouse *Peromyscus truei*
Dusky-footed Woodrat *Neotoma fuscipes*
California Vole *Microtus californicus*

MURIDAE
Norway Rat *Rattus norvegicus*
House Mouse *Mus musculus*

CANIDAE
Coyote *Canis latrans*
Common Gray Fox *Urocyon cinereoargenteus*

PROCYONIDAE
Common Raccoon *Procyon lotor*

MUSTELIDAE
Long-tailed Weasel *Mustela frenata*
Striped Skunk *Mephitis mephitis*

FELIDAE
Bobcat *Felis rufus*
CERVIDAE
Mule Deer *Odocoileus hemionus*

Appendix III: Younger Lagoon Plants

FAMILY	*Scientific name*	Common name
FERNS AND FERN-ALLIES		
DENNSTAEDTIACEAE		
	Dryopteris argute	Coastal wood fern
	Polypodium californicum	California polypody
	Polystichum munitum	Sword Fern
	Pteridium aquilinum var. pubescens	Bracken fern
CONIFERS (GYMNOSPERMS)		
PINACEAE		
	**Pinus radiate*	Monterey pine
CUPRESSACEAE		
	**Hesperocyparis macrocarpa*	Monterey cypress
FLOWERING PLANTS (ANGIOSPERMAE - DICOTYLEDONEAE)		
ADOXACEAE		
	Sambucus nigra	Black elderberry
	Sambucus racemosa var. racemosa	Pacific red elderberry
AIZOACEAE		
	**Carpobrotus edulis*	Iceplant
ANACARDIACEAE		
	Toxicodendron diversilobum	Poison oak
APIACEAE		
	**Conium maculatum*	Poison hemlock
	**Foeniculum vulgare*	Fennel
	Oenanthe sarmentosa	Pacific oenanthe
	Sanicula arctopoides	Footsteps of spring
	Sanicula crassicaulis	Pacific sanicle

ASTERACEAE		
	Achillea millefolium	Yarrow
	Ambrosia chamissonis	Beach bur
	Anaphalis margaritacea	Pearly everlasting
	**Anthemis cotula*	Stinking pineapple weed
	**Artemisia biennis*	Biiennial wormwood
	Artemisia californica	California sagebrush
	Artemisia douglasiana	Douglas' mugwort
	Artemisia pycnocephala	Beach sagewort
	Baccharis glutinosa	Douglas' baccharis
	Baccharis pilularis	Coyote brush
	**Carduus pycnocephalus*	Italian thistle
	**Centaurea melitensis*	Malta star thistle
	**Circium arvense*	Canada thistle
	Circium quercetorum	Brownie thistle
	**Cirsium vulgare*	Bull thistle
	Corethrogyne filaginifolia	Common sandaster
	Cotula coronopifolia	Brass buttons
	**Delairea odorata*	Cape ivy
	Erigeron Canadensis	Horseweed
	Erigeron glaucus	Seaside daisy
	Eriophyllum staechadifolium	Lizard's tail
	Gnaphalium palustre	Western marsh cudweed
	Grindelia stricta	Coastal gum plant
	**Helminthotheca echioides*	Bristly oxtounge
	**Hypocharis glabra*	Smooth cat's ear
	**Hypocharis radicata*	Rough cat's ear
	**Hypocharis glabra*	Bristly ox-tonge
	Jaumea carnosa	Fleshy jaumea
	**Lactuca serriola*	Prickly lettuce
	Madia gracilis	Gumweed
	**Matricaria discoidea*	Pineapple weed
	Pseudognaphalium beneolens	Cudweed
	Pseudognaphalium californicum	Ladies tobacco
	**Pseudognaphilum luteoalbum*	Jersey cudweed
	Pseudognaphalium ramosissimun	Pink everlasting

	Pseudognaphalium stramineum	Cottonbatting plant
	**Senecio cf. elegans*	Purple ragwort
	**Silybum marianum*	Milk thistle
	**Sonchus asper*	Spiny sowthistle
	**Sonchus oleraceus*	Common sowthistle
	Symphyotrichum chilense	California aster
BORAGINACEAE		
	Heliotropium curassavicum	Seaside heliotrope
BRASSICACEAE		
	Barbarea orthoceras	Winter cress
	**Brassica nigra*	Black mustard
	**Brassica rapa*	Field mustard
	**Cakile maritime*	Beach rocket
	**Raphanus sativus*	Wild radish
	**Sinapis arvensis*	Charlock mustard
CAPRIFOLIACEAE		
	Symphoricarpos albus	Common snowberry
CARYOPHYLLACEAE		
	Spergularia macrotheca	Sand spurry
	**Silene gallica*	Common catchfly
CHENOPODIACEAE		
	Atriplex patula	Saltbush
	**Atriplex prostrata*	Fat-hen
	**Chenopodium album*	Lamb's quarters
	**Chenopodium macrospermum*	Largeseed goosefoot
	Salicornia pacifica	Pickleweed
CONVOLVULACEAE		
	Calystegia occidentalis	Western morning glory
	Calystegia purpurata	Morning glory
	Calystegia soldanella	Beach morning glory
CRASSULACEAE		
	Dudleya farinaosa	Sea lettuce

CUCURBITACEAE		
	Marah fabaceus	Wild cucumber
DIPSACACEAE		
	**Dipsacus fullonum*	Fuller's teasel
FABACEAE		
	Acmispon glaber	Deer weed
	**Genista monspessulana*	French broom
	Lupinus albifrons	Silver leaf lupine
	Lupinus arboreus	Yellow bush lupine
	Lupinus bicolor	Miniature lupine
	Lupinu nanus	Sky lupine
	**Medicago polymorpha*	Burr clover
	**Melilotus indicus*	Yellow sweet clover
	**Trifolium angustifolium*	Narrowleaf clover
	Trifolium willdenovii	Tomcat clover
	**Vicia sativa ssp. sativa*	Common vetch
FRANKENIACEAE		
	Frankenia salina	Alkali heath
GERANIACEAE		
	**Erodium botrys*	Longbeak stork's bill
	**Erodium cicutarium*	Red stemmed filaree
	**Erodium moschatum*	White stemmed filaree
	**Geranium dissectum*	Cutleaf geranium
GROSSULARIACEAE		
	Ribes divaricatum	Spreading gooseberry
	Ribes sanguineum	Flowering currant
IRIDACEAE		
	Sisyrinchium bellum	Blue eyed grass
LAMIACEAE		
	Clinopodium douglasii	Yerba buena
	**Marrubium vulgare*	Common horehound
	Prunella vulgaris	Selfheal

	Stachys bullata	hedge nettle
MALVACEAE		
	**Malva nicaeenis*	Bull mallow
	**Malva parviflora*	Cheeseweed
	Sidalcea malviflora	Checkerbloom
MONTIACEAE		
	Claytonia perfoliata	Miners lettuce
MYRICACEAE		
	Morella californica	California wax myrtle
MYRINACEAE	**Anagallis arvensis*	Scarlet pimpernel
NYCTAGINACEAE		
	Abronia latifolia	Yellow sand verbena
	Abronia umbellata ssp. umbellata	Pink sand verbena
ONAGRACEAE		
	Camissoniopsis cheiranthifolia	Beach evening-primrose
	Epilobium brachycarpum	Fireweed
	Epilobium canum	California fuchsia
	Epilobium ciliatum ssp. watsonii	Willow herb
	Taraxia ovata	Sun cup
OXALIDACEAE		
	Oxalis albicans	Hairy wood sorrel
	Oxalis pes caprae	Bermuda buttercup
PAPAVERACEAE		
	Eschscholzia californica	California poppy
PHRYMACEAE		
	Mimulus aurantiacus	sticky monkey flower
	Mimulus guttatus	seep monkey flower
PLANTAGINACEAE		
	**Plantago coronopus*	Cut leaf plantain
	**Plantago lanceolata*	English plantain
	Plantago maritima	California seaside plantain
PLUMBAGINACEAE		
	Armeria maritima	California seapink

POLEMONIACEAE		
	Navarretia squarrosa	Skunkweed
POLYGONACEAE		
	Eriogonum latifolium	Coastal buckwheat
	Persicaria punctata	Dotted smartweed
	* *Polygonum aviculare*	Prostrate knotweed
	**Rumex acetosella*	Sheep sorrel
	**Rumex conglomeratus*	Green dock
	Rumex crassus	Willow-leaved dock
	**Rumex crispus*	Curly dock
RANUNCULACEAE		
	Ranunculus californicus	California buttercup
RHAMNACEAE		
	Frangula californica	California coffeeberry
PORTULACACEAE		
	**Portulaca oleracea*	Purslane
RHAMNACEAE		
	Ceanothus thyrsiflorus	Blueblossom
ROSACEAE		
	Acaena pinnatifida var. californica	California sheepburr
	Fragaria chiloensis	Beach strawberry
	Horkelia californica	Californica horkelia
	Potentilla anserina ssp. pacifica	Pacific silverweed
	Rosa californica	California wild rose
	Rosa gymnocarpa	Wood rose
	Rubus ursinus	California blackberry
	Rubus armeniacus	Himalayan blackberry
RUBIACEAE		
	***Galium sp.*	**Bedstraw
SALICACEAE		
	Salix lasiolepis	Arroyo willow
SAPINDACEAE		
	Aesculus californica	California buckeye

SCROPHULARIACEAE		
	Scrophularia californica ssp. californica	Bee plant
SOLANACEAE		
	Solanum americanum	American black nightshade
	**Solanum nigrum*	Black nightshade
URTICACEAE		
	Urtica dioica ssp. gracilis	Stinging nettle
	Urtica holosericea	Hoary nettle
FLOWERING PLANTS (ANGIOSPERMAE - MONOCOTYLEDONEAE)		
AGAVACEAE		
	Chlorogalum pomeridianum	Soap plant
CYPERACEAE		
	Bolboschoenus maritimus	Praire bulrush
	Bolboschoenus robustus	Seacoast bulrush
	Carex hafordii	Monterey sedge
	Carex obnupta	Slough sedge
	Cyperus eragrostis	Tall cyperus
	Eleocharis macrostachya	Creeping spike rush
	Isolepis cernua	Low bulrush
	Schoenoplectus acutus var. occidentalis	Hardstem bulrush
	Schoenoplectus americanus	3 Square sedge
	Schoenoplectus californicus	California tule
	Schoenoplectus cernuus var. californicus	Low club rush
JUNCACEAE		
	Juncus balticus	Baltic rush
	Juncus bufonius	Toad rush
	Juncus effusus brunneus	Bog rush
	Juncus mexicanus	Mexican rush
	Juncus occidentalis	Western rush
	Juncus patens	Common rush
	Juncus phaeocephalus	Brown-headed rush
LILIACEAE		
	Triteleia laxa	Ithuriel's spear
MELANTHIACEAE		

	Toxicoscordion fremontii	Fremont's star lily
POACEAE		
	Agrostis pallens	Bent grass
	**Aira caryophyllea*	Shiver grass
	**Avena barbata*	Slender oat
	**Avena fatua*	Wild oat
	**Briza minor*	Liittle quaking grass
	**Brachypoduim distachyon*	False brome
	Bromus carinatus	California brome
	**Bromus catharticus*	Rescue grass
	**Bromus diandrus*	Ripgut brome
	**Bromus hordeaceus*	Soft chess
	**Bromus madritensis ssp. madritensis*	Foxtail chess
	Bromus marginatus var. maritimus	Seaside large mountain brome grass
	**Cortaderia jubata*	Jubata grass
	**Cynodon dactylon*	Bermuda grass
	* *Cynosurus echinatus*	Dogtail grass
	Danthonia californica	California oatgrass
	Distichlis spicata	Salt grass
	Elymus glacus	Blue wild rye
	Elymus triticoides	Beardless wild rye
	Festuca californica	California fescue
	**Ehrharta erecta*	Panic veldtgrass
	**Festuca bromoides*	Six weeks fescue
	Festuca rubra	Creeping red fescue
	**Festuca myuros var. myuros*	Rat tail fescue
	* *Festuca perennis*	Italian ryegrass
	**Holcus lanatus*	Velvet grass
	Hordeum brachyantherum	Meadow barley
	**Hordeum murinum ssp. leporinum*	Farmer's foxtail
	Koeleria macrantha	June grass
	Melica californica	California melicgrass
	Melica torreyana	Torrey's melica
	**Polypogon monspeliensis*	Annual rabitsfoot grass
	Stipa lepida	Foothill needlegrass
	Stipa pulchra	Purple needlegrass

THEMIDACEAE		
	Brodiaea elegans ssp. elegans	Harvest brodiaea
TYPHACEAE		
	Sparganium eurycarpum var. greenei,	Simplestem bur-reed
	Typha domingensis	Southern cattail
	Typha latifolia	Broadleaf cattail
*denotes non-native plant		
**denotes species where identification is only to genera.		

Appendix IV: Younger Lagoon Fish, Reptiles, and Amphibians

Fish, Reptiles, and Amphibians of YLR

Tidewater Goby (*Eucyclogobius newberryi*)
Threespine Stickleback (*Gasterosteus aculeatus*)
Sculpin (unknown)

Reptiles

California Legless Lizard (*Anniella pulchra*)
Coast Horned Lizard (*Phrynosoma coronatum*)
Common Garter Snake (*Thamnophis sirtalis*)
Common Kingsnake (*Lampropeltis getulus*)
Gopher Snake (*Pituophis melanoleucus*)
Northern Rubber Boa (*Charina bottae*)
Racer (*Coluber constrictor*)
Ringneck Snake (*Diadophis punctatus*)
Sharp-tailed Snake (*Contia tenuis*)
Southern Alligator Lizard (*Gerrhonotus multicarinatus*)
Striped Racer (California Whipsnake) (*Masticophis lateralis*)
Western Aquatic Garter Snake (*Thamnophis couchi*)
Western Fence Lizard (*Sceloprus occidentalis*)
Western Pond Turtle (*Clemmys marmorata*)
Western Rattlesnake (*Crotalus viridus*)
Western Skink (*Eumeces skiltonianus*)
Western Terrestrial Garter Snake (*Thamnophis elegans*)

Amphibians

California Slender Salamander (*Batrachoseps attenuatus*)
Pacific Treefrog (*Pseudacris regilla*)
California Red-legged Frog (*Rana draytoni)*

1b. CLRDP Consistency Determination

As stated in Policy 1.1 (Development Consistency), "Development shall be deemed consistent with the CLRDP if it is consistent with the provisions of Chapters 5, 6, 7, 8, 9, and Appendices A and B."

The following is a list of all the Policies, Implementation Measures and Figures found in Chapter 5. Those that apply directly to this NOID are highlighted in black and followed with a comment regarding the project's consistency; those that do not are indicated with strikethrough text. In addition, any sections of Chapters 6, 7, 8, 9, and Appendices A and B that apply to this NOID are referenced with comments if relevant or as strikethrough text if they are not pertinent to this project.

CHAPTER 5 Long Range Land Use Development Plan

5.1 Application of the Long Range Land Use Development Plan

Policy 1.1 Development Consistency

The University finds the project contemplated under NOID 09-2 to be consistent with the CLRDP.

IM 1.1.1 Figures of Chapter 5.

This project does not involve physical development, but is "development" as defined in Section 8.1.1 and the Coastal Act as a "…change in …intensity of use of land…" Only Figure 5.6 applies and the project is consistent with that figure.

~~IM 1.1.2 Lease Agreements.~~

~~IM 1.1.3 Federal In-holding and CLRDP.~~

Policy 1.2 University Commitments

The University commitments in the CLRDP have been undertaken

5.2. Land Use

~~Figure 5.1 Building Program~~

~~Figure 5.2 Land Use Diagram~~

~~Figure 5.3 Locational Restrictions for Building Program~~

~~Stable Urban / Rural Boundary~~

Policy 2.1 Maintaining a Stable Urban / Rural Boundary

~~IM 2.1.1 Over sizing of Utility Lines Prohibited.~~

~~IM 2.1.2 Utility Prohibition Zone.~~

Policy 2.2 Strengthening the Urban / Rural Boundary through the Protection of Adjacent Agricultural Resources

IM 2.2.1 Setback of Development and Uses from Adjacent Agricultural Use.

As mentioned in IM 1.1.1, the project does not involve physical development, therefore agricultural setback does not apply.

Policy 2.3 Designing for the Urban Edge

~~IM 2.3.1 Cluster Development.~~

~~IM 2.3.2 Impervious Coverage.~~

~~IM 2.3.3 Windbreak Vegetation~~

~~IM 2.3.4 Buildout Planning.~~

~~IM 2.3.5 Interim Weed Abatement Measures for Undeveloped Land Within Development Zones.~~

Short-term and Caretaker Accommodations

Policy 2.4 Short-term and Caretaker Accommodations

~~IM 2.4.1 Short-Term Accommodation Use Restrictions.~~

~~IM 2.4.2 Caretaker Accommodations.~~

~~IM 2.4.3 Use Conversion.~~

Campus Land Uses Limited to Marine / Coastal Research and Education, Resource Protection, and Public Access

Policy 2.5 Ensuring Appropriate Land Uses on the Marine Science Campus

5.3 Natural Resource Protection

Policy 3.1 Protection of the Marine Environment

~~IM 3.1.1 Seawater System.~~

~~IM 3.1.2 Discharge of Drainage/Storm water.~~

Policy 3.2 Protection and Restoration of Habitat Areas

~~IM 3.2.1 Restoration of Wetlands on the Marine Science Campus.~~

~~IM 3.2.2 Management of Terrace Wetlands.~~

~~IM 3.2.3 Protection and Enhancement of Wildlife Movement.~~

~~IM 3.2.4 Management of Special Status Species Habitat.~~

IM 3.2.5 Protect Habitat Areas From Human Intrusion.

Under the project, the tours will use the existing YLR trails and will be docent-led. Additional wayfinding and interpretive signage are not required.

~~IM 3.2.6 Natural Area Management.~~
~~IM 3.2.7 Management of Water Quality and Drainage Features.~~
~~IM 3.2.8 Maintenance and Monitoring of Terrace Habitats.~~
~~IM 3.2.9 Wetland Buffers.~~
~~IM 3.2.10 Natural Areas Habitat Management.~~
~~IM 3.2.11 CRLF Protection.~~
~~IM 3.2.12 USFWS Consultation Required~~
~~IM 3.2.13 Rodenticides.~~
~~IM 3.2.14 Non-Invasive Native Plant Species Required.~~

Policy 3.3 Use and Protection of Coastal Waters and Wetlands

~~IM 3.3.1 Pre-development Evaluation of Wetland Conditions.~~
~~IM 3.3.2 Update CLRDP With Respect to Wetlands.~~

Policy 3.4 Protection of Environmentally Sensitive Areas (ESHAs)

~~IM 3.4.1 Additional Measures to Protect Habitat Areas.~~
~~IM 3.4.2 Noise Intrusion into Terrace ESHA.~~
~~IM 3.4.3 Noise Intrusion into LR (original YLR).~~
~~IM 3.4.4 Pre-development Evaluation of ESHA Conditions.~~
~~IM 3.4.5 Update CLRDP With Respect to ESHA.~~

Younger Lagoon Reserve

Policy 3.5 Special Protection for the Original Younger Lagoon Reserve

IM 3.5.1 Protection and Enhancement of YLR Habitats.

This project addresses limited access of humans to Younger Lagoon.

IM 3.5.2 Protection of Special Status Species in YLR.

Based on the results of the previous 5-year monitoring program, no special status species are anticipated to be impacted.

IM 3.5.3 Protection of YLR Resources.

Increased visitor use to beach as part of the required actions of IM 3.6.3 has the potential to impact flora and fauna. Only supervised tours will be permitted in order to minimize this potential impact.

IM 3.5.4 Development of Monitoring and Maintenance Program.

Plant, animal, and human activities/presence will be monitored as part of this project.

~~IM 3.5.5 Siting of Windbreak Vegetation.~~

IM 3.5.6 YLR Manager Consultation.

The Administrative Director of the UCSC Natural Reserves and the Field Manager of the Younger Lagoon Natural Reserve have reviewed the scope of the Public Access to and Within Younger Lagoon Natural Reserve Project (NOID 09-2) and concur the Project would not result in significant impacts to the Reserve beyond those described above.

Gage Dayton, Administrative Director, UCSC Natural Reserves

Date 8/14/18

IM 3.5.7 Movement Not Visible From YLR (original YLR)

Monitoring efforts and public use of Younger Lagoon will be visible from the original Younger Lagoon Reserve.

~~IM 3.5.8 Protective Measures for YLR (original YLRR) in Middle Terrace.~~

Policy 3.6 Public Access to and within YLR (original YLR)

IM 3.6.1 Provision of Controlled Access within YLR (original YLR).

The project is consistent with public access polices for the beach and lagoon areas of YLR.

IM 3.6.2 Visual Access to YLR (original YLR).

Visual access to the original YLR is available from existing overlooks.

IM 3.6.3 Public Beach Access within YLR (original YLR).

This project addresses Implementation Measure 3.6.3: *"Public Access to and within YLR."* The project description provides details pertaining to the schedule of tours of the beach at the YLR, parameters for beach access and a program to monitor the effects of human, plant, and animal use/presence on the beach. An assessment of beach area resources and the effect of beach area use and activities on these resources is included.

Coastal Bluffs and Blufftops

Policy 3.7 Protection of Coastal Bluff and Bluff top Areas

~~IM 3.7.1 Bluff Setbacks.~~
~~IM 3.7.2 Coastal Bluff and Bluff top Area Protection and Enhancement Measures.~~
~~IM 3.7.3 Protecting Existing Development from Coastal Erosion.~~

Agricultural Resources

Policy 3.8 Protection of Adjacent Agricultural Resources

~~IM 3.8.1 Cooperation.~~
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Cultural Resources

Policy 3.9 Conservation of Cultural Resources

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Policy 3.10 Hazardous Materials Management
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Policy 3.11 Energy Efficiency in New Construction
~~IM 3.11.1 Energy Efficiency in New Construction.~~
~~IM 3.11.2 Energy Efficiency in Use.~~
Policy 3.12 Air Quality and Energy Conservation through Land Use and Transportation Controls
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Policy 3.13 Natural Resource Protection Analysis Required
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~~IM 4.2.1 Design Standards and Illustrative Campus Build out Site Plan.~~
~~IM 4.2.2 Alteration of Natural Landforms.~~
~~IM 4.2.3 Building and Other Structure Heights.~~
~~IM 4.2.4 Laboratory Buildings.~~
~~IM 4.2.5 Maximum Building Gross Square Footage.~~
~~IM 4.2.6 Maximum Additional Gross Square Footage in Lower Terrace.~~
~~IM 4.2.7 Construction Materials.~~
~~IM 4.2.8 Building Setbacks.~~
~~IM 4.2.9 Building Length Limitations.~~
~~IM 4.2.10 Placement of Utility Lines Underground.~~
~~IM 4.2.11 Windbreak Vegetation.~~
~~IM 4.2.12 Development in Northernmost Portion of Middle Terrace.~~
~~IM 4.2.13 Development Along Edge of Lower Terrace.~~
~~IM 4.2.14 Building Development West of McAllister Way in Lower Terrace.~~
~~IM 4.2.15 Building Development West of McAllister Way in Middle Terrace.~~
~~IM 4.2.16 Building Development Outside of Subareas Prohibited.~~
Policy 4.3 Visual Intrusion and Lighting
~~IM 4.3.1 Visual Intrusion into YLR (original YLR).~~
~~IM 4.3.2 Visual Intrusion into YLR (Terrace Lands).~~
~~IM 4.3.3 All Lighting.~~
~~IM 4.3.4 Building Lighting.~~
~~IM 4.3.5 Street and Trail Lighting.~~
~~IM 4.3.6 Parking Lot and Maintenance Yard Lighting.~~
~~IM 4.3.7 Sign Lighting.~~
~~IM 4.3.8 Lighting Plan Required.~~

5.5. Circulation and Parking
~~Figure 5.5 Circulation and Parking Diagram~~
Auto Circulation
Policy 5.1 Vehicular Access
~~IM 5.1.1 New Circulation System.~~
~~IM 5.1.2 Improve Shaffer Road / Delaware Avenue Intersection~~
~~IM 5.1.3 Shaffer Road Improvements.~~
~~IM 5.1.4 Access for Wildlife Across Shaffer Road (Upper Wildlife Corridor).~~
~~IM 5.1.5 Access for Wildlife Across Shaffer Road (Lower Wildlife Corridor).~~
~~IM 5.1.6 Use of Former Access Road.~~
~~IM 5.1.7 Emergency Access.~~
Travel Mode Split
Policy 5.2 Travel Mode Split
~~IM 5.2.1 Encourage Alternatives to Single-Occupant Vehicle.~~
~~IM 5.2.2 Alternatives to the Single-Occupant Vehicle.~~
Parking
Policy 5.3 Parking for Campus Use and Public Coastal Access
~~IM 5.3.1 All Campus Users Off-Hour Parking.~~

IM 5.3.2 Public Coastal Access Parking.
IM 5.3.3 Campus Entrance Public Coastal Access Parking.
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IM 5.3.5 Lower Terrace Dual Use Parking (Public Coastal Access Parking and Discovery Center Parking).
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IM 5.3.7 Parking Demand Satisfied On-Campus.
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Parking Supply

Policy 5.4 Parking Supply

IM 5.4.1 Development of New Parking
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Policy 5.5 Parking Management

IM 5.5.1 Permits Required.
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IM 5.5.7 Parking Enforcement.

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Policy 5.6 Promotion of Bicycle Use and Walking

IM 5.6.1 Sheltered and Secured Bike Parking.
IM 5.6.2 Bike Parking Outside Buildings.
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IM 5.6.4 Coordinated Marketing with City of Santa Cruz.
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IM 5.6.6 Siting Buildings for Ease of Access.

Transit

Policy 5.7 Promotion of Transit Use

IM 5.7.1 Extension of Santa Cruz Municipal Transit District Transit Services.
IM 5.7.2 Expansion of Shuttle Services.
IM 5.7.3 Physical Infrastructure for Transit.

Transportation Demand Management (TDM) Coordination

Policy 5.8 TDM Coordination

IM 5.8.1 Carpool and Vanpool Services.
IM 5.8.2 TDM Coordination.
IM 5.8.3 Transportation Information.

Traffic Impacts on City Streets

Policy 5.9 Impacts Offset

Circulation and Parking Plan

Policy 5.10 Circulation and Parking Plan Required

5.6. Public Access and Recreation

Figure 5.6 Coastal Access and Recreation Diagram

Policy 6.1 Public Access to the Marine Science Campus

IM 6.1.1 Free Public Access for Visitors.
IM 6.1.2 Public Access Parking.

IM 6.1.3 Public Access Trails.

Access to trails to the beach are described in the project description.

IM 6.1.4 Public Access Overlooks.

IM 6.1.5 Docent-Led Tours and Education Programs for the Public.

The project provides beach access and docent led tours to the YLR beach.

IM 6.1.6 Educational Programs for Pre-College Students.
IM 6.1.7 Interpretive Information.

Policy 6.2 Management of Public Areas

IM 6.2.1 Public Use Hours for the Marine Science Campus.
IM 6.2.2 Public Trail Continuity.

IM 6.2.3 Access to Resource Protection Areas.

This project provides public access to the Younger Lagoon Beach area in conformance with the CLRDP.

IM 6.2.4 Access to Resource Protection Buffer Areas.
IM 6.2.5 Access to Coastal Bluffs.
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~~IM 6.2.10 Public Access Signage.~~
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IM 6.2.13 Public Access to Younger Lagoon Beach.
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~~IM 7.2.2 Storm water System Natural Features Maintenance.~~
~~IM 7.2.3 Drainage System Sampling.~~
~~IM 7.2.4 Long-Term Maintenance of Storm wate r System.~~
Policy 7.3 Drainage Discharge Points
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~~IM 7.3.2 Discharge Siting and Design.~~
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Policy 8.2 Protection of Biological Productivity and Quality of Coastal Waters When Providing Public Works Facilities
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CHAPTER 7 Illustrative Campus Buildout Site Plan and Preliminary Designs
Paths used for tours and research are already in place. Beyond normal maintenance, there will be no additional buildout.

CHAPTER 8 Development Procedures

This NOID and the public notification process is submitted in conformance with the requirements of the CLRDP.

CHAPTER 9 Capital Improvement Program

The beach monitoring and guided tours to the beach are consistent with Chapter 9 requirements.

APPENDIX A Resource Management Plan

The proposed project is consistent with the RMP and Younger Lagoon Natural Reserve polices.

APPENDIX B Drainage Concept Plan

The proposed project would have no impervious surface and thus would not affect storm water runoff.

1c. Environmental Compliance Documentation

N/A

1d. Technical Reports

See Section 5.

1e. Consultation Documentation with other Agencies

Not required for this NOID

1f. Implementing Mechanisms

There are no mitigations required by CEQA.

1g. Correspondence Received

None

1h. UC Santa Cruz Project Manager

Elizabeth Howard phone: 831-459-2455 email: eahoward@ucsc.edu

2. University Approval Documentation

N / A

3. Environmental Compliance Documentation

N / A

4. Plans, Specifications, etc.

(this section used if project documentation is large format or extensive)

N / A

5. Technical Reports

See attached: Younger Lagoon Natural Reserve Beach Monitoring Report, 2018.

6. Correspondence

Younger Lagoon Reserve

Beach Monitoring Report

2018

***Watsonville Area Teens Conserving Habitats* (WATCH) *Program* Participants at Younger Lagoon**

Elizabeth Howard and Gage Dayton
Younger Lagoon Reserve

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Overview and Executive Summary

In March 2010, the California Coastal Commission (CCC) approved the University of California's Notice of Impending Development Implementation for Implementation Measure 3.6.3 of the CLRDP (NOID 10-1). NOID 10-1 requires that (through controlled visits) the public have access to Younger Lagoon Reserve beach and that a monitoring program be created and implemented to document the condition of native flora and fauna within Younger Lagoon and its beach. The monitoring plan was to be implemented over a 5-year time period. At the end of the 5-year period (Winter 2015) results were to be compiled and included in a report that summarizes and discusses the potential effect of controlled beach access on flora and fauna at Younger Lagoon and submitted as a NOID to the CCC.

The campus began implementing the public access plan and monitoring program in spring 2010, and submitted the report on the results of the monitoring to the Coastal Commission in February of 2016 as part of the Younger Lagoon Reserve Annual Report. The campus submitted NOID 9 (16-2) Public Access to and Within Younger Lagoon Reserve to the California Coastal Commission (CCC) in December 2016. At the request of local coastal staff, the campus withdrew NOID 9 (16-2) resubmitted it as NOID 9 (17-1) in June 2017. The campus presented NOID 9 (17-1) at the July 2017 CCC and although CCC staff found the NOID consistent with the CLRDP, Commissioner Brownsey requested the University provide significantly more tours to the beach and that children be allowed for free. Younger Lagoon Reserve staff withdrew the NOID prior to a vote in order to better address Commissioner Brownsey's requests. Over the last year, Younger Lagoon Reserve staff have worked with Seymour Marine Discovery Center staff to design a pilot program to significantly increase the number of tours offered per year, increase tour capacity, and offer the tours free for children 16 and under. Per IM 3.6.3 of the CLRDP (NOID 10-1), the University plans to resubmit NOID 9 to the CCC in 2018.

This document serves as both a summary report for activities under NOID 10-1 that have taken place since our previous report at the end of fiscal year 2017 and a summary report for the entire 8-year monitoring program. All year's results are included. Data collected indicate that Younger Lagoon Reserve (YLR) supports a wide variety of native flora and fauna, provides habitat for sensitive and threatened species, supports a very unique beach dune community, and is extensively used for research and education. In general, in comparison to the other local beaches surveyed native plant species richness is greatest at YLR and Natural Bridges; however, there is quite a bit of annual variation among the sites. A parameter that we quantified in 2012, and is evident from visual observation and photo documentation, is the presence of dune hummocks and downed woody material at YLR, both of which are almost entirely absent at local beaches due to human use. These features provide habitat for plant species such as the succulent plant dudleya, which grow on downed woody material and dune hummocks at YLR, as well as burrowing owls that use burrows in hummocks and seek shelter beneath downed woody material at YLR. The relatively natural state of YLR beach and dune vegetation is unique among most pocket beaches in Santa Cruz County and likely represents a glimpse into what many of the pocket beaches in the greater Monterey Bay area looked like prior to significant human disturbance. Open access to the beach would likely result in the loss of the unique ecological characteristics of the site and certainly reduce its effectiveness as a research area for scientific study. Controlled beach access through the Seymour Center docent led tours, provides an appropriate level of controlled access that enables people to see and learn about the lagoon habitat while limiting impacts to the system. We recommend that this continue.

Although only required to monitor the YLR beach, YLR staff, faculty, and the Scientific Advisory Committee decided to monitor nearby beaches with varying levels of use (Natural Bridges and Sand Plant Beach) during the first 5-year period in order to examine differences in the flora, fauna and use among the three sites. This effort required hundreds of hours of staff and student time, as well as coordination with State Parks staff. As reported in the 2015 YLR Beach Monitoring Report, beginning in the summer of 2015 and moving forward, YLR staff will continue to monitor YLR as required in IM 3.6.3; however, we no longer monitor at Natural Bridges State Beach or Sand Plant Beach.

Introduction

Over 50 years ago, the University of California Natural Reserve System (UCNRS) began to assemble, for scientific study, a system of protected sites that would broadly represent California's rich ecological diversity. Today the UC Natural Reserve System is composed of 39 reserves that encompass approximately 750,000 acres of protected natural land available for university-level instruction, research, and public service. The University of California Natural Reserve System supports research and education through its mission of contributing "*to the understanding and wise management of the Earth and its natural systems by supporting university-level teaching, research, and public service at protected natural areas throughout California*." By creating this system of outdoor classrooms and laboratories and making it available specifically for long-term study and education, the NRS supports a variety of disciplines that require fieldwork in wildland ecosystems. UC Santa Cruz administers four UC Reserves: Younger Lagoon Natural Reserve, Año Nuevo Island Reserve, Landels-Hill Big Creek Reserve, and Fort Ord Natural Reserve.

The objective of the beach monitoring program is to document the presence and distribution of flora and fauna within Younger Lagoon Natural Reserve (YLR) and to evaluate changes in distribution and density over time. Additionally, YLR staff decided to monitor nearby beaches with varying levels of use (Natural Bridges and Sand Plant Beach) in order to examine differences in the flora and fauna among the three sites. Importantly, the data collected in this study provides a quantitative assessment of various attributes (species composition, abundance, etc.) but it is realized that the sites vary significantly from one another and that there is no replication. Thus, although these data comparisons are informative there are significant constraints that make meaningful statistical comparisons between the sites impossible. As such, results shouldn't necessarily be used to create strict prescriptions.

This report is a report for activities under NOID 10-1 during Fiscal Year (FY) 2017-2018 (July 1, 2017 – June 30, 2018) which surveyed YLR. Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we have included all year's results from all sites in this report in order to show the entire effort to date. Data for each monitoring objective have been added to previous year's data; thus, the results for this reporting period have been combined with all previous findings. As a result, this report provides a running summary of our findings starting from the inception of the study and running through the end of FY 2017-2018.

Younger Lagoon Access History

History of Public Access to Younger Lagoon Beach

Prior to 1972, Younger Beach was privately owned and closed to the public. The owners (Donald and Marion Younger) actively patrolled for, and removed, trespassers from their property, including the beach. In 1972, the Younger Family donated approximately 40 acres of their property to the University of California for the study and protection of the marine environment. These lands included Younger Lagoon and Beach (approximately 25 acres), and an adjoining parcel of land (approximately 15 acres) which became the site of the original Long Marine Laboratory (LML). At the time of their donation, Donald and Marion Younger intended that the lagoon, beach and surrounding slopes be protected in perpetuity by the University as a bird sanctuary.

In the years between the donation of the property and the start of LML construction (1976), the University leased the future LML site back to farmers who had been farming the property for the Younger family prior to the donation. During those years, the same no trespassing rules for the beach were enforced as they had been when the property was owned by the Younger family.

Once construction of LML began in 1976, the land was no longer under the watch of the farmers, and public pressure on the beach began to increase. Many Santa Cruz locals remember the next several years at Younger Beach fondly as it became a popular nude beach. The increased public access had a noticeable impact on the flora and fauna of the beach, and was not in accordance with the intention of the original donation by the Younger family. By 1978 discussions had begun between the University and the California Coastal Commission regarding the impact of uncontrolled public access to the beach. In 1981, it was decided that the impacts to Younger Beach were significant and the California Coastal Commission, under coastal permit P-1859, closed uncontrolled access to the beach.

After the approval of coastal permit P-1859, the University began to actively patrol the beach for trespass, educate the public about the closure, and use the site for research and education. After YLR was incorporated into the UCNRS in 1986, users were required to fill out applications, or contact NRS staff, for specific research, education, or outreach efforts. As the LML campus grew, a protective berm and fencing were constructed around the perimeter of the lagoon, and informational 'beach closed' signs were posted on the cliffs above the beach. Over time, trespass decreased and the reduced public access had a noticeable positive impact on the flora and fauna of the beach.

Public access to YLR beach came to the forefront again during the CLRDP negotiation process (2000-2008). At the time negotiations began, YLR supported a rich composition of plant and animal species despite being surrounded by agricultural and urban development. Reserve staff were concerned that any increase in public access could threaten the already heavily impacted habitat. At the time of CLRDP certification (2010), all parties agreed to the Beach Access Management Plan outlined in NOID 10-1. Under the Beach Access Management Plan, the YLR beach remains closed to unsupervised public access and the reserve is implementing a management and monitoring plan that includes docent-guided tours.

Because of the importance of maintaining a natural and pristine environment (Figure 1) and protecting scientific studies and equipment, uncontrolled access to YLR is not allowed. Uncontrolled use of YLR is likely to have a negative impact on native coastal flora and fauna that inhabit the reserve, hamper research endeavors, and impact the area for future scientific and educational endeavors. Rather than an open public access policy, users are required to fill out applications, or contact NRS staff, for specific research, education, or outreach efforts. In 2010 YLR began hosting docent-guided tours that are offered by the Seymour Marine Discovery Center (Seymour Center).

Beach Access Tours

From 2010 - 2017, docent-led beach tours were offered twice monthly through the Seymour Marine Discovery Center (Seymour Center). In addition, all of the docent led daily tours run by the Seymour Center (approximately 1,500 tours annually) include an informational stop about YLR that includes visual access to the beach. In October 2017, in an effort to meet Commissioner requests to increase the number of tours, Younger Lagoon Reserve staff met with Seymour Center staff to discuss the potential of providing more tours. Seymour Center staff analyzed historic tour data and identified those months during which tour demand had been met or exceeded (October-February), and those months during which there was higher demand (March-September). Based on these data, beginning in January 2018, we conducted a pilot program with the Seymour Center and began offering tours twice a month during the slower fall and winter months (October-February), and four times a month during the busier spring and summer months (March-September). The total number of tours offered in 2018 was increased from 24 to 38 (offering approximately 60% more tours). Moving forward, the Seymour Center will continue to offer tours between two and four times per month (depending on the season and demand), with the goal of continuing to offer at least 38 tours per year (depending on weather, docent availability, etc.), including tours on weekdays and on weekends.

The extent of the beach access area varies depending on tidal conditions and the location of plants, as foot traffic is only permitted seaward of the dune vegetation. Thus, the exact access area may vary slightly from the areas depicted in Figure 2 below and Figure 3.11 of the CLRDP. The trail provides an interpretive experience for visitors that begins with a narrative history of the UC Natural Reserve System (UCNRS), an overview of the lagoon, a walk through a restored coastal scrub habitat with opportunities to view the rear dune, and ends on the beach. Tours are led by Seymour Center docents trained in the natural history and ecology of YLR and provide detailed information about flora, fauna, geology, and the UCNRS. Tour curriculum, which was first presented to the Seymour Center docents during the regular winter docent-training program in 2010, focuses on the unique ecology of the YLR beach.

In addition to the docent-guided beach tours, visual access to the lagoon and back dune is provided to the public via a newly constructed overlook along McAllister Way. This overlook (Overlook E) is open to the public from dawn to dusk. Visual access to the Younger Lagoon beach and information about Younger Lagoon Reserve is also provided to all visitors taking the Seymour Center's docent-guided Reserved and Daily Tours via the Overlook C. Last year, nearly 15,000 visitors took these tours.

Public Education and Outreach Programming on the Coastal Science Campus

The YLR beach access tours are part of broader public education and outreach programming on the Coastal Science Campus offered through the Seymour Center.

Every year, over 60,000 people visit the Seymour Center. The Seymour Center provides marine science education to hundreds of classes, comprised of thousands of students, teachers, and adult chaperones from across the country. Many of the classes served come from schools classified as Title 1—schools with high numbers of students from low-income families. Scholarships are made available to Title 1 schools, making it possible for students to participate who would not otherwise have the opportunity to experience a marine research center. Teachers often incorporate the Seymour Center into their weeklong marine science field study courses.

In FY 2017-2018, The Seymour Center, Younger Lagoon Reserve and the Monterey Bay Aquarium continued their partnership supporting high school students in the Watsonville Area Teens Conserving Habitats (WATCH) program. WATCH students from Aptos High School designed and carried out field-based research projects in Younger Lagoon Reserve on topics including endangered fish, aquatic invertebrates, and birds. These students made repeated visits to the Reserve throughout the year. Find out more at: https://www.montereybayaquarium.org/education/teen-programs/watsonville-area-teens-conserving-habitats-watch

In April 2018, Younger Lagoon Reserve and the California Academy of Sciences partnered to host the third annual *Younger Lagoon Reserve Bioblitz.* A *bioblitz* is a community event that brings together a wide variety of people – citizen scientists - to rapidly inventory the living organisms found in a particular place. The *Younger Lagoon Reserve Bioblitz* was held during UCSC's Alumni Weekend, and was open to both alumni and members of the public. Participants explored the lagoon and beach areas as part of this event. A link to the page advertising this community event can be found here: https://www.inaturalist.org/projects/younger-lagoon-reserve-bioblitz-2018

Every year, dozens of children ages 7-14, enroll in weeklong summer science sessions known as Ocean Explorers. Students actively learn about and participate in marine research at the Seymour Center, and our associated Long Marine Laboratory, where participants work alongside marine mammal researchers and trainers. Participants gain experience with the scientific process, focusing on honing their observation and questioning skills. Ocean Explorers also investigate the coastal environment at field sites around Monterey Bay, including rivers and watersheds, sandy beaches, rocky intertidal areas, and kelp forests by kayak. Young participants generally come from Santa Cruz, Santa Clara, and San Mateo Counties. Full and partial scholarships are extended to low-income participants.

The Seymour Center actively promotes its activities with press releases and calendar listings throughout the region. Every year, traditional print ads are placed in newspaper and magazines. The Seymour Center's activities are also often covered in the local newspaper, the Santa Cruz Sentinel. Public radio ads run throughout the year on the NPR-affiliate, KAZU.

Coupons for discounted admissions are available in various formats. The most highly used program is through the many Bay Area municipal libraries. Called Discover and Go, hundreds of families from across the region utilize these discount coupons. The Seymour Center continued to connect with the public through Facebook, Twitter, Instagram, Pinterest, Flickr, and bi-monthly e-blasts.

While part of UC Santa Cruz, the Seymour Center must raise its ~$1.25 million budget annually (including all operating costs, salaries, and benefits). Earned revenue—admissions, program fees, facility rentals, and the Ocean Discovery Shop—makes up approximately half of its general operating requirements.

Figure 1. Burrowing owl on the beach at Younger Lagoon.

Study Areas

Flora, fauna, and human use were monitored at Natural Bridges State Park, Younger Lagoon Reserve, and Little Wilder/Sand Plant Beach from 2010-2015 (Figure 2). These three sites have similar characteristics (all have beach and lagoon habitat), are within close proximity to one another, and experience varying levels of human use. Although site characteristics are similar in many ways, they are also different in many ways, and these differences likely influence species composition. Three of the primary differences among the sites are human use levels, composition of adjacent upland habitat, and the overall size of the beach and wetland areas. Starting in FY 2015-2016, only Younger Lagoon Reserve is monitored; however, we continue to include all of the data collected (as well as information on the State Park beach communities).

Younger Lagoon Reserve

Younger Lagoon Reserve is located in Santa Cruz County, approximately 4.5 miles from the main UC Santa Cruz campus; adjacent to the UC Santa Cruz Long Marine Laboratory. One of the few relatively undisturbed wetlands remaining on the California Central Coast, Younger Lagoon Reserve encompasses a remnant Y-shaped lagoon on the open coast just north of Monterey Bay. For most of the year, the lagoon is cut off from the ocean by a sand barrier. During the winter and spring months, the sand barrier at the mouth of Younger Lagoon breaches briefly connecting the lagoon to the ocean. The lagoon system provides protected habitat for 100 resident and migratory bird species. Approximately 25 species of water and land birds breed at the reserve, while more than 60 migratory bird species overwinter or stop to rest and feed. Opossums, weasels, brush rabbits, ground squirrels, deer mice, coyote, bobcat, woodrat, raccoon, and skunk are known to occupy the lagoon; gray and red foxes as well as mountain lion have also been sighted. Several species or reptiles and amphibians, including the California Red-legged Frog, also are found in the Reserve. Reserve habitats include salt and freshwater marsh, backdune pickleweed areas, steep bluffs with dense coastal scrub, pocket sand beach, grassland, and dense willow thickets.

Sand Plant Beach ("Little Wilder")

Sand Plant Beach is located in Santa Cruz County, approximately 1.5 miles west of YLR adjacent to Wilder Ranch State Park. Sand Plant Beach is approximately 23 acres and includes a pocket beach, dunes, cliffs and lagoon. It is open to the public for recreational use from dawn until dusk, 365 days a year; however, requires a hike to get to it and thus experiences less human use than many of the more accessible beaches in Santa Cruz. The surrounding Wilder Ranch State Park covers approximately 7,000 acres and allows human, bike and equestrian access. Much of the interior lagoon/upland habitat has been modified for agricultural production and/or ranching over the past century. Today most of the vegetation that persists inland of the lagoon is dominated by freshwater emergent vegetation and willow thickets. Major wetland restoration projects have increased native flora and fauna in the area (Friends of Santa Cruz State Parks, 2010).

Natural Bridges Lagoon

Natural Bridges Lagoon is located in Santa Cruz County, approximately 0.5 miles east of YLR on the urban edge of the city of Santa Cruz CA in Natural Bridges State Park. Natural Bridges Lagoon, beach, and State Park encompasses approximately 63 acres and includes a wide pocket beach, lagoon, cliffs, and diverse upland habitat (scrub, grass, iceplant, willow thicket, live oak, eucalyptus, and cypress). The park is world-renowned for its yearly migration of monarch butterflies and famous natural bridge. Natural Bridges State Park allows human access as well as dogs that are on leash and remain on paved roads and in parking lots (Friends of Santa Cruz State Parks, 2010). The beach is a popular destination at all times of the year; however, it is especially popular in the spring, summer, and fall months.

Figure 2. Study Areas.

Methods

User Data

User data from tours conducted by the SMDC, as well as research and education use of YLR, were recorded and maintained by SMDC and YLR Staff. User data from educational programs and fee collection are recorded and maintained by California State Parks staff for Natural Bridges State Parks. No user data was available for Sand Plant Beach.

Human Beach Use

We used remote cameras to quantify human use quarterly througout the study peroiod. Cameras were placed along the eastern edge of Sand Plant Beach and Natural Bridges Beach from FY 2010-2011 – FY 2014-2015 and at the western edge of Younger Lagoon from FY 2010-2011 – present with each separate quarterly sampling events each consisting of two days. Cameras were set to automatically take photos at 15 minute intervals. Number of people were quantified for 15 minute intervals during the day (camera times varied across sampling periods due to day length and postion; however, were standardized within each sampling period). The total survey area varied between sites and among individual sampling efforts due the placement of the camera and available habitat for human users at the time of the survey (i.e. often less beach area surveyed at Sand Plant Beach compared to Younger Lagoon and Natural Bridges). In order to control for area, specific regions of photos were chosen and number of individuals within each region were counted; thus, the number of people counted per unit area and time was standardized. We used the largest survey area during each sampling period to standardize use within each specific region of the beach during each sampling effort. Thus, if a particular site had more or less habitat monitored, the number of individuals was standardized across sites making comparisons comparable.

Photo Documentation of Younger Lagoon Natural Reserve

Photo point locations were established at four locations within YLR (Figure 3). These locations were chosen to ensure coverage of all major areas of the beach. Photos were taken once during the reporting period. At each photo point we collected photo point number, date, name of photographer, bearing, and camera and lens size.

Tidewater Goby Surveys

Tidewater goby surveys were conducted quarterly throughout the study period. Surveys were conducted using a 4.5 ft x 9 ft beach seine with 1/8 inch mesh. The objectives of the surveys were to document tidewater goby presence and evidence of breeding activity (determined by the presence of multiple size/age classes). All fish were identified to species and counted. When individuals exceeded ~50 per seine haul, counts were estimated. Sampling was conducted with the goal of surveying the various habitats within each site (e.g. sand, sedge, willow, pickleweed, deep, shallow, etc.); thus, different numbers of seine hauls were conducted at each site. Species richness was compared among sites.

Figure 3. Locations of monitoring points, plots, and regions for YLR beach. Monitoring areas varied between sampling efforts depending upon the high water mark, vegetation patterns, and water levels.

Species Composition and Coverage of Beach Dune Vegetation

Dune vegetation from the lowest (nearest to the mean high tide line) occurring terrestrial plant to 10 meters inland into the strand vegetation was surveyed quarterly throughout the study period. The exact location and extent of the area surveyed each time varied depending upon the location of the “lowest” plant detected during each sampling effort. At each location we established a 50-m east-west transect across the dune vegetation and measured the distance from the estimated mean high tide line to the “lowest” plant on the beach. Herbaceous species composition was measured by visual estimation of absolute cover for each species in ten 0.25 m^2 quadrats along the transect. Quadrats were placed every 5 m on alternating sides of the transect starting at a randomly selected point between 1 and 5 meters (a total of 10 quadrats per transect). A clear plastic card with squares representing 1, 5, and 10% of the sampling frame was used to help guide visual cover estimations. Species cover (native and exotic), bare ground, and litter were estimated at 5% intervals. Litter was specifically defined as residue from previous year’s growth while any senescent material that was recognizable as growth from earlier in the current growing season was counted as cover for that species. After all cover estimates had been made, we conducted surveys within 2 m of either side of the transect (a 4 × 50 m belt). In the belt transects, individual plants were recorded as either seedlings or greater than 1 year old. Presence of flowers and seeds was also noted.

Non-avian Vertebrate Monitoring

Tracks

Vertebrate tracks were measured using raked sand plots at each site quarterly throughout the study period. Tracking stations were placed throughout the beach area in constriction zones where vegetation was absent. The objective of these surveys was simply to detect what species use the beach habitat. As such, size of plot varied from approximately depending upon the amount of available open sandy area at each location. Track stations were raked each evening and checked for tracks in the morning. Stations remained open for two days during each monitoring bout. Tracks were identified to species when possible. Species composition was summarized; however, abundance was not quantified due to the fact that most often tracks cannot be used to identify individual animals (e.g. a single individual could walk across the plot multiple times).

Small Mammals

Sherman live traps were placed for two nights every quarter of the study period - a total of 30 traps were placed used (60 trap nights per sampling bout). Traps were set at dusk and collected at dawn. Each trap was baited with rolled oats and piece of synthetic bedding material was placed in each trap to ensure animals did not get too cold. Individuals were identified to species, marked with a unique ear tag, and released at the site of capture.

Invertebrate Monitoring

Terrestrial invertebrates on beach habitat were monitored by placing 12 oz plastic containers (pit fall traps) at each tracking station (one at each corner of the plot) during tracking efforts. Traps were buried to the lip of the container and checked each morning and all individuals were collected, identified, and counted.

Avian Monitoring

We conducted ocular surveys of birds on the beach, lagoon, and cliff habitats quarterly throughout the study period. Survey locations were selected along one edge of the beach on the cliff. At Sand Plant Beach the entire beach area, fore portion of the lagoon, and western cliff were surveyed from the eastern edge of the lagoon (FY 2010-2011 – FY 2014-2015). At YLR the entire beach area, fore portion of the lagoon, and western cliff were surveyed from the eastern edge of the lagoon and the top and western face of the rock stack that is located at the beach/ocean edge was surveyed (FY 2010-2011 – present). At Natural Bridges surveys were conducted from the eastern edge of the beach on the cliff adjacent to De Anza Mobile Home Park or from the beach to the west; fore lagoon and approximately the western ¼ of the beach area (including beach/ocean interface) was included in the survey area (FY 2010-2011 – FY 2014-2015). Survey areas were chosen with the goal of surveying approximately the same area and types of habitat. Counts were recorded quarterly throughout the study. Surveys were conducted in the dawn or dusk hours within approximately 2 hours of sunrise or sunset and of one another. Data from the two days during each sampling effort were combined and individuals were identified and counted.

Results

User Data

Younger Lagoon Reserve

There were a wide variety of public and non-profit research and educational groups that used Younger Lagoon (Table 1). The greatest user group for YLR was undergraduate education, a breakdown of all user groups is included in Table 2. The greatest user group was “other” which consists primarily of public tour groups attending daily tours at the Seymour Center. Those users were provided an overlook of the beach, interpretive information via docent led tours, and opportunities to read interpretive material presented on signs about the reserve; however, did not access the beach. During the 17-18 fiscal year a total of 195 participants went on the Seymour Center docent led Younger Lagoon beach access tours, more than doubling the number of participants who went on the beach access tour in the previous year. Since the start of the Seymour Center docent led beach access tours, nearly 170 tours have gone out and more than 816 visitors have participated. The beach access tours are part of a broad offering of public outreach and education programming on the Coastal Science Campus managed by the Seymour Center, including K-12 school visits to the Seymour Center, the Ocean Explorers Summer Camp, Bay Area Libraries Discover and Go Program, as well as print, web, social media, and radio campaigns.

Despite ongoing staff efforts towards public outreach and education, some unauthorized uses of Younger Lagoon Reserve, including trespass and vandalism occurred in FY 2017-2018. Thus far, no significant damage to ecologically sensitive habitat areas, research sites, research equipment, or facilities has occurred. Reserve staff will continue their public outreach and education efforts, and continue to partner with UCSC campus police to ensure the security of the reserve and protect sensitive resources and ongoing research.

Table 1. Younger Lagoon user affiliations.

University of California Campus	**Non-governmental organizations**
University of California, Santa Barbara	Audubon Society
University of California, Santa Cruz	Bird School Project
	California Academy of Sciences
California State Universities	Land Trust of Santa Cruz County
California State University, Monterey Bay	Monterey Bay Aquarium WATCH Program
California State University, San Jose	Santa Cruz Bird Club
California Community College	Seymour Marine Discovery Center
Cabrillo Community College	Watsonville Wetlands Watch
Universities outside California	**Governmental Agencies**
University of Utah	California State Parks
	Volunteer Groups
K-12 system	UCSC Wilderness Orientation
Aptos High School	
Half Moon Bay High School	
Pajaro Valley High School	
Watsonville High School	

Table 2. Younger Lagoon Total Use.

RESERVE USE DATA
Period from July 1, 2017 to June 30, 2018

University of California, Santa Cruz
Younger Lagoon Reserve

	UC Home		UC Away		CSU System		CA Com'ty. Colleges		Other CA Colleges		U.S. Colleges		Int'l Colleges		Gov't		NGOs		For-Profit Business		K-12 Schools		Others		TOTALS	
	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days	Users	Days
UNIVERSITY-LEVEL RESEARCH																										
Faculty	7	83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	83
Research Assistant	0	0	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4
Graduate Student	5	101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	101
Undergraduate Student	30	412	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	412
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	120	5	120
SUB-TOTALS	42	596	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	120	48	720
UNIVERSITY-LEVEL CLASSES																										
Faculty	12	24	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	27
Research Scientist	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Graduate Student	44	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44	85
Undergraduate Student	635	2219	0	0	22	22	50	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	707	2341
Professional	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	6	6
SUB-TOTALS	694	2333	0	0	23	23	51	102	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	774	2464
PUBLIC SERVICE																										
Faculty	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2
Research Scientist	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Graduate Student	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
Undergraduate Student	107	107	0	0	0	0	0	0	0	0	11	22	0	0	0	0	0	0	0	0	0	0	0	0	118	129
K-12 Instructor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	0	0	197	199	0	0	199	204
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	76	0	0	56	76
Professional	7	13	0	0	0	0	0	0	0	0	1	2	0	0	1	1	5	21	0	0	0	0	1	1	15	38
Other	20	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	0	0	0	0	1687	2387	1708	2422
Docent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40	40	40	40
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	255	255	260	260
SUB-TOTALS	137	143	1	1	0	0	0	0	0	0	12	24	0	0	1	1	8	41	0	0	258	280	1983	2683	2400	3173
TOTALS:	**873**	**3072**	**2**	**5**	**23**	**23**	**51**	**102**	**0**	**0**	**12**	**24**	**0**	**0**	**1**	**1**	**8**	**41**	**0**	**0**	**258**	**280**	**1994**	**2809**	**3222**	**6357**

*Other includes members of the public who took the SMDC's daily tour. Although all tours include information on YLR, we estimate that 10% of these visitors can be reasonably counted as users.

Sand Plant Beach (Little Wilder)

Sand Plant Beach is located adjacent to Wilder State Park and is frequented by Wilder State Park visitors along a coastal bluff trail. Because of the size of Wilder Ranch State Park (over 7,000 acres, with over 35 miles of trails) and its multiple points of access, it is unknown exactly how many people visit Sand Plant Beach each year. However, even though it requires a hike it is one of the more popular beaches along this section of Wilder Ranch as there is relatively easy access along the coastal bluff trail. We surveyed Sand Plant Beach from FY10-11 – FY14-15.

Natural Bridges Lagoon

We did not obtain user data for Natural Reserves during the survey period; however, more than 925,000 people are estimated to have visited Natural Bridges State Park in 2005 (Santa Cruz State Parks 2010). The proportion of those visitors that use the beach and lagoon habitat is unknown. It is likely that the number of visitors remains in this range from year to year. We surveyed Natural Bridges Lagoon from FY10-11 – FY14-15.

Human Use During Survey Efforts

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Number of users at YLR beach during the survey efforts varied among beach as well as between sampling dates. However, the pattern of total use (Table 3; Figures 4-5) and the number of people per photo (15 minute interval standardized for area surveyed) was consistent across sampling periods. Examples of photos captured during a typical monitoring session in 2010 are included as Figure 6.

Table 3. Number of people observed in photo human use monitoring.

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
Natural Bridges	May, 2010	313	3.13
Sand Plant	May, 2010	92	1.21
Younger Lagoon	May, 2010	2	0.28
Natural Bridges	August, 2010	224	2.69
Sand Plant	August, 2010	15	0.17
Younger Lagoon	August, 2010	0	0
Natural Bridges	November, 2010	207	2.07
Sand Plant	November, 2010	7	0.17
Younger Lagoon	November, 2010	1	0.02
Natural Bridges	February, 2011	185	2.64
Sand Plant	February, 2011	10	0.25

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
Younger Lagoon	February, 2011	2	0.06
Natural Bridges	May, 2011	236	2.8
Sand Plant	May, 2011	13	0.38
Younger Lagoon	May, 2011	5	0.18
Natural Bridges	July, 2011	795	2.44
Sand Plant	July, 2011	7	0.25
Younger Lagoon	July, 2011	0	0
Natural Bridges	December, 2011	49	0.63
Sand Plant	December, 2011	39	1.16
Younger Lagoon	December, 2011	0	0
Natural Bridges	April, 2012	442	6.93
Sand Plant	April, 2012	120	2.05
Younger Lagoon	April, 2012	0	0
Natural Bridges	May, 2012	624	2.67
Sand Plant	May, 2012	14	0.19
Younger Lagoon	May, 2012	0	0
Natural Bridges	October, 2012	210	4.84
Sand Plant	October, 2012	83	1.06
Younger Lagoon	October, 2012	3	0.04
Natural Bridges	January, 2013	100	4.90
Sand Plant	January, 2013	24	0.81
Younger Lagoon	January, 2013	9	0.11
Natural Bridges	May, 2013	615	19.81
Sand Plant	May, 2013	21	0.52
Younger Lagoon	May, 2013	0	0
Natural Bridges	July, 2013	560	25.42
Sand Plant	July, 2013	29	0.96
Younger Lagoon	July, 2013	5	0.06
Natural Bridges	November, 2013	3.44	13.04
Sand Plant	November, 2013	6	0.19
Younger Lagoon	November, 2013	12	0.15
Natural Bridges	February, 2014	71	6.37
Sand Plant	February, 2014	6	0.20

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
Younger Lagoon	February, 2014	1	0.01
Natural Bridges	June, 2014	1723	21.01
Sand Plant	June, 2014	239	2.92
Younger Lagoon	June, 2014	2	0.02
Natural Bridges	August, 2014	852	23.68
Sand Plant	August, 2014	227	2.52
Younger Lagoon	August, 2014	2	0.02
Natural Bridges	November, 2014	2131	21.69
Sand Plant	November, 2014	146	1.78
Younger Lagoon	November, 2014	2	0.02
Natural Bridges	January, 2015	1889	23.04
Sand Plant	January, 2015	225	2.75
Younger Lagoon	January, 2015	11	0.13
Natural Bridges	April, 2015	699	7.13
Sand Plant	April, 2015	-	-
Younger Lagoon	April, 2015	0	0
Younger Lagoon	July, 2015	6	0.02
Younger Lagoon	October, 2015	0	0
Younger Lagoon	February, 2016	0	0
Younger Lagoon	May, 2016	1	0.02
Younger Lagoon	July, 2016	0	0
Younger Lagoon	November, 2016	0	0
Younger Lagoon	February, 2017	0	0
Younger Lagoon	April, 2017	0	0
Younger Lagoon	August, 2017	19	0.16
Younger Lagoon	October, 2017	6	0.05
Younger Lagoon	February, 2018	0	0
Younger Lagoon	May, 2018	27	0.22

[1]Standardized by area surveyed.

Figure 4. Photos captured by remote camera during the Spring 2010 monitoring effort. Top to bottom: Sand Plant Beach, Natural Bridges, and Younger Lagoon.

Photo Documentation of YLR

Photos were taken one time during each reporting period. Photos for this year's report are included as Appendix 1.

Tidewater Goby Surveys

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Evidence of breeding (multiple size classes) continued to be observed at YLR during the reporting period (Table 4).

Table 4. Fish species encountered during sampling efforts.

	Tidewater Goby	Stickleback	Sculpin	Mosquito Fish	Halibut	CRLF[1]	Bluegill
April 9, 2010							
Little Wilder	X	X					
Younger Lagoon	X	X					
Natural Bridges	X	X	X				
August 13, 2010							
Little Wilder	X	X					
Younger Lagoon	X	X					
Natural Bridges	X	X	X	X			
November 18, 2010							
Little Wilder	X	X					
Younger Lagoon	X						
Natural Bridges	X	X	X	X			
February 23, 2011							
Little Wilder	X	X					
Younger Lagoon	X						
Natural Bridges	X	X	X	X			
May 12, 2011							
Little Wilder	X	X					
Younger Lagoon	X	X	X		X		
Natural Bridges	X	X	X				
August 8, 2011							
Little Wilder	X	X					
Younger Lagoon	X	X					
Natural Bridges	X	X					
December 12, 2011							

Little Wilder	X	X			
Younger Lagoon	X				
Natural Bridges	X	X			
March 8, 2012					
Little Wilder	X	X			
Younger Lagoon	X				
Natural Bridges	X	X			
May 15, 2012					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X	X	X		
August 29, 2012					
Little Wilder	X	X			X
Younger Lagoon	X	X			X
Natural Bridges	X	X			
October 23, 2012					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X	X			
February 2, 2013					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X	X			
May 6, 2013					
Little Wilder	X	X			X
Younger Lagoon	X	X			X
Natural Bridges	X	X			
July 16, 2013					
Little Wilder	X	X			X
Younger Lagoon	X	X			
Natural Bridges	X	X		X	
November 14, 2013					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges					
February 21, 2014					
Little Wilder	X	X			
Younger Lagoon	X	X			
Natural Bridges	X				
May 2, 2014					

Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X		
August 11, 2014			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X	X	
November 25, 2014			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X	X	
January 26, 2015			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X		
April 13, 2015			
Little Wilder	X	X	
Younger Lagoon	X	X	
Natural Bridges	X	X	X
July 8, 2015			
Younger Lagoon	X	X	
November 4, 2015			
Younger Lagoon	X	X	
February 9, 2016			
Younger Lagoon	X	X	
May 13, 2016			
Younger Lagoon	X	X	
July 20, 2016			
Younger Lagoon	X	X	
November 17, 2016			
Younger Lagoon	X	X	
March 1, 2017			
Younger Lagoon			
May 3, 2017			
Younger Lagoon	X	X	
August 9, 2017			

Younger Lagoon	X	X					
November 9, 2017							
Younger Lagoon	X	X					
February 9, 2018							
Younger Lagoon	X	X					
May 2, 2018							
Younger Lagoon	X	X					
No. of sites	3	3	2	2	1	2	1

[1]CRLF = California Red-legged Frog (*Rana draytonii*). Tadpoles have been observed at Little Wilder. Juveniles, young of year, and adults have been observed at YLR and Little Wilder.

Species Composition and Coverage of Beach Dune Vegetation

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Evidence of reproduction (flowers, seeds, and seedlings) of native and non-native vegetation has been detected at all three sites. Distance from mean high tide to the lowest plant on the beach was consistently greatest at Natural Bridges and lowest at Sand Plant Beach and Younger Lagoon (Table 5). Plant cover was generally higher at Sand Plant and Younger Lagoon (as exhibited by proportion of bare ground) but varied across sampling efforts (Figure 5).

Native plant species richness was consistently greatest at Younger Lagoon; however, it varied across sampling periods (Figure 6). Mean proportion of non-native species was greatest at Natural Bridges (53%) and least at Younger Lagoon (27%) (Table 6).

Table 5. Distance (m) from mean high tide to the lowest plant on the beach.

Site	Spring, 10	Summer, 10	Fall, 10	Winter, 11	Spring, 11	Summer, 11	Fall, 11	Winter, 12	Spring, 12
Younger Lagoon	56	51	20	42	55	49	26	30	28
Sand Plant Beach	33	34	56	56	40	51	29	31	38
Natural Bridges	128	130	141	146	146	138	155	160	123

Site	Summer, 12	Fall, 12	Winter, 13	Spring, 13	Summer, 13	Fall, 13	Winter, 14	Spring, 14
Younger Lagoon	47	20	30	36	37.3	32.1	26.4	36.5
Sand Plant Beach	35	38	31	41	48.1	49.9	45.6	24.2
Natural Bridges	91	75	100	72	88.9	107.3	87.4	83.2

Site	Summer, 14	Fall, 14	Winter, 15	Spring, 15	Summer, 15	Fall, 15	Winter, 16	Spring, 16
Younger Lagoon	21.4	10	26.4	19.5	19.3	20.5	31.4	42.8
Sand Plant Beach	27.5	31	24.5	29.2				
Natural Bridges	74.3	89.4	71	75.8				

Site	Summer, 16	Fall, 16	Winter, 17	Spring, 17	Summer, 17	Fall, 17	Winter, 18	Spring, 18
Younger Lagoon	36.6	46.3	19.5	37.3	22.3	39.3	32	29

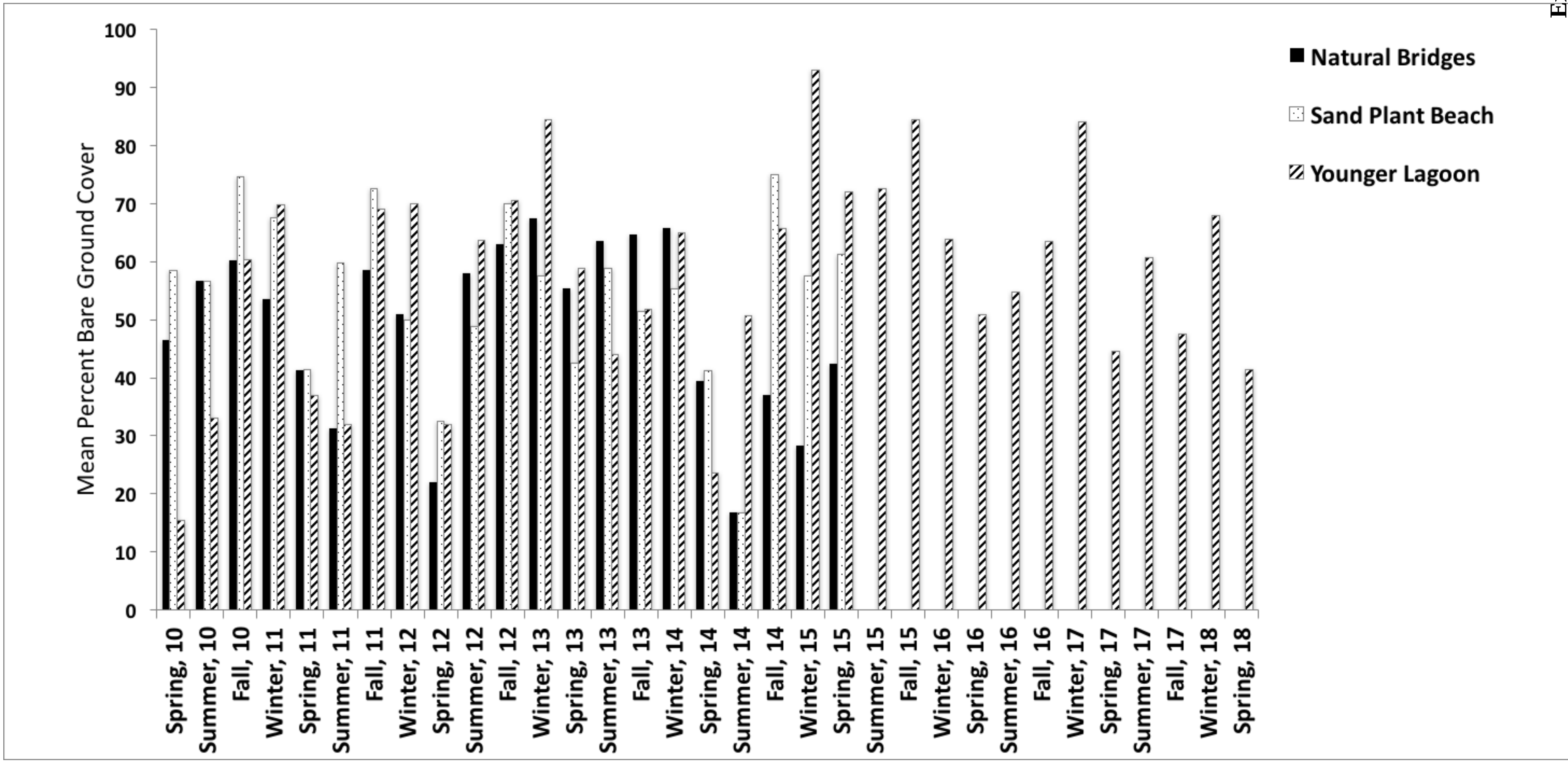

Figure 5. Mean percent bare ground encountered at each site.

Table 6. Number and proportion of native and non-native plant species encountered during surveys. Mean is calculated across all samples.

Site	Spring, 10	Summer, 10	Fall, 10	Winter, 11	Spring, 11	Summer, 11	Fall, 11	Winter, 12	Spring, 12
Natural Bridges									
Native	7 (41%)	8 (44%)	9 (60%)	8 (44%)	9 (43%)	6 (67%)	8 (62%)	9 (47%)	11 (48%)
Non-native	10 (59%)	10 (56%)	5 (40%)	10 (66%)	12 (57%)	9 (33%)	5 (38%)	10 (53%)	12 (52%)
Total	17	18	14	18	21	15	13	19	23
Younger Lagoon									
Native	11 (85%)	11 (85%)	11 (85%)	11 (73%)	12 (80%)	13 (81%)	9 (82%)	6 (50%)	6 (43%)
Non-native	2 (15%)	2 (15%)	2 (15%)	4 (27%)	3 (20%)	3 (19%)	2 (18%)	6 (50%)	8 (57%)
Total	13	13	13	15	15	16	11	12	14
Sand Plant Beach									
Native	7 (88%)	7 (63%)	7 (70%)	8 (80%)	7 (88%)	7 (88%)	9 (82%)	3 (33%)	4 (40%)
Non-native	1 (12%)	2 (37%)	3 (30%)	2 (20%)	1 (12%)	1 (12%)	2 (18%)	6 (67%)	6 (60%)
Total	8	9	10	10	8	8	11	9	10

Site	Summer, 12	Fall, 12	Winter, 13	Spring, 13	Summer, 13	Fall, 13	Winter, 14	Spring, 14
Natural Bridges								
Native	5 (35%)	10 (59%)	7 (88%)	9 (56%)	7 (37%)	6 (35%)	6 (43%)	10 (50%)
Non-native	9 (65%)	7 (41%)	8 (12%)	6 (44%)	12 (63%)	11 (65%)	8 (57%)	10 (50%)
Total	14	17	15	16	19	17	14	20
Younger Lagoon								
Native	12 (67%)	7 (88%)	9 (69%)	12 (75%)	13 (72%)	14 (74%)	10 (83%)	12 (67%)
Non-native	6 (33%)	1 (12%)	4 (31%)	4 (25%)	5 (28%)	5 (26%)	2 (17%)	6 (33%)
Total	18	8	13	16	18	19	12	18
Sand Plant Beach								
Native	2 (40%)	3 (50%)	4 (100%)	4 (67%)	6 (100%)	6 (100%)	5 (100%)	5 (83%)
Non-native	3 (60%)	3 (50%)	0 (0%)	2 (33%)	0 (0%)	0 (0%)	0 (0%)	1 (17%)

Total	5	6	4	6	6	6	5	6

Site	**Summer, 14**	**Fall, 14**	**Winter, 15**	**Spring, 15**	**Summer, 15**	**Fall, 15**	**Winter, 16**	**Spring 16**
Natural Bridges								
Native	5 (42%)	5 (45%)	4 (33%)	5 (31%)				
Non-native	7 (58%)	6 (55%)	8 (67%)	11 (69%)				
Total	12	11	12	16				
Younger Lagoon								
Native	9 (69%)	5 (62%	10 (67%)	10 (67%)	11 (73%)	2 (67%)	5 (100%)	10 (83%)
Non-native	4 (31%)	3 (38%)	5 (33%)	5 (33%)	4 (27%)	1 (33%)	0 (0%)	2 (17%)
Total	13	8	15	15	15	3	5	12
Sand Plant Beach								
Native	4 (50%)	4 (40%)	5 (50%)	4 (33%)				
Non-native	4 (50%)	6 (60%)	5 (50%	8 (67%)				
Total	8	10	10	12				

Site	**Summer, 16**	**Fall, 16**	**Winter, 17**	**Spring, 17**	**Summer, 17**	**Fall, 17**	**Winter, 18**	**Spring, 18**
Younger Lagoon								
Native	10 (83%)	8 (57%)	3 (60%)	13 (68%)	12 (70%)	13 (76%)	12 (70%)	9 (82%)
Non-native	2 (17%)	6 (43%)	2 (40%)	6 (32%)	5 (30%)	4 (24%)	5 (30%)	2 (18%)
Total	12	14	5	19	17	17	17	11

Site	**Proportion of native and non-native species across all sample periods**
Natural Bridges	
Native	**47%**
Non-native	**53%**
Total	
Younger Lagoon	

Native	**74%**
Non-native	**26%**
Total	
Sand Plant Beach	
Native	**68%**
Non-native	**31%**
Total	

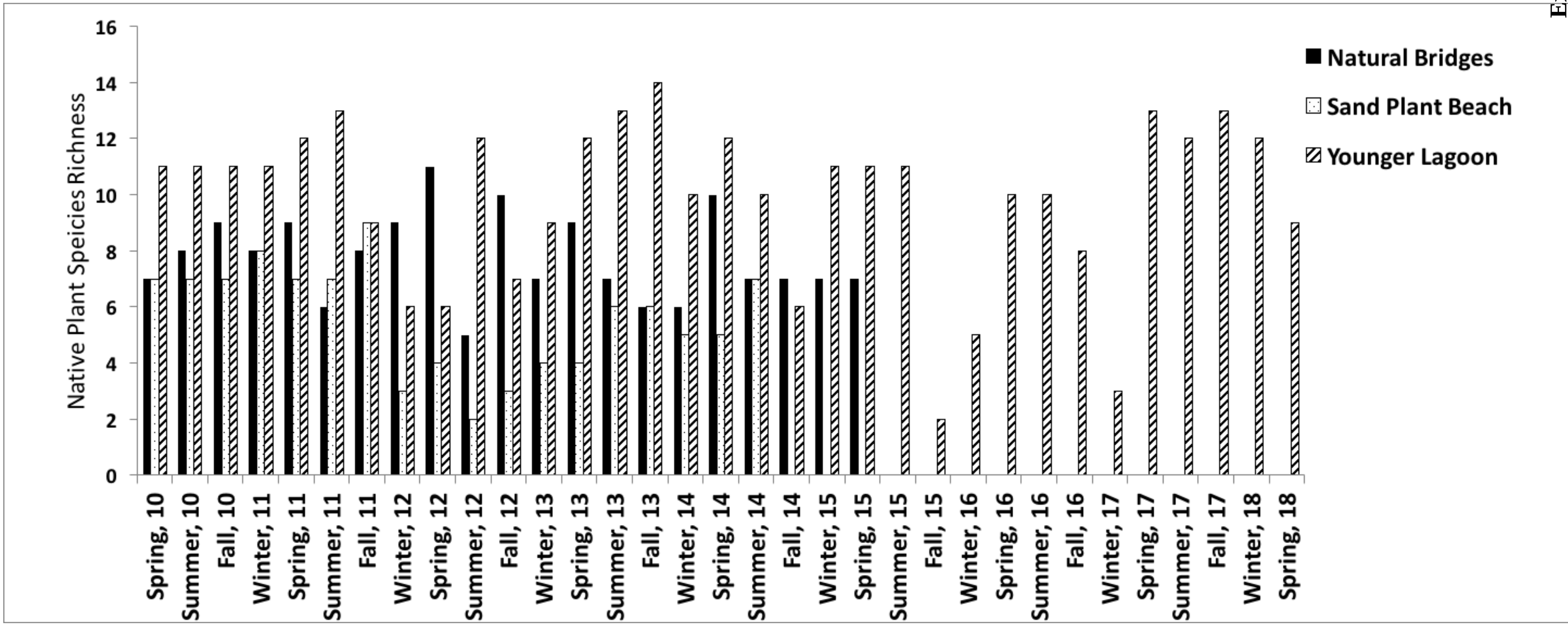

Figure 6. Number of native plant species encountered at each site.

Track Plate Monitoring

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Native species richness of mammals detected in raked sand plots was across all three sites (n = 8). Ground squirrel were not detected at Natural Bridges and opossum have not been detected in our track surveys at Sand Plant Beach or Younger Lagoon Reserve (Table 7). It is likely that ground squirrels occur at Natural Bridges and opossum are likely using upland habitat at Sand Plant Beach and Younger Lagoon Reserve; however, they were not detected in our survey efforts. Dogs and bicycles were detected at Natural Bridges and Sand Plant Beach and vehicles were detected at Natural Bridges (Table 7). Frequency of detection and species richness for each species is summarized in Table 8.

Table 7. Summary of track plate sampling effort at each site.

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
May 1-2, 2010													
Little Wilder	X			X	X	X			X	X			X
Younger Lagoon	X	X		X	X								X
Natural Bridges	X	X		X	X				X	X	X	X	X
August 11-12, 2010													
Little Wilder		X		X	X							X	X
Younger Lagoon	X	X	X	X		X							
Natural Bridges	X	X	X									X	X
November 17-18, 2010													
Little Wilder	X		X	X					X				X
Younger Lagoon	X	X											X
Natural Bridges	X	X		X							X	X	X
February 8 -9, 2011													
Little Wilder	X			X	X				X	X			X
Younger Lagoon	X	X			X				X				
Natural Bridges		X		X					X		X		X
May 3 - 4, 2011													

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
Little Wilder	X		X	X									
Younger Lagoon		X	X	X	X				X				
Natural Bridges		X			X				X			X	X
July 22 - 23, 2011													
Little Wilder	X	X			X				X				X
Younger Lagoon	X	X	X	X	X								
Natural Bridges	X	X	X		X							X	X
March 8 & 9, 2012													
Little Wilder	X								X				X
Younger Lagoon				X					X				
Natural Bridges							X				X	X	X
May 15 & 16, 2012													
Little Wilder	X		X	X									X
Younger Lagoon	X	X		X					X				
Natural Bridges	X			X				X				X	X
August 16 & 17, 2012													
Little Wilder	X	X	X	X	X		X		X				X
Younger Lagoon	X	X		X		X	X						
Natural Bridges	X	X	X	X	X		X				X	X	X
October 22 & 23, 2012													
Little Wilder	X						X		X				X
Younger Lagoon		X		X					X				X
Natural Bridges			X		X		X				X		X
January 16 & 17, 2013													
Little Wilder	X			X					X				X
Younger Lagoon	X	X		X					X				X
Natural Bridges		X		X	X				X			X	X
May 15 & 16, 2013													
Little Wilder	X			X	X								X

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
Younger Lagoon	X	X		X					X				X
Natural Bridges	X	X			X							X	X
July 18 & 19, 2013													
Little Wilder	X	X		X					X			X	X
Younger Lagoon	X	X		X					X				
Natural Bridges		X		X	X						X	X	X
October 21 & 22, 2013													
Little Wilder		X		X									
Younger Lagoon		X		X					X				X
Natural Bridges	X	X			X				X		X	X	X
February10 &11, 2014													
Little Wilder	X	X		X									X
Younger Lagoon									X				X
Natural Bridges		X			X						X		X
April 27 & 28, 2014													
Little Wilder		X		X					X				X
Younger Lagoon		X							X				
Natural Bridges		X		X	X						X	X	X
July 30-31, 2014													
Little Wilder		X		X					X				X
Younger Lagoon		X		X					X				
Natural Bridges		X			X		X		X		X	X	X
November 4-5, 2014													
Little Wilder				X					X			X	X
Younger Lagoon		X		X					X				
Natural Bridges		X					X				X		X
January 26-27, 2015													
Little Wilder	X								X				X

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
Younger Lagoon	X	X		X			X						X
Natural Bridges	X				X		X		X		X	X	X
April 14-15, 2015													
Little Wilder	X	X							X				X
Younger Lagoon	X	X		X					X				
Natural Bridges	X				X		X		X		X	X	X
July 8-9, 2015													
Younger Lagoon	X			X	X								
									X				X
October 29-30, 2015													
Younger Lagoon		X		X									
February 2-3, 2016													
Younger Lagoon		X							X				
May3-4, 2016													
Younger Lagoon		X							X				
July 12-13, 2016													
Younger Lagoon		X		X									
November 9-10, 2016													
Younger Lagoon		X		X					X				
March 1-2, 2017													
Younger Lagoon	X	X		X									
April 25-26, 2017													
Younger Lagoon		X					X		X				X
August 2-3, 2017													
Younger Lagoon					X				X				

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
October 25-26, 2017													
Younger Lagoon		X					X		X	X			X
February 7-8, 2018													
Younger Lagoon	X			X	X								X
May 1-2, 2018													
Younger Lagoon	X								X				
	3	3	3	3	3	2	3	1	3	3	1	2	3

[1]Unidentified small rodent.

Table 8. Frequency of occurrence, and native species richness, of animals and human use types through spring 2017 track plate sampling efforts. Actual detections are included parenthetically.

Site	Rodent	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human	[1]Native sp. Richness
Little Wilder	(15) 71%	(10) 48%	(4) 19%	(15) 71%	(6) 29%	(1) 6%	(2) 10%	0%	(15) 71%	(2) 10%	0%	(3) 14%	(19) 91%	8
Younger Lagoon	(17) 53%	(21) 65%	(2) 6%	(23) 72%	(9) 28%	(2) 6%	(4) 12%	0%	(21) 65%	(1) 3%	0%	0%	(12) 37%	8
Natural Bridges	(9) 43%	(15) 71%	(4) 19%	(9) 43%	(13) 62%	0%	(8) 38%	(1) 5%	(9) 43%	(1) 5%	(14) 67%	(16) 76%	(21) 100%	8

[1]Bicycle, vehicle, dog, and human excluded.

Small Mammal Trapping

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. A total of 281 individual small mammals representing four species have been captured during small mammal trapping efforts (Table 9).

Table 9. Summary of Sherman trapping efforts

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
April 24 -25, 2010					
Little Wilder	8	5			**13**
Younger Lagoon	2				**2**
Natural Bridges			3		**3**
August 11-12, 2010					
Little Wilder	5	4			**9**
Younger Lagoon			1		**1**
Natural Bridges					**0**
November 15-16, 2010					
Little Wilder	5	1			**6**
Younger Lagoon				1	**1**
Natural Bridges		3	1		**4**
February 15-16, 2011					
Little Wilder	5				**5**
Younger Lagoon	6	5	0		**11**
Natural Bridges			2		**2**
April 29-30, 2011					
Little Wilder	4				**4**
Younger Lagoon	1				**1**
Natural Bridges					**0**
August 8-9, 2011					
Little Wilder	6	2			**8**
Younger Lagoon	3		3		**6**
Natural Bridges		1	5		**6**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
March 30, 2012					
Little Wilder	6				**6**
Younger Lagoon	1		1		**2**
Natural Bridges		5	2		**7**
May 15-16, 2012					
Little Wilder	4	1			**5**
Younger Lagoon	3				**3**
Natural Bridges		5			**5**
August 25-26, 2012					
Little Wilder	4				**4**
Younger Lagoon	3				**3**
Natural Bridges		4	2		**6**
November 5-6, 2013					
Little Wilder	2		1		**3**
Younger Lagoon	3				**3**
Natural Bridges		3	1		**4**
January 13-14, 2013					
Little Wilder	2		4		**6**
Younger Lagoon	2				**2**
Natural Bridges		2	1		**3**
May 1-2, 2013					
Little Wilder	1		1		**2**
Younger Lagoon	3		2		**5**
Natural Bridges		5			**5**
July 16-17, 2013					
Little Wilder	3		1		**4**
Younger Lagoon	1				**1**
Natural Bridges			1		**1**
October 22-23, 2013					
Little Wilder	5	1		1	**7**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
Younger Lagoon	1				**1**
Natural Bridges		1	2		**3**
February 12-13, 2014					
Little Wilder	2	1	1		**4**
Younger Lagoon	1		1		**2**
Natural Bridges		2			**2**
April 28-29, 2014					
Little Wilder	4	1			**5**
Younger Lagoon	3		1		**4**
Natural Bridges	1				**1**
July 30-31, 2014					
Little Wilder	1	1			**2**
Younger Lagoon	2				**2**
Natural Bridges	1		1		**2**
November 4-5, 2014					
Little Wilder	3	1			**4**
Younger Lagoon	4				**4**
Natural Bridges	2	1	3		**6**
January 26-27, 2015					
Little Wilder	3		1		**4**
Younger Lagoon	4		5		**9**
Natural Bridges			3		**3**
April 14-15, 2015					
Little Wilder	2		3		**5**
Younger Lagoon	3				**3**
Natural Bridges					**0**
July 8-9, 2015					
Younger Lagoon	7		1		**8**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
October 29-30, 2015					
Younger Lagoon	2		6		**8**
February 2-3, 2016					
Younger Lagoon			6		**6**
May 3-4, 2016					
Younger Lagoon			3	1	**4**
July 12-13, 2016					
Younger Lagoon			4		**4**
November 9-10, 2016					
Younger Lagoon	2		1		**3**
March 1-2, 2017					
Younger Lagoon	2		1		**3**
April 25-26, 2017					
Younger Lagoon			1		**1**
August 2-3, 2017					
Younger Lagoon					**0**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
October 25-26, 2017					
Younger Lagoon	1	1	2		**4**
February 8-9, 2018					
Younger Lagoon	2				**2**
May 1-2, 2018					
Younger Lagoon	1		2		**3**
TOTAL	**142**	**56**	**80**	**3**	**281**

[1]Pema = *Peromyscus maniculatus*; Mica = *Microtus californicus*; Rema = *Reithrodontomys megalotis*; Rara = *Rattus norvegicus.* [2]Escaped before positive ID; however, suspected to be Norway Rat.

Invertebrate Monitoring

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Over all, Younger Lagoon consistently had the greatest number of individuals captured; however, patterns of species richness varied among sampling sessions (Figures 9-10). This may have been at least partially due to trapping methodology and disturbance as raccoons and perhaps coyote disturbed sample cups during some of the sampling efforts. Individuals were identified as distinct taxa; however, at the time of the writing of this report they have not been taxonomically keyed out.

Avian Surveys

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Avian species varied among sites and sampling dates (Table 10); however, number of species and abundance were consistently greatest at Natural Bridges and Younger Lagoon.

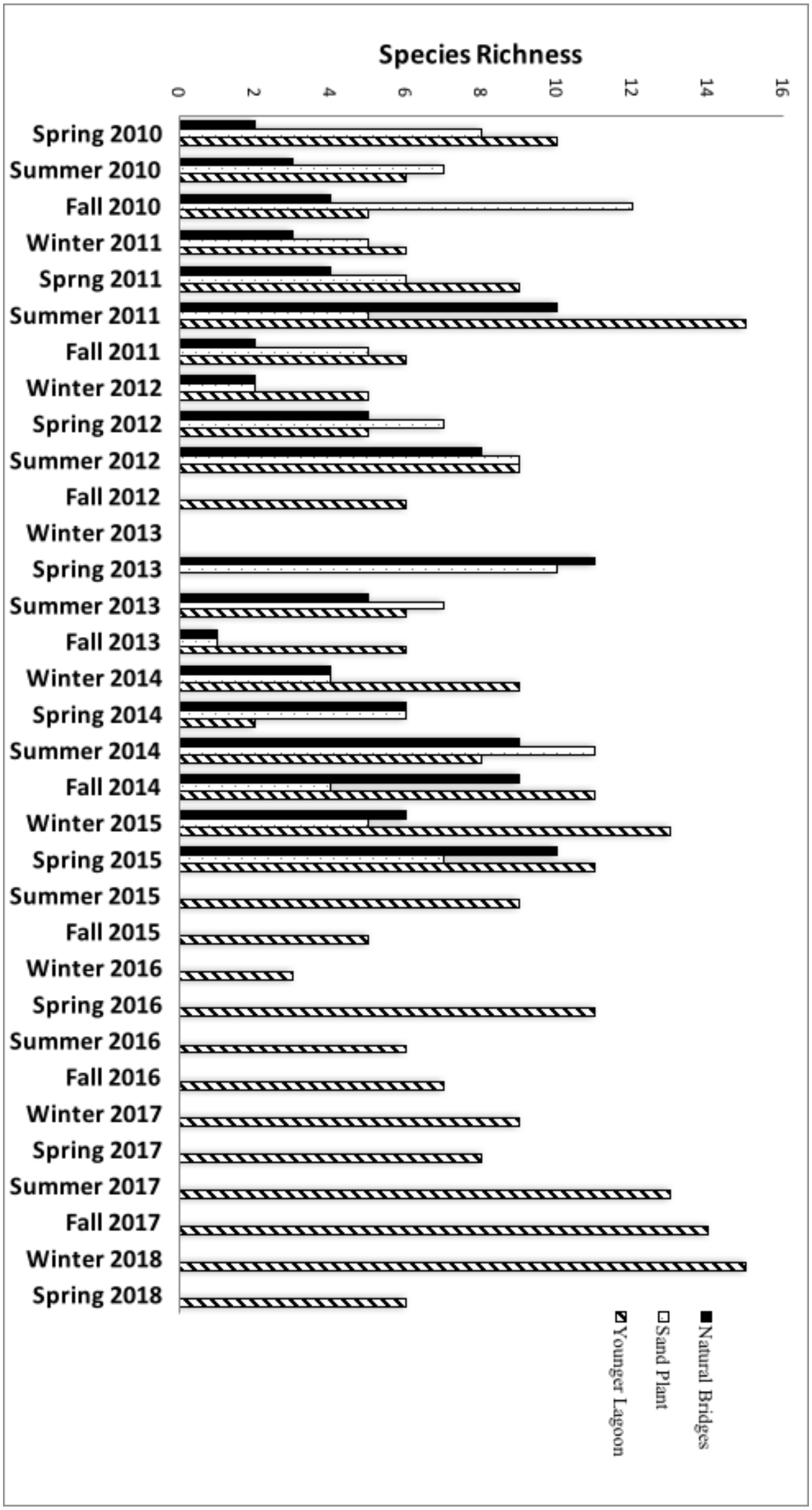

Figure 7. Species richness of invertebrates across all beaches

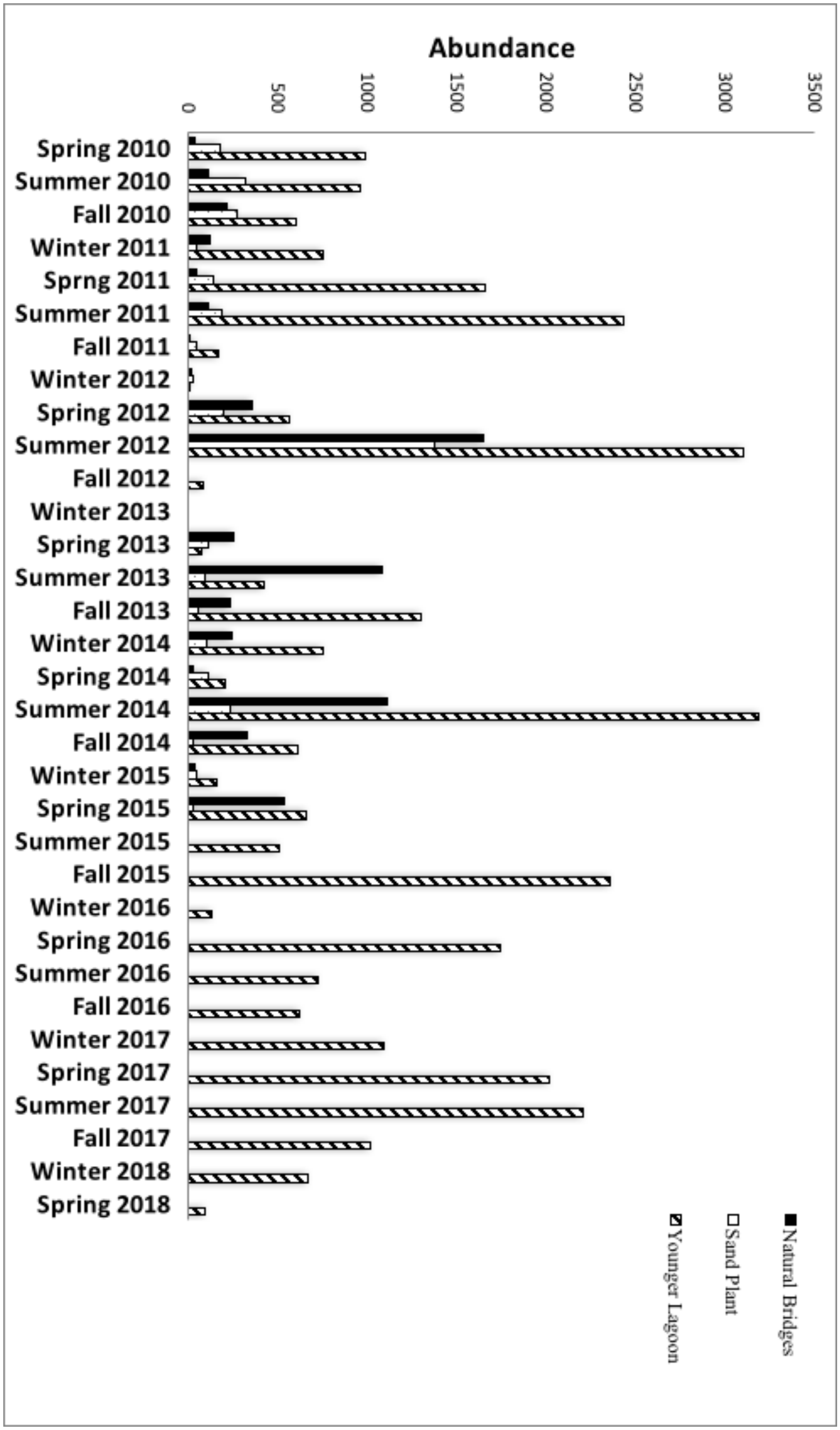

Figure 8. Total abundance of invertebrates at Natural Bridges, Sand Plant Beach, and Younger Lagoon beaches.

Table 10. Summary of bird surveys at Sand Plant Beach, Younger Lagoon, and Natural Bridges beaches.

Site	AMCR	AMPE	BBPL	BCNH	BASW	BLOY	BLPH	BLTU	BRAC	BRBL	BRPE	BUHE	CAGO	CAGU	CLSW	CORA	COOT	DOCO	DUSP	EUST	GCSP	GRHE	GREG	GRTE	HEGU	HOFI
April 24 & 26, 2010																										
Sand Plant																										
Younger Lagoon																										
Natural Bridges										2																
August 11-12, 2010																										
Sand Plant																									1	
Younger Lagoon						2												1		1					2	
Natural Bridges	2									19																
November 15 & 16, 2010																										
Sand Plant																						3				
Younger Lagoon								1			27						2		3	1						
Natural Bridges										1												2	2		24	
February 15 & 16, 2011																										
Sand Plant																										
Younger Lagoon																		5								
Natural Bridges	3									2		1		58												
May 3 & 4, 2011																										
Sand Plant	2										8															
Younger Lagoon																										
Natural Bridges	1						1							3				6					1			
July 22 & 23, 2011																										
Sand Plant					4		1								4										8	
Younger Lagoon																										
Natural Bridges	9				4					6								10							48	
March 29 & 30, 2012																										
Sand Plant														1												
Younger Lagoon										5							3			2						
Natural Bridges								1																2		
May 15 & 16, 2012																										
Sand Plant																										
Younger Lagoon						3				2										2						
Natural Bridges	1									1																
August 25 & 26, 2012																										
Sand Plant														2		2										
Younger Lagoon		1				1	1							4												
Natural Bridges														1												
November 5& 6, 2012																										
Sand Plant																	5									
Younger Lagoon										4							8									
Natural Bridges	2																									
January 13&14, 2013																										
Sand Plant																										
Younger Lagoon						1						1					5									
Natural Bridges																1						1				
May 1 & 2, 2013																										
Sand Plant																										
Younger Lagoon										1			2							2						
Natural Bridges	2																						2			
July 16-17, 2013																										
Sand Plant				1										1		1										
Younger Lagoon				1			2			7				2								1				
Natural Bridges							2			1				1								1			11	
October 22-23, 2013																										
Sand Plant														1		2										
Younger Lagoon			3				3							2				1		1					300	
Natural Bridges	2		1								1			3											3	
February 13-14, 2014																										
Sand Plant													6													
Younger Lagoon																							1			
Natural Bridges	1																									
April 27-28, 2014																										
Sand Plant	3										20															
Younger Lagoon						8					13		2													
Natural Bridges	3					2					11			7	2			8					1			
July 30-31, 2014																										

Site	AMCR	AMPE	BBPL	BCNH	BASW	BLOY	BLPH	BLTU	BRAC	BRBL	BRPE	BUHE	CAGO	CAGU	CLSW	CORA	COOT	DOCO	DUSP	EUST	GCSP	GRHE	GREG	GRTE	HEGU	HOFI
Sand Plant														10									1		10	
Younger Lagoon											18												4			
Natural Bridges											18														15	
November 4-5, 2014																										
Sand Plant																	2								6	
Younger Lagoon							2				5						6									
Natural Bridges	11									2							10						1		9	
January 26-27, 2015																										
Sand Plant							2						2													
Younger Lagoon											6						9									
Natural Bridges	12						1				27					3							1			
April 14-15, 2015																										
Sand Plant							1						2				1									
Younger Lagoon							2										1									
Natural Bridges											6						7									
July 8-9, 2015																										
Younger Lagoon				2	4																					
October 29-30, 2015																										
Younger Lagoon							1				4			2												
February 2-3, 2016																										
Younger Lagoon							1													2						
May 3-4, 2016																										
Younger Lagoon					4		2						2												1	
July 12, 2016																										
Younger Lagoon					3		1			12				2									1			
November 9-10, 2016																										
Younger Lagoon							2				1												1			
March 1-2, 2017																										
Younger Lagoon							1							3									1			
April 25-26, 2017																										
Younger Lagoon	1														6					2						
August 2-3, 2017																										
Younger Lagoon					8	2	2		8														1		2	6
October 25-26, 2017																										
Younger Lagoon							1		6		2															
February 7-8, 2018																										
Younger Lagoon							1		2		2										1				3	
May 2-3, 2018																										
Younger Lagoon					5	2	2		5	1																

Site	KILL	LOCU	MALL	MAGO	MEGU	MODO	NOHA	PECO	PIGR	PIGU	REHA	REPH	RWBB	RODO	SAND	SAPH	SNEG	SPSA	SURF	WEGU	WESA	WHIM	Richness
April 24 & 26, 2010																							
Sand Plant			2																	2			1
Younger Lagoon			3														2			2			3
Natural Bridges	1											2					2						2
August 11-12, 2010																							
Sand Plant																							1
Younger Lagoon	2	1	10														4			32			9
Natural Bridges	1																			3			5
November 15 & 16, 2010																							
Sand Plant																				1			2
Younger Lagoon								15							11			1		4			9
Natural Bridges	4				2										140		1	1		17		1	11
February 15 & 16, 2011																							
Sand Plant			2																	6			2
Younger Lagoon																1							2
Natural Bridges		3	4					47									18			6		19	10
May 3 & 4, 2011																							
Sand Plant			4				2			35										5		1	7
Younger Lagoon																							0
Natural Bridges	7	4	4	1										1						16		7	12
July 22 & 23, 2011																							
Sand Plant										17							1			1			7
Younger Lagoon																							0
Natural Bridges			7							3				2			2			81		1	11
March 29 & 30, 2012																							
Sand Plant			5																				2
Younger Lagoon	1		8					13									2			16		2	9
Natural Bridges			10	3						2					65		2			10		5	9
May 15 & 16, 2012																							
Sand Plant																				4		5	2
Younger Lagoon	3		2					25		5				1			2			15			10
Natural Bridges			6														2						4
August 25 & 26, 2012																							
Sand Plant	3																						3
Younger Lagoon			4					35				8		1			1			7			10
Natural Bridges	5		1															1		5	1		6
November 5& 6, 2012																							
Sand Plant																				1			2
Younger Lagoon	5							14			1			4			2			3		10	9
Natural Bridges	4		9														2	1	2			12	7
January 13&14, 2013																							
Sand Plant																							0
Younger Lagoon								3	1						38	1	1						8
Natural Bridges																	1			11			4
May 1 & 2, 2013																							
Sand Plant										8										2			2
Younger Lagoon			3			2		9												11		2	8
Natural Bridges			4																	23		2	5
July 16-17, 2013																							
Sand Plant										7													4
Younger Lagoon	2		25					8		1							4						10
Natural Bridges	1																			10			7
October 22-23, 2013																							
Sand Plant																							2
Younger Lagoon	4			1				33									3			150		26	13
Natural Bridges			2														4			110		24	8
February 13-14, 2014																							
Sand Plant			2											1						103			4
Younger Lagoon								8									4			7		10	5
Natural Bridges			2														1			19		24	5
April 27-28, 2014																							
Sand Plant			6							4										24		2	6
Younger Lagoon	3		6							8			1							2		2	9
Natural Bridges	1		4																	18		7	11
July 30-31, 2014																							

Site	KILL	LOCU	MALL	MAGO	MEGU	MODO	NOHA	PECO	PIGR	PIGU	REHA	REPH	RWBB	RODO	SAND	SAPH	SNEG	SPSA	SURF	WEGU	WESA	WHIM	Richness
Sand Plant	4									3										25		2	8
Younger Lagoon	2		2							3							3			28		1	8
Natural Bridges	3														7					80		7	6
November 4-5, 2014																							
Sand Plant													2							3			4
Younger Lagoon															11		1			10		8	7
Natural Bridges	4														20		4	1		18			10
January 26-27, 2015																							
Sand Plant			2																	25			4
Younger Lagoon			4										10							27		1	7
Natural Bridges			2										9				2			175		3	10
April 14-15, 2015																							
Sand Plant			2							3										5			6
Younger Lagoon	1												5				2			5			6
Natural Bridges													4				3			21		9	7
July 8-9, 2015																							
Younger Lagoon	2		2							4							2			31			7
October 29-30, 2015																							
Younger Lagoon																				6			4
February 2-3, 2016																							
Younger Lagoon			3							2							3			9		4	7
May 3-4, 2016																							
Younger Lagoon	1		3										1					1		8			10
July 12, 2016																							
Younger Lagoon			3														1			2			7
November 9-10, 2016																							
Younger Lagoon	6												5							6			8
March 1-2, 2017																							
Younger Lagoon								1					6				1			2		1	10
April 25-26, 2017																							
Younger Lagoon			4										2							2		4	8
August 2-3, 2017																							
Younger Lagoon	1																						8
October 25-26, 2017																							
Younger Lagoon	6																1	1		10			7
February 7-8, 2018																							
Younger Lagoon	6												7							3			8
May 2-3, 2018																							
Younger Lagoon	4												9									2	8

Discussion

Data collected indicate that Younger Lagoon Reserve (YLR) supports a wide variety of native flora and fauna, provides habitat for sensitive and threatened species, supports a very unique beach dune community, and is extensively used for research and education.

A parameter that we have mapped, and is evident from visual observation and photo documentation, is the presence of dune hummocks and downed woody material at YLR, both of which are almost entirely absent at Sand Plant Beach and Natural Bridges (Figure 11). It is likely that the hummocks and woody material are absent at Natural Bridges and Little Wilder due to human trampling, collection, and burning. These features provide habitat for plant species such as the succulent plant dudleya, which grow on downed woody material and dune hummocks at YLR, as well as burrowing owls that use burrows in hummocks and seek shelter beneath downed woody material at YLR.

Although Younger Lagoon does experience human use, the intensity and number of users is small. Additionally, users of the YLR beach are educated about the reserve, unique natural features, and are not allowed to collect woody material or trample dune vegetation. The relatively natural state of YLR beach and dune vegetation is unique among the three sites and most pocket beaches in Santa Cruz County and likely represents a glimpse into what many of the pocket beaches in the greater Monterey Bay area looked like prior to significant human disturbance.

Open access to the beach would likely result in the loss of the unique ecological characteristics of the site and certainly reduce its effectiveness as a research area for scientific study. Controlled beach access through the Seymour Center docent led tours, provides an appropriate level of controlled access that enables people to see and learn about the lagoon habitat while limiting impacts to the system. We recommend that this continue.

Figure 9. Younger Lagoon dune map. Survey data and resulting elevation model output shows topographic features on Younger Lagoon Beach.

Literature Cited

Friends of Santa Cruz State Parks. Natural Bridges. Retrieved from http://thatsmypark.org/naturalBridges.php. Accessed December 10, 2010.

Friends of Santa Cruz State Parks. Wilder Ranch. Retrieved from http://thatsmypark.org/wilderRanch.php. Accessed December 10, 2010.

Hyland, Tim. Personal communication December 22, 2010.

University of California at Santa Cruz. 2008. Final Compiled Coastal Long Range Development Plan. Prepared for California Coastal Commission, December 2008.

University of California at Santa Cruz. 2010. Notice of Impending Development 10-1, Beach Access Management Plan. Prepared for California Coastal Commission, March 2010.

Appendix 1. Younger Lagoon Photos.


YLR Beach Photopoint #1. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #1. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #1. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #2. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s


YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #3. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

YLR Beach Photopoint #4. May 8, 2018. Photographer: Kyla Roessler. Camera: iPhone 5s

Fig 3.11 Biotic Resources

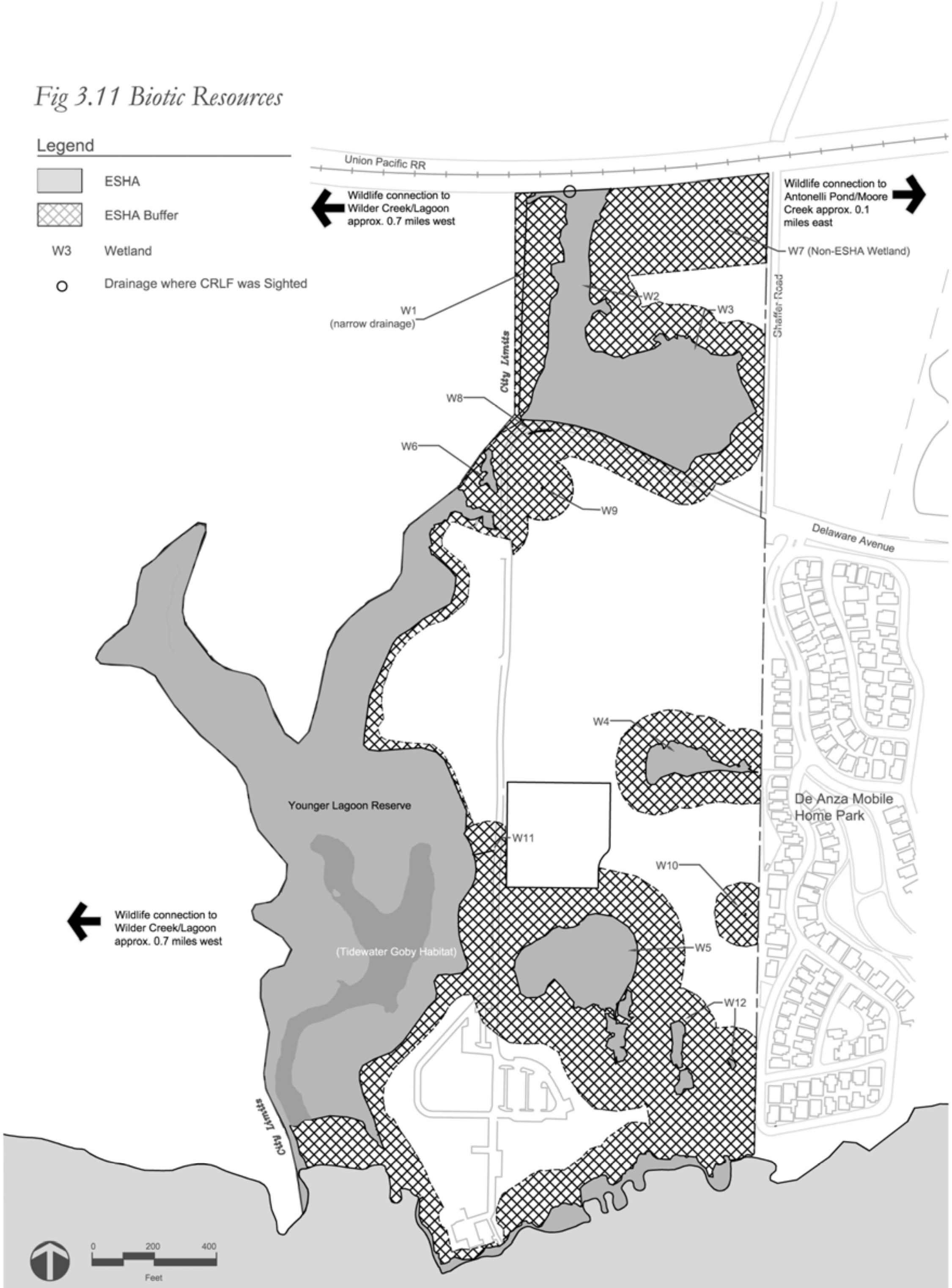

Exhibit 4
SCZ-NOID-0004-18
Page 1 of 2

Fig. 5.6 Coastal Access and Recreation Diagram

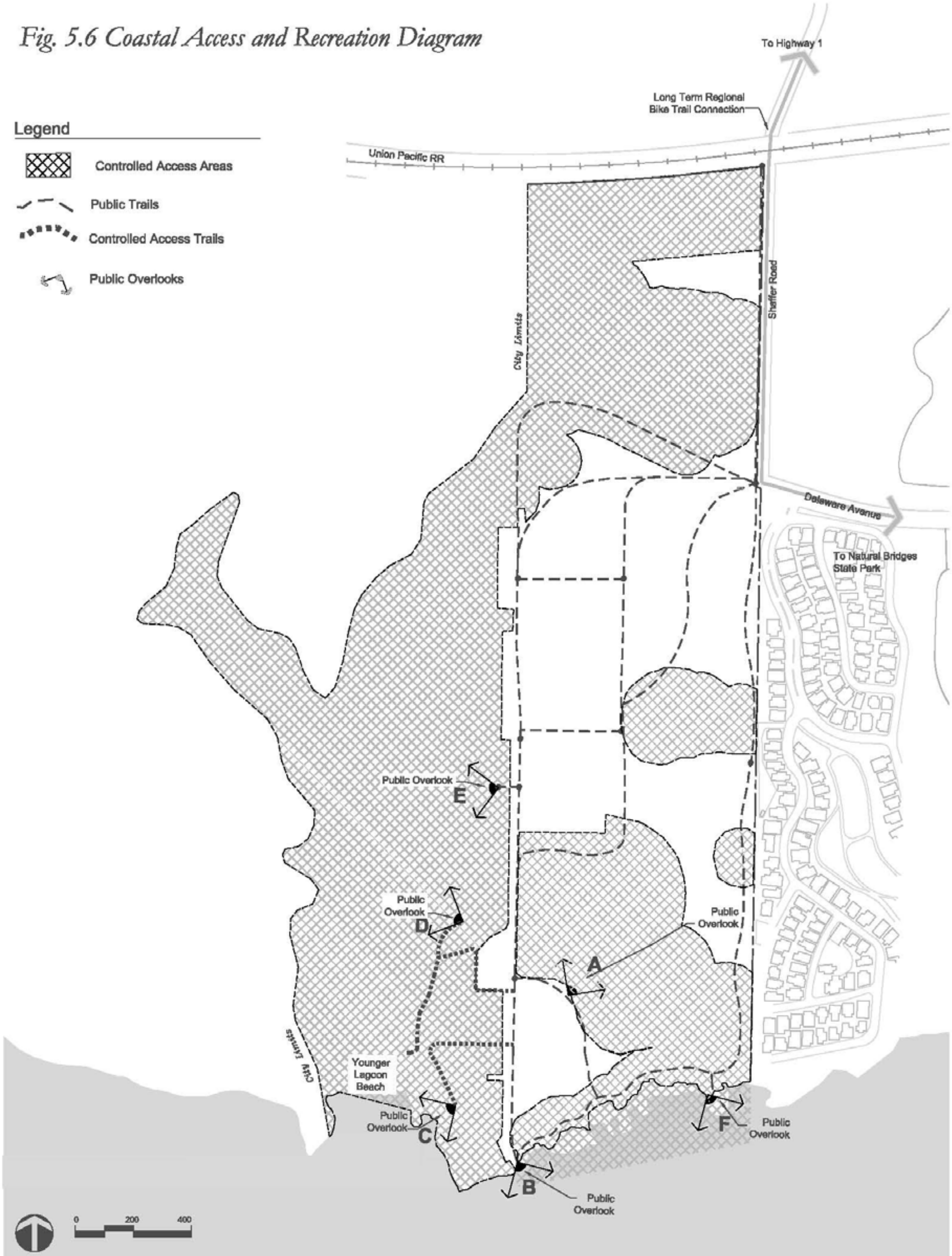

Exhibit 4
SCZ-NOID-0004-18
Page 2 of 2

CALIFORNIA COASTAL COMMISSION
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Th12a

Prepared September 10, 2018 for September 13, 2018 Hearing

To: Commissioners and Interested Persons

From: Susan Craig, Central Coast District Manager
Sarah Carvill, Coastal Planner

Subject: Additional hearing materials for Th12a
UCSC Notice of Impending Development Number SCZ NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan)

Where checked in the boxes below, this package includes additional materials related to the above-referenced hearing item as follows:

- [ ] Staff report addendum
- [X] Correspondence received since the staff report was distributed
- [ ] Additional ex parte disclosures received since the staff report was distributed
- [ ] Other

Carvill, Sarah@Coastal

From:	Kimberly Swan <KSwan@mbayaq.org>
Sent:	Friday, September 07, 2018 2:12 PM
To:	CentralCoast@Coastal
Cc:	Amy Wolfrum; Rita Bell; Elizabeth Howard
Subject:	Public Comment on September 2018 Agenda Item Thursday 12a - University of California Santa Cruz Notice of Impending Development SCZ-NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan, Santa Cruz)

On behalf of Monterey Bay Aquarium, I'm contacting you in support of agenda item Th12a, the University of California at Santa Cruz's Marine Science Campus Coastal Long Range Development Plan that includes Younger Lagoon.

Since 2006, over 550 high school students from Pajaro Valley Unified School District (PVUSD) have participated in Watsonville Area Teens Conserving Habitats (WATCH), a year-long field-based research program co-taught by PVUSD faculty and Monterey Bay Aquarium educators. Many of these students have been Latino, first generation students who have a limited experience with the environment. Beginning in 2014, WATCH students from Aptos High School began conducting field research investigations at Younger Lagoon. The reserve staff and volunteers provide guidance, equipment and expertise as the students develop their own testable questions, design their investigations and gather and analyze data in the Lagoon. This unique ecosystem provides a fantastic location for students to conduct experiments, carry out long-term scientific monitoring projects, and learn about this unique natural space that has limited impact from the public.

We truly appreciate the access and resources that the staff of Younger Lagoon has provided for the students of the Monterey Bay Aquarium's WATCH program. The experience the students receive at Younger Lagoon and support from the staff are critical elements to the success of WATCH. Thank you for your consideration.

Sincerely,

Kim Swan
Teen Programs Manager
Monterey Bay Aquarium

Kimberly Swan
Teen Programs Manager
P 831-647-6852 M 831-402-9014 F 831-855-1461

Monterey Bay Aquarium
886 Cannery Row, Monterey, CA 93940
www.montereybayaquarium.org
Our mission is to inspire conservation of the ocean.

Carvill, Sarah@Coastal

From: Kevin Condon <kevcomail@gmail.com>
Sent: Friday, September 07, 2018 1:41 PM
To: CentralCoast@Coastal
Subject: Public Comment on September 2018 Agenda Item Thursday 12a - University of California Santa Cruz Notice of Impending Development SCZ-NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan, Santa Cruz)

Dear Coastal Commission,
My name is Kevin Condon and I am Executive Director of a small non profit in Santa Cruz, California called The Bird School Project. I am writing to comment on how important the beach at Younger Lagoon Reserve has been to me as an avid birder, as well as to our small organization.
Each quarter The Bird School Project trains staff and interns at the Younger Lagoon bird banding station and at the overlook to Younger Lagoon. The observations we are able to make from inside the protected area of the beach and lagoon are invaluable. There are always birds, coyotes, bobcats, and more importantly, all sorts of undisturbed evidence of these creatures in the protected area. We just can't find that type of natural history in areas that aren't protected. The protected area of Younger Lagoon Reserve has served as an amazing resource for outdoor science education and natural history and our organization intends to grow its use of the space with the many classrooms we work with throughout the year. Thank you for reading my comment. I hope you will take it into consideration when dealing with decision making around the use of the reserve and protected space. I think it is a very valuable resource as a protected space.

Thank you,
Kevin

Kevin Condon
Co-founder of The Bird School Project
(858) 525-2147
www.birdschoolproject.org

Carvill, Sarah@Coastal

From:	ben.a.wasserman@gmail.com on behalf of Ben Wasserman <bawasser@ucsc.edu>
Sent:	Friday, September 07, 2018 10:05 AM
To:	CentralCoast@Coastal
Cc:	Elizabeth Howard; Eric Palkovacs
Subject:	Public Comment on September 2018 Agenda Item Thursday 12a - University of California Santa Cruz Notice of Impending Development SCZ-NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan, Santa Cruz)

Dear Commissioners,

My name is Ben Wasserman. I'm a PhD Candidate at UC Santa Cruz. I'd like to comment on how critical Younger Lagoon Natural Reserve is to my research. For my thesis, I study the evolutionary ecology of threespine stickleback, a native fish, in bar-built estuaries such as Younger Lagoon. While there are may such lagoons on the landscape, Younger Lagoon is the only one near to UC Santa Cruz that is in a protected research reserve. This has allowed me opportunities to understand the ecology of Younger in a way that isn't possible in other sites. The lagoon staff maintains a weather station and water quality monitoring equipment that give me access to more data than at other sites. The limited public access down at the beach has allowed me to set up experimental enclosures inside the lagoon to test my hypothesis about stickleback evolution in the wild. I would not be able to run such experiments in the other lagoons I work at, which are almost entirely on public land, because the enclosures would be easily accessible to public visitors and may be disturbed. Two of the four chapters of my thesis focus exclusively on Younger Lagoon's population of stickleback. Since I can do more in-depth research at Younger Lagoon Reserve, these two chapters chapters help me explain the patterns I see across the landscape in the other two chapters.

The proximity of the Younger Lagoon Natural Reserve to the Long Marine Lab has made it particularly easy for me to include undergraduate students, including many from historically underrepresented groups in my field research. In this way I'm able to help introduce students to all aspects of ecological research. In addition, I've helped high school students from two programs, Watsonville Area Teens Conserving Habitat (WATCH), which is run by the Monterey Bay Aquarium, and the UC Santa Cruz Science Internship Program (SIP), utilize the reserve for their own research projects. These experiences have been formative for many students, including inspiring students to pursue careers in the sciences. I think these programs are wonderful and I'm glad that the Natural Reserve is able to support them.

The protected outdoor research facility at Younger Lagoon Natural Reserve has been a core part of my graduate education. At the Reserve I have touched on every aspect of my work: research, mentorship, teaching, and outreach. I look forward to continuing to do so.

Sincerely,

Ben Wasserman
PhD Candidate - Palkovacs Lab
Department of Ecology and Evolutionary Biology
University of California at Santa Cruz
Coastal Biology Building
130 McAllister Way
Santa Cruz, CA 95060
O: (831) 502-8694
C: (516) 286-4015
bawasser@ucsc.edu

Carvill, Sarah@Coastal

From: Eric Palkovacs <epalkova@ucsc.edu>
Sent: Friday, September 07, 2018 8:29 AM
To: CentralCoast@Coastal
Cc: Elizabeth Howard
Subject: Public Comment on September 2018 Agenda Item Thursday 12a - University of California Santa Cruz Notice of Impending Development SCZ-NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan, Santa Cruz)

Dear Coastal Commission,

Younger Lagoon Reserve (YLR) is an important research facility for scientists at the University of California, Santa Cruz and beyond. My own research in YLR examines how environmental variation impacts the ecology of bar-built estuaries. These ecosystems are unique to California. We have much to learn about how they are responding to environmental changes such as droughts, rising sea levels, and increasing temperatures. Limiting public access to docent-led tours at YLR is very important for the research value of this reserve because it allows us to deploy instrumentation and conduct in-situ experiments that are impossible at other sites.

The research being conducted at YLR is important for understanding and managing bar-built estuaries all along the California coast. Docent-led tours allow the public to access the reserve in a way that protects research infrastructure and ongoing studies, allows research to be described and interpreted so the public can understand its value, and protects the integrity of the ecosystem itself. Increased and unsupervised public access would endanger the value of YLR as an outdoor laboratory for research and education.

Sincerely,

Eric Palkovacs

--
Eric Palkovacs
Associate Professor
Department of Ecology & Evolutionary Biology
University of California-Santa Cruz
Ph: 831-502-7387
Email: epalkova@ucsc.edu

Carvill, Sarah@Coastal

From: Alison Young <ayoung@calacademy.org>
Sent: Friday, September 07, 2018 7:33 AM
To: CentralCoast@Coastal
Subject: Public Comment on September 2018 Agenda Item Thursday 12a - University of California Santa Cruz Notice of Impending Development SCZ-NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan, Santa Cruz)

The California Academy of Sciences Citizen Science Department has partnered with the University of California Santa Cruz Younger Lagoon Reserve for the past three years (2016-2018) to hold annual public bioblitzes at the Younger Lagoon. This allows the public to come to the Younger Lagoon and gather biodiversity data by taking photos of organisms via the iNaturalist app. Groups are sent to particular areas of the site, with a group leader, to document as many species as they can in that area over a period of 2-3 hours. Bioblitzes provide interested members of the public a chance to explore the Younger Lagoon with an experienced naturalist, learn more about the biodiversity that can be found there, and contribute to science and conservation by gathering data about the species that occur on the Reserve.

Thank you,
Alison Young & Dr. Rebecca Johnson, Co-Directors, Citizen Science, California Academy of Sciences

--
Alison Young
Citizen Science
California Academy of Sciences
p. 415.379.5807
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Carvill, Sarah@Coastal

From:	Sabrina Shirazi <sashiraz@ucsc.edu>
Sent:	Friday, September 07, 2018 12:22 AM
To:	CentralCoast@Coastal
Subject:	Public Comment on September 2018 Agenda Item Thursday 12a - University of California Santa Cruz Notice of Impending Development SCZ-NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan, Santa Cruz)

Hello,

My name is Sabrina Shirazi, and I am a PhD student at UC Santa Cruz in the Ecology and Evolutionary Biology Department. I use environmental DNA to study past and current environments- their compositions, biotic interactions, and associations with abiotic factors. The majority of this work is in collaboration with CaleDNA, a large project that aims to assess the biodiversity and distribution of life across California by having Citizen Scientists collect 17,000 soil samples across the state.

Working with Younger Lagoon Reserve over the past year has been an amazing experience. The reserve provides me protected study sites of known history and material resources for field work. The staff have made themselves available at all requests where their expertise on the reserve aided in data collection and project design. And they helped organize a joint bioblitz/ CaleDNA sample collection day, attracting over fifty people from the local community. At this joint event, we brought citizen scientists onto the beach, into the lagoon, and across the terrace to collect soil samples and record iNaturalist observations. Managing the movement of so many people across a protected reserve is not an easy task, yet the Reserve staff did it with organization and ease.

Younger Lagoon Reserve has my full support and gratitude. I am excited to continue my work there and I look forward to tracking its developments.

Sabrina

Carvill, Sarah@Coastal

From:	Allison Gong <algong@cabrillo.edu>
Sent:	Thursday, September 06, 2018 1:22 PM
To:	CentralCoast@Coastal
Subject:	Public Comment on September 2018 Agenda Item Thursday 12a - University of California Santa Cruz Notice of Impending Development SCZ-NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan, Santa Cruz)

To Whom It May Concern:

I am a Biology professor at Cabrillo College in Aptos, CA. I take students to Younger Lagoon for various class activities, including vegetation restoration and bird banding in the terrace lands. Every year I take students down to the beach for a community Bioblitz to document biodiversity.

Sincerely,

Allison

****

Dr. Allison J. Gong
Biology Department
Cabrillo College
algong@cabrillo.edu
831-477-3700 x1476

CALIFORNIA COASTAL COMMISSION
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Th12a

Prepared September 11, 2018 for September 13, 2018 Hearing

To: Commissioners and Interested Persons

From: Susan Craig, Central Coast District Manager
Sarah Carvill, Coastal Planner

Subject: Additional hearing materials for Th12a
UCSC Notice of Impending Development Number SCZ NOID-0004-18 (Younger Lagoon Reserve Beach Public Access Plan)

Where checked in the boxes below, this package includes additional materials related to the above-referenced hearing item as follows:

- [ ] Staff report addendum
- [ ] Correspondence received since the staff report was distributed
- [X] Ex parte disclosures received since the staff report was distributed
- [ ] Other

RECEIVED
SEP 11 2018

EX PARTE COMMUNICATION DISCLOSURE FORM

Filed by Commissioner: Carole Groom

1) Name or description of project: Th12a - SCZ-NOID-0004-18 (Santa Cruz)

2) Date and time of receipt of communication: Sept. 10, 2018 at 12 p.m.

3) Location of communication: Phone call

(If not in person, include the means of communication, e.g., telephone, e-mail, etc.)

4) Identity of person(s) initiating communication: Beth Howard, Gage Dayton

5) Identity of person(s) on whose behalf communication was made: Younger Lagoon Reserve & UC Santa Cruz Natural Reserves

6) Identity of persons(s) receiving communication: Carole Groom

7) Identity of all person(s) present during the communication: Gage Dayton, Beth Howard, Carole Groom

Complete, comprehensive description of communication content (attach complete set of any text or graphic material presented):

The representatives of Younger Lagoon Reserve indicated that in the 2017 NOID, they made changes as per the Coastal Commission's request to increase tours from 24 to 38 in a year as well as free tours for kids. They consider the five conditions recommended currently to be excessive. The Seymour Marine Discovery Center runs the tours and there is a capacity issue regarding the ability to do tours and offer them for free to everyone.

Sept 10 2018
Date

Carole Groom
Signature of Commissioner

TIMING FOR FILING OF DISCLOSURE FORM: File this form with the Executive Director within seven (7) days of the ex parte communication, if the communication occurred seven or more days in advance of the Commission hearing on the item that was the subject of the communication. If the communication occurred within seven (7) days of the hearing, provide the information orally on the record of the proceeding and provide the Executive Director with a copy of any written material that was part of the communication. This form may be filed with the Executive Director in addition to the oral disclosure.

Appendix 6. SRP Phase 1 Summary Report

University California, Santa Cruz

Younger Lagoon Reserve

Specific Resource Plan Phase 1 Summary Report

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Figures

Tables

Appendices

Executive Summary

Over the past seven years, Younger Lagoon Reserve has successfully implemented Phase 1 of the Specific Resource Plan for the Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve. Nearly all Priority 1 weeds have been eliminated from the Terrace Lands. Over ten acres have been planted with native species. Nearly all of those plantings are meeting or exceeding their success criteria targets. Upper terrace wetland reconnection work has been completed. In addition, teaching, research, and public service was incorporated into every aspect of SRP Phase 1 implementation.

Introduction

This report provides a summary of the activities that were conducted at Younger Lagoon Reserve (YLR) during Phase 1 of the Specific Resource Plan for the Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve (SRP). The Resource Management Plan (RMP) within the Coastal Long Range Development Plan (CLRDP) provides a broad outline with general recommendations and specific guidelines for resource protection, enhancement, and management of all areas outside of the mixed-use research and education zones on the Coastal Science Campus (CSC) site (areas that will remain undeveloped). In addition to resource protection, the CLRDP requires extensive restoration, enhanced public access/education opportunities on site, and extensive monitoring and reporting requirements. The entire project is to be completed over 20 years and, as a condition of inception into the University of California Natural Reserve System, UCSC Campus has committed to providing perpetual funding for the project and continued management of YLR.

The SRP for Phase 1A of restoration (first 7 years) was approved by the CCC in September 2010 (NOID 3, 10-2). The SRP for Phase 1B of restoration (upper terrace wetland work) was approved by the CCC in July 2013 (NOID 6, 13-1). Phase 1A projects included Priority 1 weed removal, re-vegetation, baseline monitoring and selection of reference systems. Phase 1B projects included work in wetland areas, including the reconnection of upper terrace wetlands 1 and 2.

The SRP for Phase 1A and 1B of restoration outlined detailed success criteria for each of the reserve's habitat types (Ruderal, Coyote Brush Grassland-Scrub, and Grassland, Coastal Bluffs, Wetlands, and Wetland Buffers). These criteria set an initial threshold of species richness and cover for specific habitat types throughout the restoration area. These criteria were further refined at the recommendation of the Scientific Advisory Committee (SAC, see Appendix 1) based on results from reference site monitoring of local coastal terrace prairie grassland, seasonal wetland, and coastal scrub sites (See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016 and 2016-2017 Annual Reports).

Phase 1A Summary

Over ten acres of the Terrace Lands were planted with native species in Phase 1A (Table 1. Figure 1). Phase 1A restoration sites were located primarily in the middle and lower terrace, although some work also took place in the upper terrace. In addition to native plantings, there are 6.25 acres of native vegetation - primarily coyote brush (*Baccharis pilularis*) and Douglas' baccharis (*Baccharis glutinosa*) on the site.

Table 1. Native Acreage

Habitat type	**Acres planted**
Coastal Prairie	5.6
Coastal Scrub	4
Wetlands	.64
Research	1.2
Total	10.32

Figure 1. SRP Phase 1A Restoration Sites.

Year 0 (2010)

The SRP for Phase 1A was approved in September 2010. Restoration activities during this year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 0.5 acres of coastal bluff habitat (Figure 2).

Figure 2. SRP Phase 1A Planting Areas, 2010.

Year 1 (2011)

Restoration activities during the first full year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 1 acre of coastal prairie habitat (Figure 3).

Figure 3. SRP Phase 1A Planting Areas, 2011.

Year 2 (2012)

Restoration activities during the second full year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 1.5 acres of grassland, scrub, and wetland buffer habitat (Figure 4).

Figure 4. SRP Phase 1A Planting Areas, 2012.

Year 3 (2013)

Restoration activities during the third full year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 1 acre of coastal prairie and scrub habitats (Figure 5).

Figure 5. SRP Phase 1A Planting Areas, 2013.

Year 4 (2014)

Restoration activities during the fourth full year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 1.15 acres of coastal prairie and scrub habitats (Figure 6).

Figure 6. SRP Phase 1A Planting Areas, 2014.

Year 5 (2015)

Restoration activities during the fifth full year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 1 acre of coastal prairie and scrub habitat (Figure 7).

Figure 7. SRP Phase 1A Planting Areas, 2015.

Year 6 (2016)

Restoration activities during the sixth full year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 1.9 acres of grassland, scrub, and wetland habitats (Figure 8).

Figure 8. SRP Phase 1A Planting Areas, 2016.

Year 7 (2017)

Restoration activities during the final year of SRP Phase 1A implementation included priority 1 weed removal, seed collection, and planting of 1 acre of coastal prairie and scrub habitats (Figure 9).

Figure 9. SRP Phase 1A Planting Areas, 2017.

Monitoring

The SRP for Phase 1A of restoration outlined detailed success criteria for each of the reserve's habitat types (Ruderal, Coyote Brush Grassland-Scrub, and Grassland, Coastal Bluffs, Wetlands, and Wetland Buffers). These criteria set an initial threshold of species richness and cover for specific habitat types throughout the restoration area. These criteria were further refined at the recommendation of the SAC based on results from reference site monitoring of local coastal terrace prairie grassland, seasonal wetland, and coastal scrub sites. Final success criteria for each habitat are summarized below (Table 2).

Table 2**.** Final SRP Phase 1A success criteria

Habitat type	**Performance standard**
Coastal Bluffs	8 native plant species appropriate for habitat established in planted areas to comprise 40% cover, and evidence of natural recruitment.
Coastal prairie	8 native plant species appropriate for habitat established in planted areas to comprise 25% cover, and evidence of natural recruitment.
Scrub	8 native plant species appropriate for habitat established in planted areas to comprise 40% cover, and evidence of natural recruitment.
Wetlands (except W 1/2)	4 native plant species appropriate for habitat established in planted areas to comprise 30% cover, and evidence of natural recruitment.
Wetland 1/2 Complex	3 native plant species appropriate for habitat established in planted areas to comprise 30% cover, and evidence of natural recruitment.

All plantings are meeting or exceeding the performance standards except for the 2011 coastal prairie site (Table 3 and See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016 and 2016-2017 Compliance Monitoring Reports). This site met the performance standards initially, and continues to meet the species richness and natural recruitment targets, but has fallen below the 25% percent native cover target (Table 3). Coastal prairie is notoriously difficult to restore and maintain. In addition, the 2011 site was impacted by construction and drought. The SAC recommended monitoring this site (and any others that fall below target) once a year rather than every other year, and replanting or changing management regimes it does not rebound.

Table 3. Coastal Prairie Restoration Site Performance

Years post planting	**Goal**	2010 Planting	2011 Planting	2013 Planting	2014 Planting	2015 Planting
2 years after planting	6 or more native plant species established comprising ≥ 5% cover and evidence of natural recruitment present	12 native plant species established, 58% native cover, recruitment observed. (2012 Monitoring)	14 native plant species established, 28% native cover, recruitment observed. (2013 Monitoring)	6 native plant species established, 29% native cover, recruitment observed. (2015 Monitoring)	9 native plant species established, 42% native cover, recruitment observed. (2016 Monitoring)	9 native plant species established, 56% native cover, recruitment observed. (2017 Monitoring)
4 years after planting	6 or more native plant species established comprising ≥ 15% cover and evidence of natural recruitment present	8 native plant species established, 39% native cover, recruitment observed. (2014 Monitoring)	6 native plant species established, 31% native cover, recruitment observed. (2015 Monitoring)	8 native plant species established, 24% native cover, recruitment observed. (2017 Monitoring)		
6 years after planting and every 5 years after that	8 or more native plant species established comprising ≥ 25% cover and evidence of natural recruitment present	10 native plant species established, 26% native cover, recruitment observed. (2016 Monitoring)	10 native plant species established, 18% native cover, recruitment observed. (2017 Monitoring)			

Phase 1B

Reconnection of Wetlands W1 and W2:

The Resource Management Plan within the CLRDP requires the reconnection of Upper Terrace wetlands W1 and W2. Wetland W1, on the western margin of the Upper Terrace, is a former agricultural ditch, probably constructed to drain the adjacent agricultural field. It is separated from wetland W2 (located immediately to the east) by a slightly elevated berm that may partially represent spoils left from the ditch construction.

To reconnect hydrology between W1 and W2, five brush packs (ditch plugs) were installed within W1 in the summer of 2016 and 2017 (Figure 10). Two ditch plugs were installed on the upstream end and constructed at a height to allow for the detention of water to back up and flow through over the berm to W2 but also allow flows to continue downstream to the remaining ditch plugs. Three brush packs were installed on the downstream end and also constructed at a height to allow for the detention of water but also to allow flows to continue downstream through W1. The brush packs were constructed from wooden stakes, biodegradable rope, and coyote brush slash found on-site. The brush packs range between, 13-20' long x 24-31" high x 20-28" wide. (Figure 11).

No native plantings were initiated with the instillation of the brush packs. As the hydrology of the site begins to shift to become more favorable to wetland plants, native wetland plants will be installed on the site.

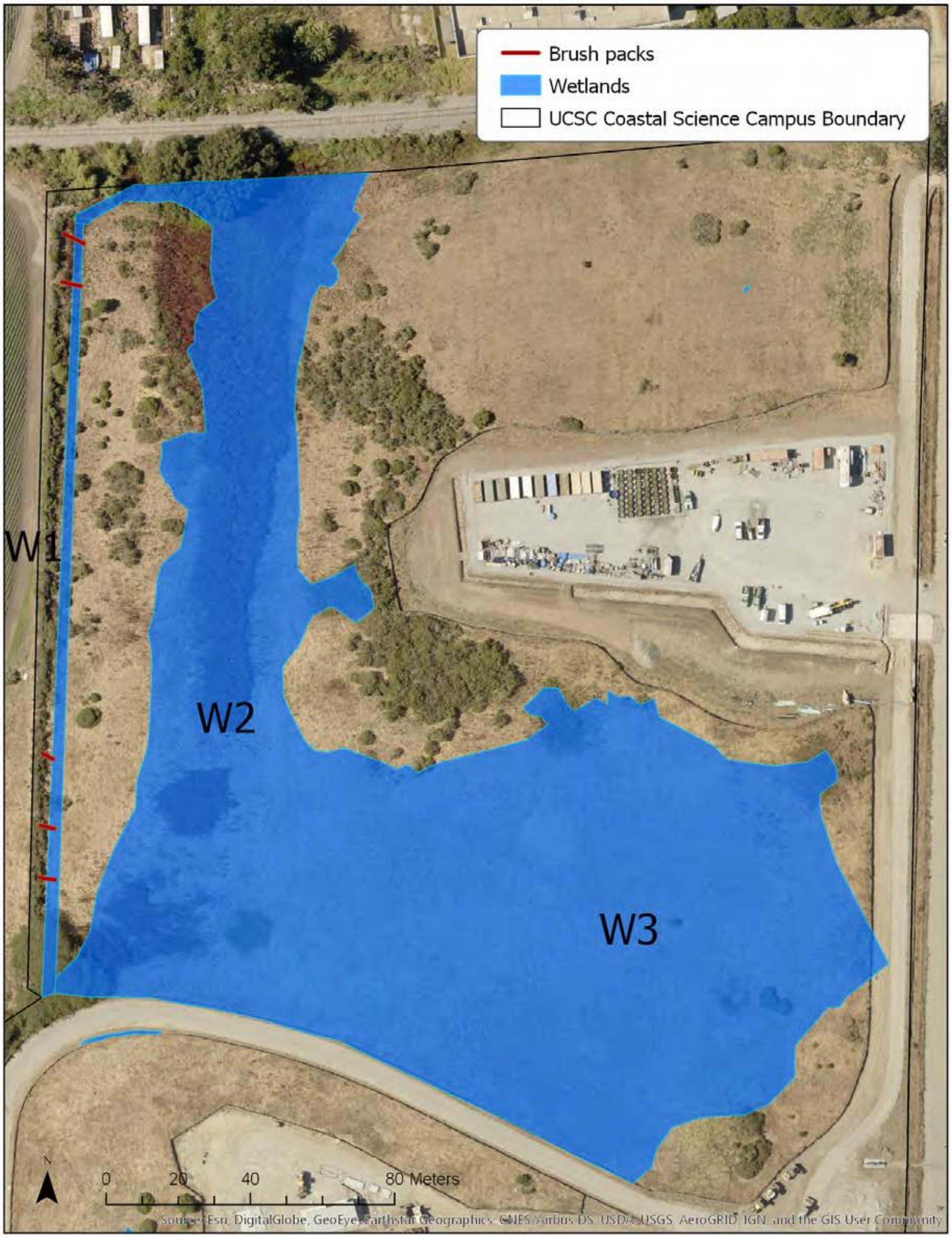

Figure 10. Upper terrace wetland reconnection work. Brush pack locations shown in red.

Figure 11. Northern brush packs after installation, summer 2017.

Monitoring

All of the brush packs are intact and functioning as designed (Figure 12 and See 2016-2017 Annual Report). Although not yet observed, the ditch plugs may create small open water pool habitat and potentially provide new breeding habitat for amphibians.

Figure 12. Northernmost brush pack during a winter storm, January 2018.

SAC Recommendations

Scientific Advisory Committee (SAC) Meetings / Recommendations

Creation and implementation of the Specific Restoration Plan (SRP) for Phase 1 of Restoration was guided by a Scientific Advisory Committee (SAC). The SAC is comprised of four members: Dr. Karen Holl (SAC chair) Professor Environmental Studies at UCSC; Tim Hyland, Environmental Scientist, State Parks, Santa Cruz District; Bryan Largay, Conservation Director, Land Trust of Santa Cruz County; and Dr. Lisa Stratton, Director of Ecosystem Management, Cheadle Center for Biodiversity and Ecological Restoration, University of California, Santa Barbara (UCSB). SAC members met as a group with reserve staff on-site throughout Phase 1 of

Restoration. At their May 2018 meeting, SAC members discussed 1) the outcome of the SRP for Phase 1A and 1B and 2) goal setting/planning for the SRP for Phase 2 of restoration.

The SAC was pleased with the results of Phase 1 of the Specific Resource Plan for the Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve. The SAC recommended keeping all of the success criteria used in Phase 1 for Phase 2 efforts. In response to two of the coastal prairie restoration sites falling below native cover targets, the SAC recommended monitoring these sites (and any others that fall below target) once a year rather than every other year, and replanting or changing management regimes if the sites do not rebound.

Conclusion

Over the past seven years, Younger Lagoon Reserve has successfully implemented Phase 1 of the Specific Resource Plan for the Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve. Nearly all Priority 1 weeds have been eliminated from the Terrace Lands. Over 10 acres have been planted with native species. Nearly all of those plantings are meeting or exceeding their success criteria targets. Upper terrace wetland reconnection work has been completed. In addition, teaching, research, and public service was incorporated into every aspect of SRP Phase 1 implementation. We look forward to the successful implementation of Phase 2 of the Specific Resource Plan for the Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve.

Appendix 1 Younger Lagoon Reserve Scientific Advisory Committee (SAC)

Charge

As outlined in the in the CLRDP, restoration, enhancement, and management activities on the Marine Science Campus will be guided by a Scientific Advisory Committee (SAC) that is made up of independent professionals and academicians experienced in and knowledgeable about the habitats of the natural areas on the Marine Science Campus. The SAC shall guide the development of Specific Resource Plans, which shall be consistent with the performance standards set forth in the Resource Management Plan (RMP), and which may be adapted periodically based on findings from ongoing restoration work. The RMP goals and performance standards may be adjusted as directed by the SAC in coordination with the Executive Director to ensure the success of Campus restoration, enhancement, and management efforts. As such, the RMP goals and performance standards are not static requirements per se so much as initial guidelines that may be refined during the SAC process so long as such refinement is consistent with current professional restoration, enhancement, and management goals and standards, and with achieving high quality open space and natural habitat area in perpetuity consistent with this CLRDP. RMP adjustments in this respect may require a CLRDP amendment, unless the Executive Director determines that an amendment is not necessary.

The committee provides guidance for the restoration, enhancement, and management efforts at YLR, and collaborates with YLR staff on the creation and implementation of the Specific Resource Plan as outlined in CLRDP Implementation Measure 3.2.10 (below).

Implementation Measure 3.2.10 – Natural Areas Habitat Management. *Within six (6) months of CLRDP certification, the University in consultation with the Executive Director of the California Coastal Commission shall convene a scientific advisory committee (SAC) to guide the restoration, enhancement, and management of natural areas (i.e., all areas outside defined development zones, except for Younger Lagoon Reserve) on the Marine Science Campus (see Appendix A). Natural areas restoration, enhancement, and management may be completed in up to three phases corresponding to dividing the natural area into thirds (i.e., where Phase 1 accounts for at least one-third of the natural area, Phase 1 plus Phase 2 accounts for at least* *two thirds, and all of the three phases together account for all of the natural area). All restoration, enhancement, and management activities shall be guided by Specific Resource Plans developed by the University in accordance with the SAC and the criteria contained in the Resource Management Plan (Appendix A) and current professional standards for such plans. The SAC shall be responsible for guiding development of Specific Resource Plans and shall complete its work on the Specific Resource Plan for Phase I restoration and enhancement efforts within four (4) months of convening. The content of Specific Resource Plans shall be consistent with the performance standards set forth in Appendix A, which may be adapted periodically based on findings from ongoing restoration work. The University shall file a Notice of Impending Development for Phase I work within one (1) year of CLRDP certification. All natural areas restoration and enhancement shall be completed within 20 years of CLRDP certification, with interim benchmarks that at least one-third of the restoration and enhancement shall be completed within seven years of CLRDP certification and that at least two-thirds shall be completed within 14 years of CLRDP certification.*

The SAC was seated in January 2009. In addition to the chair, membership of the committee is comprised of three independent professionals and academicians experienced in and knowledgeable about the habitats of the natural areas on the Marine Science Campus. Brief bios of the four SAC members are below.

Dr. Karen Holl- Professor, Environmental Studies, University of California at Santa Cruz (UCSC).

Dr. Karen Holl has been on the faculty in the Environmental Studies Department at the University of California, Santa Cruz for over 15 years. She has conducted research on restoration ecology in a wide variety of ecosystems, including tropical rain forests, eastern hardwood forests, chaparral, grassland, and riparian systems in California. She has published over 50 journal articles and book chapters on restoring damaged ecosystems and is on the editorial board of the journal Restoration Ecology. She teaches the Restoration Ecology class at UCSC and supervises many of the undergraduate students who work on the UCSC Natural Reserves. She regularly advises numerous public and private agencies along the Central

California Coast on land management issues. She recently was selected as an Aldo Leopold Leadership Fellow. Dr. Holl's expertise in restoration ecology, experimental design and data analysis, as well as her affiliation with UCSC and her excellent rapport with University students and staff make her an irreplaceable member of the Scientific Advisory Committee.

Dr. Holl received a Ph.D. in Biology from Virginia Polytechnic Institute and State University, and a Bachelors degree in Biology from Stanford University.

Tim Hyland - Environmental Scientist, State Parks, Santa Cruz District.

Mr. Hyland has worked in the field of wildlands restoration for over 15 years. Much of his work has focused on coastal scrub, dune, and wetland restoration at sites throughout the Central Coast, including Wilder Ranch State Park (located approximately one mile west of YLR). He has extensive experience in restoration planning and implementation, vegetation mapping, exotic species control, and native plant propagation. In addition, Mr. Hyland is highly skilled in public education and outreach. His long tenure with California State Parks and direct experience in designing and implementing large-scale restoration projects make him a valuable member of the Scientific Advisory Committee.

Mr. Hyland has a B.A. from California Polytechnic State University, San Luis Obispo.

Bryan Largay – Conservation Director, Land Trust of Santa Cruz County.

Mr. Largay has worked in the fields of hydrology, water quality, and wetlands for fourteen years with a focus on restoration and wildlife habitat. He has conducted wetland restoration, watershed hydrology, and water quality investigations and designed measures to control erosion and treat water quality problems using vegetation. Much of his work has focused on collaborative water quality protection projects with agricultural landowners and growers. He has worked to solve water resource problems with a broad array of individuals, including scientists, planners, engineers, growers, private landowners, and contractors. Prior to joining the staff of The Land Trust of Santa Cruz County, he worked as the Tidal Wetland Project Director at

Elkhorn Slough National Estuarine Research Reserve (ESSNER) and participated in the Tidal Wetland Project as a member of the Science Panel and Model Advisory Team. Mr. Largay's experience working on complex, large-scale restoration projects with agricultural neighbors in a non-profit setting make him a very important addition to the Scientific Advisory Committee.

Mr. Largay received an M.S. in Hydrologic Sciences at U.C. Davis, and a Bachelor's degree at Princeton University.

Dr. Lisa Stratton - Director of Ecosystem Management, Cheadle Center for Biodiversity and Ecological Restoration, University of California, Santa Barbara (UCSB).

Dr. Lisa Stratton has worked in the field of science-based restoration for over 15 years. She has extensive experience in restoration planning and implementation in conjunction with campus construction projects. Much of her work at UCSB has focused on involving students and faculty in the Cheadle Center's restoration projects. Dr. Stratton's work at the UCSB has provided her with a rare understanding of some of the unique challenges and opportunities YLR staff face as they undertake the restoration project at YLR. Her combined experience in wildlands restoration and management, scientific research, and working within the University of California system make her a very important member of the Scientific Advisory Committee.

Dr. Stratton received a Ph.D. in Botany and Ecology from the University of Hawai'i, a M.S. in Conservation Biology and Sustainable Development from the University of Wisconsin-Madison, and a Bachelors degree in Comparative Literature from Stanford University

Appendix 7. SRP Phase 2

Specific Resource Plan

Phase 2

Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve

December 30, 2018

This document was a collaborative effort among UCSC Staff and the Younger Lagoon Reserve Scientific Advisory Committee.

Scientific Advisory Committee Members

Karen Holl, Ph.D. (Committee Chair)

Tim Hyland

Bryan Largay, M.S.

Lisa Stratton, Ph.D.

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INTRODUCTION

On January 7, 2009 the California Coastal Commission (CCC) certified UCSC's Coastal Long Range Development Plan (CLRDP) for its Coastal Sciences Campus (CSC). The CLRDP is a comprehensive physical development and land use plan that governs development, land use and resource protection at the CSC, including Younger Lagoon Reserve (YLR).

The CLRDP states that all "natural areas" outside of the Campus Development Zone on the CSC are to be incorporated into Younger Lagoon Reserve, restored, and preserved in perpetuity (CLRDP 2009). On July 24, 2008 the University of California Natural Reserve System (UCNRS) and UCSC Campus Administration signed an agreement incorporating the approximately 47 ac (19 ha) of natural areas (CLRDP 2009) into the University of California Natural Reserve System (UCNRS) as part of UCSC's Younger Lagoon Reserve (YLR now encompasses approximately 72 ac [29 ha]). These additional natural areas are collectively referred to as the Terrace Lands. The agreement outlines the commitment by the NRS and campus to comply with restoration, management, and research on all YLR lands.

The Resource Management Plan (RMP) within the CLRDP provides a broad outline with general recommendations and specific guidelines for resource protection, enhancement, and management of all areas outside of the mixed-use research and education zones on the CSC site (areas that will remain undeveloped). A critical component of the CLRDP is the creation of a Specific Resource Plan (SRP) for each phase of restoration guided by a Scientific Advisory Committee (SAC). Thus, the intent of the RMP is for the SAC to use it as an initial framework for development of a more detailed SRP for implementation. The subsequent SRP's may be adapted to address current physical and ecological conditions, current understanding of biological and ecological processes, and current approaches to habitat re-vegetation, restoration, and enhancement. Although the SRP's are meant to be consistent with the performance standards set forth in the RMP, they may be adapted periodically based on findings from ongoing restoration work or input from the SAC. As such, the RMP goals and performance standards are not static requirements per se so much as initial guidelines that may be refined during the SAC process so long as such refinement is consistent with current professional restoration, enhancement, and management goals and standards, and with achieving high quality open space and natural habitat in perpetuity and consistent with the CLRDP.

Although the SRP's provide specific methodology and criteria for restoration and enhancement of the Terrace Lands within YLR it is important to note that other education and research endeavors will occur throughout YLR. These education, research, and outreach projects are concurrent with UCNRS's mission to "*contribute to the understanding and wise management of the Earth and its natural systems by supporting university-level teaching, research, and public service at protected natural areas throughout California*." Interpretive signs have been placed throughout the Terrace Lands and student and faculty users conduct a wide range of projects ranging from observational studies of vertebrates to manipulative experiments focused on evaluating various restoration strategies and techniques to studies of wetland hydrology on coastal wetland species. These educational and research endeavors help train students, inform the public, provide insight into the natural world, and guide future restoration and management efforts at YLR and other similar habitats. In fact, undergraduate student investigators contributed greatly to this SRP both through research and restoration efforts. Thus, restoration efforts outlined below in the SRP, combined with future uses consistent with the UCNRS mission, will provide a unique opportunity for researchers, students, and the public to participate in, and observe, restoration and to use the reserve as an outdoor classroom and living laboratory.

The following document provides the SRP for Phase 2 (years 7-14) of the restoration of the Terrace Lands within YLR. There are approximately 36 ac (15 ha) outside of the development zone that will be restored over 20 years; thus, approximately 12 ac (5 ha) will be restored during each of the three phases. Phase 1 (years 1-7) is now complete (See SRP Phase 1 Summary Report). At the conclusion of Year 14 the final SRP will be written for Phase 3 (years 14-21).

Complete SRP guidelines are included as Appendix 1.

BASELINE ASSESSMENT (SRP 1)

This SRP applies to Phase 2 restoration of the Younger Lagoon Reserve Terrace Lands, located on UCSC's Coastal Science Campus. The CSC is located on the coast at the western edge of the City of Santa Cruz. It encompasses the laboratory complex known as Joseph M. Long Marine Laboratory (LML), a flat, gently southward-sloping coastal terrace that ends at a bluff approximately 35 ft (10.5 m) above the waters of the Monterey Bay National Marine Sanctuary, and the University of California's Younger Lagoon Reserve. The site is located within the coastal zone of the City of Santa Cruz.

The CSC is bordered by a variety of land uses. Agricultural land lies to the west of the site along the western boundary of YLR. The northern boundary of the campus is formed by the Union Pacific Railroad tracks beyond which is an industrial area. Shaffer Road runs along the eastern boundary of the site north of Delaware Avenue. East of Shaffer Road is undeveloped land that is currently vacant except for a community garden. Antonelli Pond lies to the east of this area. South of Delaware Avenue the CSC is bounded on the east by the De Anza Mobile Home Park. The Pacific Ocean forms the site's southern boundary.

The 93-acre (37.5 hectare) Coastal Science Campus site brings together the Campus Development Zones (approximately 29 ac [12 ha]), including the original 15.7 acre (6.3 hectare) LML site, the original YLR (approximately 25 ac [10 ha]), and YLR Terrace Lands (approximately 47 ac [19 ha]). The upland terrace, which encompasses both the Campus Development Zone and the YLR Terrace Lands, stretches from the coastal bluff area northward to the Union Pacific Railroad tracks at the site's northern boundary. The majority of the site was used for agriculture and produced Brussels sprouts until 1987. Since 1987 the area has remained fallow. As described more fully below, the coastal bluff and terrace support a mix of native and non-native vegetation, most of which is characterized as coastal prairie and coyote brush scrub. Seasonal freshwater wetlands are also present on the terrace. A narrow intertidal rock shelf exists at the base of the bluff. Younger Lagoon lies along the western edge of the site. The reserve includes the lagoon itself as well as portions of tributary drainages and adjacent upland habitats. YLR contains known and potential habitat for several special-status wildlife species. No special-status plant species are known to occur on the reserve.

Several areas in YLR meet the definition of environmentally sensitive habitat area (ESHA) under the California Coastal Act. An ESHA is defined as any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments. At the time of CLRDP certification portions of the original YLR qualified as ESHA, as did seasonal wetlands on the Terrace and the rocky intertidal zone.

The terrace and bluff are part of the lowest and southernmost of a series of marine terraces along the Santa Cruz coastline. The terrace is essentially flat, with a 1-2% slope to the south. Its elevation ranges from 51 ft (15.5 m) above sea level at the northern edge to 37 ft (11 m) above sea level at the bluff top; its southern boundary. The southwestern edge of the terrace, between the Conservation Annex and Younger Lagoon, is partially edged by an artificial berm approximately 10 to 12 ft (3 to 3.5 m) high and 40 to 50 ft (12 to 15 m) wide.

The site is subject to a Mediterranean climate with wet cool winters and dry warm summers with little rainfall. This pattern helps to account for the mostly seasonal nature of the site's wetlands. Summer fog is present on 30% to 40% of the days. Prevailing winds are from the northwest in the summer and winter storm winds are generally from the south. Total rainfall averages approximately 30 inches (76 cm) per year. The site is exposed and subject to relatively high wind velocities, coastal fog, and salt spray compared to more protected areas to the east.

Soils on the terrace exhibit generally poor drainage, with portions of the site experiencing saturated soil conditions and temporary shallow inundation during the wet season (November through March). Soils fall into three soil series, Elkhorn Sandy Loam, 0-2% slope; Elkhorn Sandy Loam, 2-9% slope; and Watsonville Loam, thick surface, 0-2% slope (Soil Conservation Service 1980). These soils were formed from alluvial fans and marine deposits and tend to be deep with loamy textures and slow runoff. The 0-2% slope soils are categorized by the Natural Resource Conservation Service as hydric soils for Santa Cruz County (Natural Resource Conservation Service 1992). The soils are underlain by Santa Cruz Mudstone, with the water table generally 2 to 10 ft (0.6 to 3 m) below the surface depending on time of year (Philip Williams and Associates 1995).

Surface water primarily enters the property from a culvert at the railroad tracks near the northwest corner of the site, through on-site precipitation and by site runoff (Huffman-Broadway Group, Inc. 2004). The watershed above the Terrace Lands is significantly restricted by HWY 1 which diverts potential (and likely historical) runoff that would have ended up in Younger Lagoon, Wilder (West), or Antonelli Pond (East). Thus, the approximate size of the watershed that flows into the upper Terrace area is only approximately 50 ac (20 ha). Water leaves the site through evaporation and evapotranspiration, as well as drainage to Younger Lagoon, De Anza Mobile Home Park, and the ocean. Natural drainage patterns have been altered by LML and related Campus development as well as ditches and surface re-conveyance from past farming activities. Seasonal subsurface seeps on the coastal bluff and YLR slopes also indicate that near surface perched groundwater exits on the site at the/se locations. Extensive burrowing activity by rodents is evident throughout the Terrace and may have loosened the upper portions of the soil profile and aerated the soils. This may be improving soil drainage characteristics and increasing vertical and horizontal water movement through the site (Huffman-Broadway Group, Inc. 2004).

Development zones

The built environment is organized into four primary zones of development, one each in the lower (approximately 7 ac [3 ha]), middle (approximately 20 ac [8 ha]), and upper portions of the site (approximately 1.4 ac [0.6 ha]), and one at the Campus entrance (approximately 0.5 ac [0.2 ha]), referred to in the CLRDP as Lower Terrace, Middle Terrace, Upper Terrace, and Campus Entrance development zones (Figure 1). Each development zone is intended to include a mix of marine research and education uses, except for the Campus Entrance zone, which is intended for more general support facilities such as parking and an entrance kiosk (University of California Santa Cruz 2008).

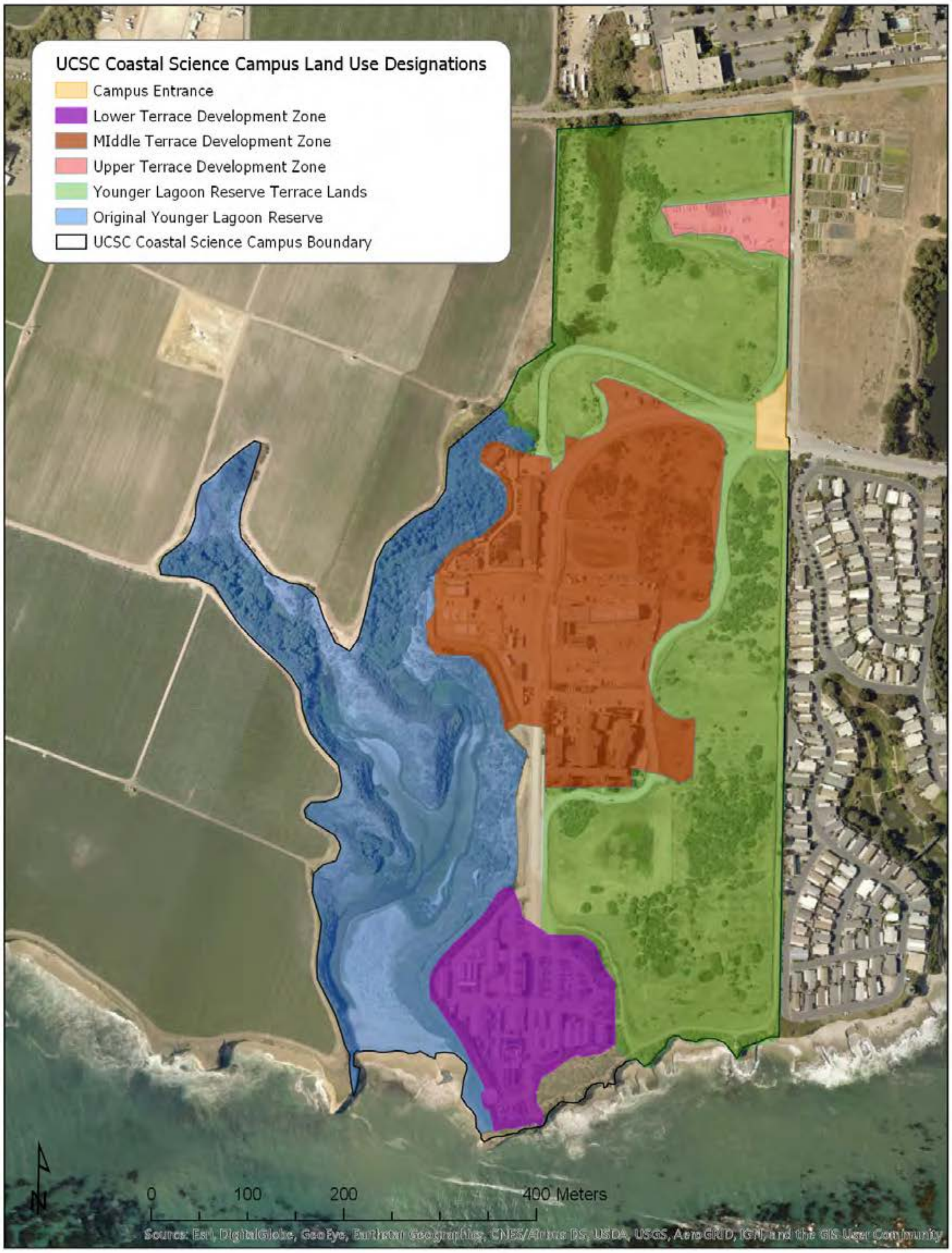

Figure 1. Coastal Science Campus Land Use Designations.

Natural areas outside of the CSC Development Zones (YLR Terrace Lands)

Below, the current conditions of YLR Terrace Lands is described.

Coastal Prairie

Coastal Prairie is one of two dominant vegetation types, along with coyote brush (*Baccharis pilularis*) scrub on the terrace.

Non-native coastal prairie became firmly established after farming ceased in 1987 and when the Terrace Lands were incorporated into YLR, these areas were composed almost entirely of weedy non-native and mostly annual species. The dominant non-native species include ripgut brome (*Bromus diandrus*), soft chess (*Bromus hordeaceus*), rattail sixweeks grass (*Festuca myuros*), brome fescue (*Festuca bromoides*), slender wild oat (*Avena barbata*), hare barley (*Hordeum murinum* ssp. *leporinum*), and Italian ryegrass (*Festuca perenne*). Herbs include wild radish (*Raphanus sativus*), cut-leaved geranium (*Geranium dissectum*), bristly ox-tongue (*Helminthotheca echioides*), and Bermuda-buttercup (*Oxalis pes-caprae*). The abundance of Bermuda-buttercup, which reproduces by vegetative bulblets, likely results from past cultivation and tilling activities.

During Phase 1 of restoration, approximately 5.6 ac (2.26 ha) were planted with native coastal prairie species. Nearly all of these plantings are meeting or exceeding their restoration goals; however, two plantings have fallen below their restoration targets, illustrating the difficulty of maintaining restored native coastal prairie (See SRP Phase 1 Summary Report). The dominant native species include purple needlegrass (*Stipa pulchra*), meadow barley (*Hordeum brachyantherum*), creeping wild rye (*Elymus triticoides*), blue wildrye (*Elymus glaucus*), yarrow (*Achillea millefolium*), gum plant (*Grindelia stricta*), and California aster (*Symphyotrichum chilense*).

Coyote-brush scrub

Coyote-brush scrub is the second dominant vegetation community on the terrace. It is characterized by patches of coyote brush of various sizes interspersed with native coastal scrub species and non-native grassland. It also includes scattered patches of Douglas' baccharis (*Baccharis glutinosa*). Many coyote brush individuals are very tall, reaching 10 ft (3 m) or more. Bermuda-buttercup (*Oxalis pes-caprae*) is generally abundant under the coyote brush.

During Phase 1 of restoration, approximately 4 ac (1.62 ha) were planted with native coastal scrub species. All of these plantings are meeting or exceeding their restoration targets (See SRP Phase 1 Summary Report). The dominant native species include California sagebrush (*Artemisia californica*), lizard tail (*Eriophyllum staechadifolium*), California bee plant (*Scrophularia californica*), and coffee berry (*Frangula californica*).

Ruderal

Areas identified as 'ruderal' in the CLRDP are included in this SRP as either part of the coastal prairie or coyote-brush scrub categories. Restoration activities in "ruderal" areas will be the same as in the adjacent coastal prairie and coyote-brush scrub areas. The ruderal designation included an area that supports a linear (north-south) underground utility corridor (University of California Santa Cruz 2008). All vegetation was removed during construction and the area is now colonized by a dense cover of the weedy, non-native herb bur-clover (*Medicago polymorpha*). Other species include non-native weeds such as white-stemmed filaree (*Erodium moschatum*), Cretan mallow (*Malva pseudolavatera*), Jubata grass (*Cortaderia jubata*), poison hemlock (*Conium maculatum*), and non-native annual grasses.

Coastal bluffs

Current coastal bluff vegetation can be classified into two groups: native coastal bluff and ice plant (*Carpobrotus edulis*). The coastal bluff area is exposed to salt spray and ocean winds and is represented as a narrow zone along the top of bluff at the Terrace's southern end just south of LML (Figure 2).

During Phase 1 of restoration, nearly all of the ice plant was removed from the bluff top, and native coastal bluff species planted in its place. All of these plantings are meeting or exceeding their restoration targets (See SRP Phase 1 Summary Report). The dominant native species include creeping wild rye (*Elymus triticoides*), lizard tail (*Eriophyllum staechadifolium*), coast buckwheat (*Eriogonum latifolium*), seaside daisy (*Erigeron glaucus*), yarrow (*Achillea millefolium*) and sand lettuce (*Dudleya caespitosa*).

Ice plant currently extends along portions of the cliff face. Other non-native species include wild radish (*Raphanus sativus*), ripgut brome (*Bromus diandrus*), Bermuda-buttercup (*Oxalis pes-caprae*), and Italian thistle (*Carduus pycnocephalus*).

Figure 2. Coastal bluff area.

Wetlands

The CLRDP cites 12 wetlands (W) on the Terrace Lands (Figure 4; Huffman-Broadway Group, Inc. 2004). These wetlands support six vegetation types: seasonal ponds, freshwater marsh-coastal terrace, willow herb-Douglas' baccharis, moist meadow, willow riparian forest, and annual coastal prairie (University of California Santa Cruz 2008, EcoSystems West 2002). In addition, some wetland indicator species (e.g. Italian ryegrass and Douglas' baccharis) are patchily distributed outside of the 12 delineated wetlands (Huffman-Broadway Group, Inc. 2004).

W1 is the drainage channel along the northwestern boundary of the property (approximately 0.14 ac [0.05 ha]). W2 is a flatter wetland swale in the northwestern portion of the property (it connects with W1 at its northern and southern ends). W3 is a large ponded area adjacent to the intersection of Delaware Avenue and Shaffer Road. W2 and W3 combined are approximately 4.57 ac (1.85 ha). W4 is a seasonal wetland swale in the eastern portion of the site (approximately 0.42 ac [0.17 ha]). W5 is a seasonal pond in the depressional area immediately south of the NOAA building (approximately 2.21 ac [0.89 ha]). W6 is an isolated wetland complex just north of the California Department of Fish and Game (CDFG) building (approximately 0.09 ac [0.036 ha]). W8 is an isolated wetland immediately south of Delaware Avenue Extension (approximately 0.01 ac [0.004 ha]). W9 is an isolated wetland approximately 200 ft^2 (61 m^2) south southeast of the road bend where Delaware Avenue Extension turns south to become McAllister Way (87 ft^2, 8 m^2). W10 is an isolated wetland south of the DeAnza drainage adjacent to the eastern property boundary (four ft^2, 0.37 m^2). W11 is a drainage channel that extends westward from McAllister Way (115 ft^2, 10.6 m^2). W12 is a complex of wetlands south and east of the W5 (approximately 0.21 ac [0.085 ha]). Other than wetland W7, all wetlands qualify as ESHAs and together total approximately 7.65 ac. Each of these is described in more detail below.

Figure 3. Wetlands.

In addition to delineating wetlands that qualified as ESHA on the Coastal Science Campus, the Huffman-Broadway Group (2004) found one area that qualified as wetland but not as ESHA. This is designated as Wetland W7. Wetland W7 was determined to have no plant or animal life or habitat that was either rare or especially valuable because of its role in the ecosystem. Wetland W7 is approximately 43 ft^2 (4 m^2) and is located in the northeast corner of the site approximately 150 ft (46 m) south of the northern property line.

Wetland Vegetation Types

EcoSystems West (2002) described five wetland vegetation types on the Terrace Lands based on vegetation characteristics. These include seasonal pond, freshwater marsh-coastal terrace, herb community dominated by willow-herb and Douglas' baccharis, moist meadow, and central coast arroyo willow riparian forest. EcoSystems West (2002) characterized Italian ryegrass (*Lolium multiflorum*) as an upland vegetation type. However, at the time that the U.S. Fish and Wildlife Service (USFWS) issued its 1988 list of species that grow in wetlands, Italian ryegrass was considered synonymous with perennial ryegrass (*L. perenne*), a hydrophyte with a wetland designation of "FAC" (equally likely to occur in uplands or wetlands). Although the 1996 USFWS list does not include Italian ryegrass (the perennial ryegrass is now considered by many to be a separate species), in California it occurs in the same habitat conditions as its congener. On the Terrace Lands Italian ryegrass grows in locations that are continuously inundated for months as well as in areas with upland hydrology. As such, the species is considered a FAC species and a sixth wetland vegetation type (Coastal Prairie dominated by Italian ryegrass) is suggested to be included on the Terrace Lands (Huffman-Broadway Group, Inc. 2004). The following six wetland vegetation types exist on the Terrace Lands:

1. Seasonal ponds—Located within the grasslands south of the NOAA building in the southwestern portion of the terrace (Wetland W5). Patches of alkali bulrush (*Bolboschoenus maritimus*) dominate the central pond, along with smaller dense patches of pale spike-rush (*Eleocharis macrostachya*). Scattered on the pond bed are patches of the coastal salt marsh species such as pickleweed (*Salicornia pacifica*) and non-native

brass buttons (*Cotula coronopifolia*), swamp grass (*Crypsis schoenoides*), and biennial sagewort (*Artemisia biennis*). An annual native herb, water starwort (*Callitriche marginata*), is abundant along the pond margins where the vegetation is not otherwise sharply distinct from that of the adjacent non-native grassland. Douglas' baccharis and Italian ryegrass also grow in the transitional areas.

2. Freshwater marsh—Found in three areas throughout the Terrace. The first area is near the western boundary of the site just north of the sharp curve where Delaware Avenue Extension curves to the south near the southwest corner of Wetland W2. The marsh is in a small topographic depression, dominated by a dense patch of California bulrush (*Schoenoplectus californicus*). Dotted smartweed (*Persicaria punctatum*) and willow-herb (*Epilobium* spp.) occur around the edges along with a small arroyo willow (*Salix lasiolepis*).

   The second area of freshwater marsh-coastal terrace is just south of the railroad tracks in the northwestern corner of the property at the northwest end of Wetland W2 at its intersection with W1. Dominated by a large arroyo willow in the center, the marsh also supports a dense colony of broad-leaved cattail, (*Typha latifolia*), floating marsh-pennywort (*Hydrocotyle ranunculoides*), dotted smartweed, willow-herb, and alkali bulrush. Saltgrass (*Distichlis spicata*) occurs in dense patches along the marsh margins.

   The third location of freshwater marsh-coastal terrace is in the small wetland complex in the northwestern area of the terrace north of the CDFG building. This marsh drains into the eastern arm of Younger Lagoon. Alkali bulrush and willow-herb grow along the margins of the marsh, which can have open water as late as May. Willow-herb, alkali bulrush, and tall cyperus (*Cyperus eragrostis*) are the dominant species in the drainage way.

3. Herb community—This type is dominated by willow-herb and Douglas' baccharis as well as non-native cut-leaved geranium and bristly ox-tongue. Although these species occur elsewhere on the property, only a small area in the east-portion of W4 supports this vegetation type.

4. Moist meadow habitat—Occurs at the northern end of the W6 wetland complex and to the north of the freshwater marsh-coastal terrace from which it is separated by an area of non-native grassland. The moist meadow intergrades with the non-coastal prairie habitat, but is floristically distinct and its soil retains moisture until relatively late in the season. It is dominated by the non-native velvet grass (*Holcus lanatus*) which is a perennial that indicates at least seasonally moist conditions. The native Pacific silverweed (*Potentilla anserina* ssp. *pacifica*) is an associate. Other species include willow-herb, cut-leaved geranium, wild radish (*Raphanus sativa*), Spiny sow-thistle (*Sonchus asper*), and bristly ox-tongue.

5. Central coast arroyo willow riparian forest—Although abundant in Younger Lagoon, this habitat is found in only one location on the Terrace. Beyond the freshwater marsh-coastal terrace and moist meadow habitats, arroyo willow riparian forest also occurs near W6 and in one small patch at the southeast end of the freshwater marsh-coastal terrace. It is dominated by arroyo willow with no other arborescent species present and little understory.

6. Coastal Prairie dominated by Italian ryegrass—This habitat is a significant part of the vegetation in wetlands W2, W3, W4, W5, W8, W9, W10, and W12.

Dense patches of Douglas' baccharis (*Baccharis glutinosa*) are found throughout the Terrace Lands both within and outside of delineated wetlands.

At the time of the Huffman-Broadway Group wetland delineation for the Coastal Science Campus, the U.S. Fish and Wildlife Service considered Douglas' baccharis in California to be an Obligate Wetland species meaning that under natural conditions it occurs almost always (estimated probability 99%) in wetlands (U.S. Fish and Wildlife Service 1988). The U.S. Fish and Wildlife Service now considers Douglas' baccharis in California to be a Facultative Wetland species meaning that under natural conditions it usually occurs in wetlands (estimated probability 67% – 99%), but is occasionally found in non-wetlands (estimated probability 1% – 33%) (U.S. Fish and Wildlife Service 1988, Lichvar, 2016).

Description of wetlands

Below are more detailed descriptions of specific characteristics of each wetland that occurs on the Terrace Lands.

Wetland W1

W1 and W2 both receive water from the culvert beneath the berm at the railroad tracks near the northwestern corner of the Terrace Lands. A small bermed area separates the wetland from adjacent agricultural lands to the west. Water flows in a north to south direction along the northwestern property boundary, then veers to the southwest before discharging to the eastern arm of Younger Lagoon. W1 was originally a drainage channel constructed to prevent inundation and allow agricultural cultivation in the northern portion of property. At present, it provides a major source of freshwater to Younger Lagoon. Sediment accumulation along portions of the channel has caused small ponds to form in some areas.

W1 is dominated by arroyo willow (*Salix lasiolepis*), willow-herb (*Epilobium ciliatum* ssp. *watsonii*), and the non-native curly dock (*Rumex crispus*). A non-native weeping willow (*Salix babylonica*) and the weedy invasive Jubata grass (*Cortaderia jubata*) also grow in W1. Poison hemlock (*Conium maculatum*) grows along its upper banks.

Wetland W1 and adjacent upland habitat provide an opportunity for wildlife to travel between Younger Lagoon and Antonelli Pond/Moore Creek (and along the railroad tracks to the west more generally).

During the final year of Phase 1 of restoration, a series of 5 brush packs were placed in the W1 channel in order to hydrologically reconnect W1 and W2. Although only recently installed, these brush packs are currently meeting performance criteria (See SRP Phase 1 Summary Report).

Wetland W2

W2 shares a water source with W1 and also receives sheet flow from upland areas to the east. Historical aerial photographs show that W2 previously included a man-made drainage ditch feature but active management of the ditch apparently stopped in the early 1980s. The channel gradually filled in with sediment and W2 no longer contains a clearly defined bed and bank, making it difficult to define its lateral boundaries. As delineated in 2001, it diverges from its origin near the culvert into two narrow bands, one extending south to just north of Delaware Avenue Extension and the other extending west and east along the northern Campus boundary. The Delaware Avenue Extension road grade promotes flooding, ponding, and surface soil saturation during the wet season and through early spring. This results in some recharge of the shallow water table as well as settling of suspended solids and associated pollutants.

Wetland W2 supports both Italian ryegrass and two locations of freshwater marsh-coastal Terrace habitat (one in the southwest corner and the other in the northwest corner). This habitat contains California bulrush, dotted smartweed, willow-herb, and arroyo willow. The non-native dominated coastal prairie in W2 is not sharply distinct in species composition from the adjacent upland. The lowest portion of the area is overwhelmingly dominated by Italian ryegrass (*Festuca perenne*) and curly dock (*Rumex crispus*). Several large patches of the non-native herb green dock (*Rumex conglomeratus*) occur in the northern portion of the site, along with two patches of Douglas' baccharis at the margin of the wetland.

Wildlife habitat in W2 includes seasonal aquatic habitat in areas of ponded water and California Red-legged Frogs have been sighted in a small pond in the northwest corner of W2 in 1997 (Mori 1997, EcoSystems West 2002). Pacific tree frogs also use the seasonal wetland habitat for breeding as do many aquatic invertebrates which serve as prey for amphibians, reptiles, birds, and small mammals.

Wetland W3

W3 is located just north of Delaware Avenue Extension and east of the southern boundary of W2. It is slightly lower in elevation than its surroundings and as a result water ponds after significant rainfall events. W3 receives overland flow from adjacent areas to the north and west; historical aerial photos indicate it was once part of a larger drainage that flowed from west to east and eventually discharged into Antonelli Pond. This drainage pattern was altered by agricultural activities and installation of the Campus access road that extends from the end of Delaware Ave Extension.

Mapped as non-native grassland, W3 is not sharply distinct in species composition from the surrounding areas except that it contains algal mats, reflecting the seasonally flooded condition. Two large patches of the native creeping wild rye occur at the south-east corner of W3. The vegetation is otherwise overwhelmingly dominated by Italian ryegrass with scattered patches of curly dock.

Wetland W4

W4 is a seasonal drainage swale that originates in the central part of the Terrace Lands (approximately 300 ft [91.5 m] northeast of the NOAA parking lot). During rainfall events water accumulates in the upper portion of the swale and then flows eastward to a corrugated metal pipe culvert near the eastern Campus boundary. Historical aerial photos indicate this was once part of a continuous drainage that flowed to Natural Bridges Lagoon until an underground culvert was installed to accommodate construction of De Anza Mobile Home Park. The upper portion of the remnant swale has been disturbed by agricultural plowing, leaving no clearly defined channel, but a clearly defined drainage way does exist in the lower portion of the swale. The wetland likely functions to improve water quality through settling of suspended solids and associated pollutants while ponded.

The upper portion of the swale is dominated by hydrophytic species, such as willow-herb, Douglas' baccharis, non-native annual rabbit's foot grass (*Polypogon monspeliensis*) and curly dock. The central portion is not sharply distinct in species composition from the adjacent upland non-native grassland. The lower portion of the drainage is dominated by Italian ryegrass with scattered curly dock and wild radish. Patches of brown-headed rush (*Juncus phaeocephalus*), Common rush (*Juncus patens*), Harford's sedge (*Carex harfordii*), and Douglas' baccharis also occur in the lower portion.

Wetland W5

This wetland is a seasonal pond that forms in a small topographic depression in the southern portion of the Terrace immediately south of the NOAA building and is the wettest portion of the Terrace Lands. Historical aerial photos show this wetland has been a persistent feature on the terrace since at least the 1950s. The hydroperiod and depth of ponding depends on rainfall and ranges from two to five months and up to approximately 16 inches (40.5 cm) deep. In the early 1900s, a small channel was excavated to drain water from the pond to the ocean bluffs; however, after this ditch ceased to be maintained it rapidly filled in with sediment, limiting drainage to the ocean from the ponded area. The channel exhibited wetland characteristics in 1993 but by 2002 the channel had disappeared except for a linear wetland corridor extending south approximately 200 ft (61 m). A storm drain outlet was constructed from the NOAA site near the pond's northern end to allow water to flow into the pond when the NOAA underground detention/percolation system reaches capacity. A pre-existing outlet near McAllister Way functions as a hydrologic control and limits lateral expansion of surface water within the pond.

W5 is characterized by the seasonal pond vegetation type. Sedges, broad-leaved cattail, curly dock, pale spikerush, and pickleweed occur in the wetter areas with Douglas' baccharis and Italian ryegrass dominating the transitional areas that merge with the surrounding non-native coastal prairie habitat.

The pond supports many aquatic and benthic invertebrate species which provide a food source for amphibians, reptiles, and birds. Pacific tree frogs have been observed at W5 and likely breed at this site. The open water area provides habitat for migratory waterfowl and shorebirds to rest and forage. The pond is used recreationally by bird watchers.

During Phase 1 of restoration, extensive weed removal was conducted in W5, including seasonal mowing and hand pulling of curly dock.

Wetland W6

W6 is a small isolated wetland complex, occupying a low-lying area in the northwestern portion of the site north of the CDFG building along the western edge of McAllister Way. This area may have been used to retain irrigation water when the area was farmed. A partial berm that prevents the area from draining into the adjacent stream habitat of Younger Lagoon is still visible. Although the area mapped as W6 includes only moist meadow habitat, other wetland vegetation types (e.g. freshwater marsh-coastal terrace and central coast arroyo willow riparian forest) occur nearby separated by non-native grassland. These areas are treated together in this SRP. The marsh can contain open water through mid-May or later, and the moist meadow retains moisture much later in the season than the non-native coastal prairie habitat.

W6 and the adjacent upland habitat likely facilitate wildlife movement between YLR and Antonelli Pond/Moore Creek (as well as up the coast along the railroad track corridor) and the relatively dense arroyo willow stand offers screening and escape cover.

During Phase 1 of restoration, W6 was planted with native wetland species. All of these plantings are meeting or exceeding their restoration targets (See SRP Phase 1 Summary Report). The dominant native species include common rush (*Juncus patens*), meadow barley, and Pacific silverweed (*Potentilla anserina* ssp. *pacifica*).

Wetland W7

W7 is a small isolated wetland located in the northeast corner of the Campus approximately 150 ft (45.72 m) south of the northern Campus property line at the railroad right-of-way.

Wetland W8

This seasonal wetland just south of Delaware Avenue Extension occupies a low-lying area immediately adjacent to the former roadbed. Vegetation primarily consists of non-native grassland, and is subject to (and probably formed by) periodic disturbance by passing vehicles whose tires leave the paved trail. The depressional area supports wetland hydrologic conditions during the rainy season (particularly within the tire ruts) but is hydrologically isolated from other wetlands on the site due to the presence of Delaware Avenue Extension.

Wetland W9

W9 is a small isolated wetland located northeast of the CDFG facility approximately 200 ft (61 m) south southeast of the road bend where the Ocean Shore Railroad Trail (the former Shaffer Road Extension) turns south to join McAllister Way.

Wetland W10

W10 is a small isolated wetland located south of the DeAnza drainage adjacent to the Campus's eastern boundary.

Wetland W11

W11 is a small drainage extending west from McAllister Way into YLR.

Wetland W12

W12 is a complex of wetlands immediately south and east of W5 and is similar in characteristics to the southern reaches of W5 which formed around the small channel that was dug long ago to drain water from W5.

Wetland buffers

Wetland Buffers do not constitute a specific habitat type in themselves and include mostly native and non-native coastal prairie, coyote brush scrub, and ruderal vegetation types (Figure 5). The "Buffer" designation and creation was applied with the goal of providing a buffer for wildlife from potential anthropogenic disturbances.

During Phase 1 of restoration, native planting occurred in W4, W5, W6, W10, and W12 buffers. All of these plantings are meeting or exceeding their restoration targets See SRP Phase 1 Summary Report).

Figure 4. Wetland buffer areas.

Non-Native weeds

Non-native weeds on the Terrace Lands are categorized into four categories for removal according to life-history characteristics, current distribution on the Terrace Lands, feasibility of control, and potential for spread (Table 1). The highest removal rating (Priority one) is given to large stature, slow moving exotic plants that are capable of invading and out-competing native plants in established plant communities. These plants are typically perennial or biennial and are generally straightforward to eliminate from an area. The distribution of Priority one weeds on YLR Terrace Lands is shown in Figure 6. Equal (if not greater) importance is given to the prevention of the introduction of new weeds that are known or suspected to be invasive but do not currently exist on the Terrace Lands (Watch List weeds). These classifications reflect current research on exotic invasives and concur with the California Native Plants Society's definition of an exotic invasive plant: "*a plant which is able to proliferate and aggressively alter or displace indigenous biological communities*" (California Native Plant Society 1996).

During Phase 1 of restoration, all Priority 1 weeds – with the exception of ice plant on the cliff faces of the bluffs, a few blackberry patches, and a few Monterey pine trees, were eliminated from the Terrace Lands. Follow-up monitoring and removal of re-emergent Priority 1 weeds was conducted annually (See SRP Phase 1 Summary Report).

Table 1. Known non-native weeds on YLR Terrace and adjacent lands.

Common Name	*Scientific Name*	*Priority Rating* for Removal*
Blackwood acacia	*Acacia melanoxylon*	W
Everblooming acacia	*Acacia retinodes*	W
Thoroughwort	*Ageratina adenophora*	W
European beachgrass	*Ammophila arenaria*	W
Giant reed	*Arundo donax*	W
Mediterranean Lineseed	*Bellardia trixago*	W
Red valerian	*Centranthus ruber*	W
Portuguese Broom	*Cytisus striatus*	W
Scotch broom	*Cytisus scoparius*	W

Common Name	*Scientific Name*	*Priority Rating* for Removal*
Purple awned wallaby grass	*Rytidosperma penicillatum*	W
Pepperweed	*Lepidium latifolium*	W
Yellow parentucellia	*Parentucellia viscosa*	W
Fountain grass	*Pennisetum setaceum*	W
Spanish broom	*Spartium junceum*	W
Ice plant	*Carpobrotus edulis*	1
Jubata grass	*Cortaderia jubata*	1
Monterey cypress	*Hesperocyparis macrocarpa*	1
Cape ivy	*Delairea odorata*	1
Panic veldgrass	*Ehrharta erecta*	1
Fennel	*Foeniculum vulgare*	1
French broom	*Genista monspessulana*	1
Harding grass	*Phalaris* aquatica	1
Monterey pine	*Pinus radiata*	1
Himalayan blackberry	*Rubus armeniacus*	1
Slender oat	*Avena barbata*	2
Wild oat	*Avena fatua*	2
Common mustard	*Brassica rapa*	2
Rescue grass	*Bromus catharticus*	2
Ripgut brome	*Bromus diandrus*	2
Soft chess	*Bromus hordeaceus*	2
Italian thistle	*Carduus pycnocephalus*	2
Bull thistle	*Cirsium vulgare*	2
Bermuda grass	*Cynodon dactylon*	2
Poison hemlock	*Conium maculatum*	2
Black mustard	*Brassica nigra*	2
Velvet grass	*Holcus lanatus*	2
Farmer's foxtail	*Hordeum murinum* ssp. *Leporinum*	2
Prickly lettuce	*Lactuca serriola*	2
Poison wild lettuce	*Lactuca virosa*	2
Italian ryegrass	*Festuca perennis*	2
Cheeseweed mallow	*Malva parviflora*	2
Sourgrass	*Oxalis pes-caprae*	2

Common Name	*Scientific Name*	*Priority Rating* for Removal*
Bristly ox-tongue	*Helminthotheca echioides*	2
Rabbitsfoot grass	*Polypogon monspeliensis*	2
Wild radish	*Raphanus sativus*	2
Curly dock	*Rumex crispus*	2
Spiny sow thistle	*Sonchus asper*	2
Sow thistle	*Sonchus oleraceus*	2
Scarlet pimpernel	*Lysimachia arvensis*	3
Pineapple weed	*Matricaria discoidea*	3
Lambs quarters	*Chenopodium album*	3
Nettle-leaved goosefoot	*Chenopodium murale*	3
Brass buttons	*Cotula coronopifolia*	3
Filaree	*Erodium spp.*	3
Cut-leaved geranium	*Geranium dissectum*	3
Rough cat's ear	*Hypochaeris radicata*	3
Loosestrife	*Lythrum hyssopifolium*	3
Bur clover	*Medicago polymorpha*	3
Cut-leaved plantain	*Plantago coronopus*	3
English plantain	*Plantago lanceolate*	3
Annual bluegrass	*Poa annua*	3
Prostrate knotweed	*Polygonum aviculare ssp. Depressum*	3
Sheep sorrel	*Rumex acetosella*	3
Common groundsel	*Senecio vulgaris*	3
Chickweed	*Stellaria media*	3
Rattail sixweeks grass	*Festuca myuros*	3

Notes: *Priority rating:

W. Watch List. These weeds are currently undetected at YLR Terrace Lands but are known to exist on nearby lands. Reserve staff will actively patrol for these weeds and eliminate them as soon as they are detected as part of YLR's Early Detection Rapid Response (EDRR) program (outlined in SRP 3).

1. High priority. These weeds are capable of invading and out-competing native plants in established plant communities. They are typically large stature, slow spreading perennial or biennials. Effective removal techniques for these weeds are generally well documented, and reserve staff will actively work to eliminate these weeds from YLR Terrace Lands. Once eliminated, on-going monitoring for reemergence of these weeds will take place in conjunction with patrols for Watch List weeds.

2. Medium priority. These weeds are mostly biennial or annual and are ubiquitous on YLR Terrace Lands. They are typically smaller in stature than Priority 1 weeds and more difficult to control. Weed control efforts for Priority 2 weeds will take place in conjunction with active restoration projects (e.g. planting), but P2 weeds are not expected to be eliminated from YLR Terrace Lands.

3. Low priority. These weeds are mostly annuals and are ubiquitous on YLR Terrace Lands. They are typically smaller in stature than Priority 1 weeds and more difficult to control. While many can effectively compete with native plants once they are established, they typically do not aggressively push out native plants. Most are commonly associated with native and non-native grasses and forbs in grasslands. Incidental weed control efforts for Priority 3 weeds may take place in conjunction with active restoration projects (e.g. planting), but P3 weeds are not expected to be eliminated from YLR Terrace Lands.

Source: Modified from John Gilcrest and Associates and Environmental Hydrology 1998.

Figure 5. Distribution of priority one weeds.

Phase two restoration areas

The CLRDP states that 2/3 of the Terrace Lands (~24 ac [10 ha]) need to meet the criteria outlined in section SRP 7 (Tables 3-6) after 14 years (end of Phase 2). Conceptual goals for habitat restoration for the entire project area over the 20-year restoration period are discussed in detail below in SRP 2. Spatial localities for the various target vegetation communities may change based on site conditions, hydrology, etc. overtime if adaptations are deemed necessary/appropriate by the SAC. Phase 2 of the enhancement effort (this SRP) will focus on three areas in the middle terrace: grasslands, and wetlands 4 and 5 (Figure 6), as well as maintenance of Phase 1 restoration sites and continued monitoring and removal of re-emergent priority one weeds. These restoration areas total approximately 8.45 ac (3.42 ha). Existing vegetation is dominated primarily by non-native grasses.

Although efforts will primarily focus on the middle terrace during Phase 2, enhancement and protection of other areas will also take place. One potential project outside of the middle terrace that may occur during Phase 2 of restoration is the creation of a breeding pond for the federally protected California Red-Legged Frog (CRLF) in the upper terrace. This project would be a collaborative effort between UCSC, the US Fish and Wildlife Service (USFWS), the Resource Conservation District (RCD), the Natural Resources Conservation Service (NRCS), and would require additional coordination and permitting. The SAC has discussed and approved the creation of a breeding pond for CRLF in the upper terrace (See 2014-2015, 2015-2016 and 2016-2017 Younger Lagoon Reserve Annual Reports).

This section describes the locations and baseline conditions of the enhancement areas for Phase 2.

Figure 6. Primary Restoration Areas for Phase 1, 2 and 3.

Coastal Prairie

Native grasses and forbs will be planted in relatively dense patches throughout approximately 5.45 ac (2.20 ha) of wetland buffer regions for W4 and W5, and the area around the generator yard. Although these areas will comprise the most intensive coastal prairie restoration for Phase 2, native grasses will also be planted throughout the Terrace Lands.

Wetland Buffers (Figure 5)

Wetland buffers represent prescribed distances from wetland edges (100 ft [30.5 m] for all wetlands with the exception of W5 which has a 150 ft [45.7 m] buffer). During Phase 2, primary restoration efforts in wetland buffers will focus on approximately 1 acre (0.4 ha) of buffer area in buffers 4 and 5; however, other buffer areas will also be planted. Soil conditions within and among wetland buffer areas differ greatly and thus significantly influence the potential plant species that can inhabit a particular location. As such, wetland buffer areas are currently composed primarily of non-native grasses, coyote brush, Douglas' baccharis, and willow.

Central Areas of Wetlands 4 and 5

Wetland 4 (Figure 4)

The central area of W4 is approximately 0.5 ac (0.2 ha). Phase 2 restoration activities in W4 will include weed control, enhancement of existing native vegetation with small-scale plantings and collection of seeds and cuttings for propagation. Small scale experiments investigating best practices for wetland restoration may also be conducted in this area.

Wetland 5 (Figure 4)

The central area of W5 is approximately 2.5 ac (1 ha). Phase 2 restoration activities in W5 will include weed control, enhancement of existing native vegetation with small-scale plantings and collection of seeds and cuttings for propagation. Small scale experiments investigating best practices for wetland restoration may also be conducted in this area.

Priority One Weed Patches

During Phase 1 of restoration, all Priority 1 weeds – with the exception of ice plant on the cliff faces of the bluffs and two Monterey pine trees, were eliminated from the Terrace Lands. During Phase 2, the remaining Priority 1 weeds will be eliminated from the terrace. Removal of re-emergent Priority 1 weeds will be conducted annually.

DESCRIPTION OF PLAN GOALS (SRP 2)

The goal of the restoration project is to create and protect a mosaic of rare habitats that provide substantial ecosystem services including the preservation of biodiversity, habitat for special status species, and buffering of stormwater runoff. These habitats include coastal bluff, coastal prairie, seasonal wetlands, forested wetlands and grasslands. Additionally, because the site is a UC Natural Reserve, research focused on restoration and native flora and fauna will provide opportunities to guide future restoration in similar habitats and provide educational and outreach material for Reserve users. This section of the SRP defines restoration goals for Phase 2 of the restoration effort and conceptual goals for the entire 20-year restoration plan (Figure 8).

Phase 2 activities will primarily focus on the three distinct restoration projects discussed above: native coastal prairie establishment, and central wetland habitat in wetlands 4 and 5. Maintenance of Phase 1 restoration sites and control of priority one weeds will also occur.

The overarching goal for Phase 2 is to meet success criteria for 2/3 of the Terrace Lands natural habitats. Success criteria for Phase 2 restoration activities are described in detail below in SRP 2. Specific success criteria were established based on setting goals that are achievable within the context of the site and are realistic objectives that will enhance ecological functions of the area. Although restoration efforts during Phase 2 will be primarily focused on areas identified in Figure 6, planting and weed control will be conducted throughout the entire site (following specific guidelines outlined below), including testing methodologies to be used in Phase 3. Below, the restoration goals for each habitat type are outlined in greater detail.

Coastal Prairie restoration goals

Restoration within coastal prairie areas will focus on increasing native grass species (see Table 2 for restoration palate) and decreasing non-native plant cover. Species richness and percent cover goals are outlined in Table 3. Although the primary effort will be to increase native grass cover and species richness, other native shrubs will be scattered throughout these areas through natural recruitment. There will be no change in topography and/or hydrology.

Central areas of wetlands 4 and 5 restoration goals

Restoration within the central areas of wetlands 4 and 5 will focus on increasing native plant species richness and percent cover (see Table 2 for restoration palate) and decreasing non-native plant cover. Species richness and percent cover goals are outlined in Table 5. There will be no change in topography and/or hydrology.

Wetland buffer restoration goals

Restoration efforts in wetland buffers will focus on increasing native plant species richness and percent cover (see Table 2 for restoration palate) and decreasing non-native plant cover. Plants used in the wetland buffers will vary depending upon soil conditions. Buffer areas throughout the Terrace Lands differ drastically depending upon the distance from each particular wetland and moisture content of the soil. As such, species richness and percent cover goals will vary (e.g. some areas will likely be dominated by grasses while others will be dominated by shrubs). Table 6 provides an overview of success criteria for wetland buffer areas. There will be no change in topography and/or hydrology.

Priority one weed removal goals (for all P1 weeds)

All priority-one weeds (see Table 2) will be controlled as they are detected throughout the Terrace Lands. Elimination of reproductive individuals is the goal, however YLR is surrounded by priority-one weed seed sources and it is likely that there will always be some level of priority-one weeds persisting on the terrace.

SITE AREA PREPARATION AND INVASIVE PLANT REMOVAL (SRP 3)

Early Detection Rapid Response (EDRR)

Preventing the introduction of new invasive species is the first line of defense against new invasions. However, even the best prevention efforts will not stop all invasive species introductions, particularly at a small urban reserve like YLR which is surrounded by potential weed sources. Besides prevention, the most time and cost-effective way to manage the potential negative impacts of new invasive plants is through EDRR efforts.

EDDR focuses on surveying and monitoring at-risk areas to find infestations at their earliest stages of invasion and then rapidly beginning the control of these species. These efforts greatly increase the likelihood that new invasions will be addressed successfully and new weeds will be prevented from becoming established and widespread in a given area. Along with prevention this method is the most successful, cost effective, and least environmentally damaging means of control (National Invasive Species Council 2008).

After initial introduction of a new invasive plant there is a short period of opportunity for eradication or containment. Once permanently established a new invader becomes a long-term management problem. The costs associated with catching weeds before they become established are also drastically less than those of long-term invasive species management for noxious weeds that have already become widespread. Therefore, any low incidence weed known or suspected to be invasive (and feasible to control) will be removed when detected.

Weeds that are currently undetected on YLR Terrace Lands, but known to exist nearby (W – see Table 1) will be actively patrolled for and eliminated as soon as they are detected. High priority (P1 – see Table 1) weeds have been or will be eliminated from YLR Terrace Lands. Once eliminated, on-going monitoring for reemergence of these weeds will take place in conjunction with patrols for watch-listed weeds. Control efforts for medium priority (P2 – see Table 1) weeds will take place in conjunction with active restoration projects (e.g. planting), but P2 weeds are not expected to be eliminated from YLR Terrace Lands. Incidental control efforts for low priority (P3 – see Table 1) weeds may take place in conjunction with active restoration projects (e.g. planting), but P3 weeds are not expected to be eliminated from YLR Terrace Lands.

Site area preparation and invasive plant removal techniques will vary from site to site as needed, but will draw from a set of standard methods for weed control, outlined below.

Priority one weed control

Removal techniques for priority one weeds may include one or more of the following: hand pulling / mechanical control, clipping / weed whacking, flaming, solarization, burning, grazing, and herbicide application. Due to their potential harmful impact to human health, wildlife, waterways, as well as negative public perception and neighbor concerns, herbicide use will be avoided whenever possible. When herbicide is applied all UC policies and listed safety instructions will be followed to protect surrounding biological resources. Due to their potential to re-invade, all priority one weeds with viable propagules will either be solarized and composted on site or bagged after removal and disposed of offsite. Some priority one weed control activities will be ongoing throughout the year. Other activities will be restricted to the winter and spring months (exact timing will be dependent on soil moisture conditions and seed-set).

The distribution of priority-one weed species on YLR Terrace Lands and possible weed control methods for each is described below.

Ice plant (Carpobrotus edulis). *Family: Aizoaceae*
Extent of Ice plant on YLR Terrace Lands—Nearly all of the Ice plant on the coastal bluff tops was removed during Phase 1 of Restoration. Ice plant is currently found primarily along the faces of the coastal bluffs. (Figure 5).

Methods of Control for Ice plant on YLR Terrace Lands —Ice plant on the coastal bluff tops can be controlled by manual methods, solarization, and herbicide application (Bossard et al. 2000). When hand removal is employed all above-ground plant material will be removed and the soil will be raked in order to expose and remove any remaining roots or stolons. When solarization is employed, black agricultural plastic held in place by sandbags will be used to tarp Ice plant patches for 3-6 months. After solarization or herbicide application, dead ice plant may be left in place to prevent erosion and control weeds; dead ice plant can serve as 'mulch' that can be planted into. For patches on the coastal bluff cliff faces, spraying may be preferred in order to minimize erosion.

Jubata grass (Cortaderia jubata). *Family: Poaceae.*

Extent of Jubata grass on YLR Terrace Lands—Jubata grass has been eliminated from the Terrace Lands, and is restricted to new recruits on the upper Terrace primarily along the northern and western property lines. The jubata grass on YLR Terrace Lands is part of a population that extends beyond the northern and western property lines, thus, effective control of jubata grass will require cooperation between adjacent land owners and reserve staff.

Methods of Control for Jubata grass on YLR Terrace Lands —Jubata grass is effectively controlled by mechanical means (hand pulling / grubbing), and herbicide application (Bossard et al. 2000). Hand removal is most effective for new recruits. When hand removal is employed, all above ground jubata grass material will be removed before seed set, and then the root mass will be removed. When winching is employed the root mass will be removed from the ground.

Monterey cypress (Hesperocyparis macrocarpa). Family: Cupressaceae.

Monterey cypress is native to the Monterey coast area, but is considered moderately invasive in other parts of California (including Santa Cruz County) where it spreads via seed from planted windbreaks or hedgerows.

Extent of Monterey cypress on YLR Terrace Lands—All of the Monterey cypress trees that currently exist on YLR Terrace Lands are 'volunteers' that have grown from seeds that were either brought to the site in landscaping mulch or that blew into the reserve from CSC landscaping plantings. All but one Monterey cypress tree has been eliminated from the reserve and the population is primarily restricted to new recruits (Figure 5).

Methods of Control for Monterey cypress on YLR Terrace Lands—Seedlings will be controlled by hand pulling/digging. In addition to removal efforts on Terrace Lands, collaborative efforts among UCSC staff and other CSC groups (e.g. NOAA/NMFS and CDFW) will continue to limit the transport of Monterey cypress to the site.

Cape ivy (Delairea odorata). *Family: Asteraceae.*

Extent of Cape ivy on YLR Terrace Lands—Cape ivy is not present on the Terrace Lands; however, it was established in a patch on the northwest border of Younger Lagoon at the beginning of Phase 1 (Figure 5). The patch was located on a shady west facing slope and had overrun the herbaceous understory of the area and was beginning to climb into the Arroyo willow canopy. During Phase 1 of restoration, Cape Ivy was eliminated from the reserve; however, it is notoriously difficult to control. Thus, regular monitoring and removal of any re-emergent Cape Ivy will continue during Phase 2.

Methods of Control for Cape ivy on YLR Terrace Lands —Cape ivy is difficult to eliminate for two reasons: stolons and underground parts readily fragment while being removed and plants will grow from almost any remaining fragment. Therefore, frequent post removal monitoring and maintenance is necessary if removal efforts are to be successful. Cape ivy can be controlled through mechanical means or herbicide application (Bossard et al. 2000). When hand removal is employed, all above ground plant material (both native and non-native plants, except native trees) will be removed in the infested area. After the removal of above ground material soil will be raked to expose and remove any remaining roots or stolons.

Panic veldtgrass (Ehrharta erecta). *Family: Poaceae.*

Extent of Panic veldtgrass on YLR Terrace Lands – During Phase 1 of restoration, Panic veldtgrass was eliminated from the YLR Terrace Lands. Monitoring and removal of any re-emergent Panic veldtgrass will continue during Phase 2.

Methods of Control for Panic veldt grass on YLR Terrace Lands —Once established panic veldtgrass is extremely difficult to control / eliminate. Mechanical means of control (hand pulling / grubbing), and herbicide application have had mixed results (Bossard et al. 2000). Therefore, the highest priority must be given to preventing the further spread of this weed and eliminating it while it is still at a low incidence. When hand removal is employed, the entire plant will be removed from the ground (including the root mass).

Fennel (Foeniculum vulgare). *Family: Apiaceae.*

Extent Fennel on YLR Terrace Lands – During Phase 1 of restoration, Fennel was eliminated from the Terrace Lands. One small patch remains in the Original Younger Lagoon Reserve. Removal of this patch, and monitoring and removal of any re-emergent Fennel will continue during Phase 2.

Methods of Control for Fennel on YLR Terrace Lands —Fennel is effectively controlled by mechanical means (hand pulling / grubbing), and herbicide application (Bossard et al. 2000). When hand removal is employed all above ground fennel material will be removed before seed set (root mass will also be removed).

French broom (Genista monspessulana). *Family: Fabaceae.*

Extent of French broom on YLR Terrace Lands—French broom was not detected on YLR During Phase 1 of restoration. However, it has previously been sighted in the middle terrace Development Zone near the greenhouses. In addition, an extremely large French broom population is located north of the reserve in the City of Santa Cruz Moore Creek Preserve making future re-infestations likely. Monitoring and removal of any re-emergent French broom will continue during Phase 2.

Methods of Control for French broom on YLR Terrace Lands —French broom is effectively controlled by hand pulling (weed wrenching), prescribed burning, flaming of seedlings, grazing by goats, herbicide application, or a combination (Bossard et al. 2000). Weed wrenches will be used to remove entire plants before seed set. Seedlings will be removed by flaming or manual methods.

*Harding grass (*Phalaris aquatica). *Family: Poaceae*

Extent of Harding grass on YLR Terrace Lands – During Phase 1of restoration, Harding grass was eliminated from the Terrace Lands. Monitoring and removal of any re-emergent Harding grass will continue during Phase 2.

Methods of Control for Harding grass on YLR Terrace Lands —Harding grass is effectively controlled by mechanical means (hand pulling / grubbing), and herbicide application (glyphosate) (Bossard et al. 2000). When hand removal is employed all above-ground material will be removed before seed set (the root will also be removed).

Monterey pine (Pinus radiata). *Family: Pinaceae*.

Monterey pine is the most widely planted commercial timber tree in the world (Brossard et al, 2000). However, in its native range, consisting of five populations in California and Baja California, Mexico, the species is threatened by development, human-dispersed plant pathogens, non-native herbivores, etc (Brossard et al, 2000). Our classification of Monterey pine as a Priority one weed on the YLR Terrace Lands is specifically based on the fact that the Monterey pines on the YLR Terrace Lands became established on the site due to human introduction. Once established, Monterey pines can displace and shade out native vegetation and alter fire regimes. Monterey pines produce thousands of light winged seeds that are easily wind dispersed.

Extent of Monterey pine on the YLR Terrace Lands – Monterey pine on the YLR Terrace Lands is currently limited to one individual (Figure 5).

Methods of Control for Monterey pine on YLR Terrace Lands—Mature Monterey pine trees will be controlled by cutting the trunk at ground level. Seedlings will be controlled by hand pulling/digging. In addition to removal efforts on Terrace Lands, collaborative efforts among UCSC staff and other CSC groups (e.g. NOAA/NMFS and CDFG) will be initiated to limit the transport of Monterey pines to the site.

Himalayan blackberry (Rubus armeniacus). *Family: Roseaceae.*
Extent of Himalayan blackberry on YLR Terrace Lands – Himalayan blackberry is found at low incidence throughout YLR Terrace Lands. Two large patches remain at the northern end and eastern edge of the site (Figure 5).

Methods of Control for Himalayan blackberry on YLR Terrace Lands — Himalayan blackberry is effectively controlled by mechanical means (hand digging /weed wrenching). All above ground Himalayan blackberry material will be removed before seed set (roots will also be removed).

Medium and low priority coastal prairie weed control

Although mowing, grazing, herbicide application, scraping, and burning are effective methods for reducing annual seed set and thatch in non-native grasslands, managing to reduce exotic grasses without seeding or planting natives is relatively ineffective in restoring natives because it simply shifts the species composition to low stature exotic forbs (DiTomasso 2000, Hayes and Holl 2003a, Hayes and Holl 2003b, Stromberg et al. 2007). Therefore, medium and low priority weeds will not be controlled until active restoration projects (e.g. planting) are taking place in a site. Once active restoration has begun, a combination of weed control techniques will be implemented. Additionally, an experimental approach to non-native grass control may be used to evaluate emerging techniques with the goal of incorporating promising methodologies into management activities.

Some non-native coastal prairie control activities will be ongoing throughout the year. Other activities will be restricted to the winter and spring months (their exact timing dependent on soil moisture conditions and seed-set).

PLANTING PLAN (SRP 4)

The planting plan is composed of the following key components for successful restoration, plant palette and selection, planting design (plant mix and spacing), local plant material source, plant installation, erosion control, irrigation, and remediation. The planting palette is made up exclusively of native taxa that are appropriate to the habitat and region. Seed and/or vegetative propagules will be obtained from local natural habitats so as to protect the genetic makeup of natural populations. Horticultural varieties will not be used.

The use of locally collected seeds and cuttings in restoration projects reduces the risks of introducing non-local genes into the population; potentially decreasing species fitness. In order to maintain the genetic integrity of the rich assemblage of plants found along the central coast of California, all seeds and cuttings will be collected from coastal Santa Cruz and San Mateo Counties.

The restoration planting palate (Table 2) is comprised of possible revegetation species for each habitat type. If other species appropriate for restoration are identified they will be added to the restoration palate.

Table 2. Possible revegetation species.

Common Name	*Scientific Name*	*Coastal Prairie/ Erosion Control*	*Coastal Bluff*	*Wetland/ Riparian*	*Wildlife Corridor*	*Upland Buffer*	*Coastal Scrub*
Trees							
California box elder	*Acer negundo*			x	x		
California buckeye	*Aesculus californica*				x	x	
Coast live oak	*Quercus agrifolia*				x	x	
Wax myrtle	*Morella californica*			x	X		
Arroyo willow	*Salix lasiolepis*			x	X		

Common Name	*Scientific Name*	*Coastal Prairie/ Erosion Control*	*Coastal Bluff*	*Wetland/ Riparian*	*Wildlife Corridor*	*Upland Buffer*	*Coastal Scrub*
Shrubs and Subshrubs							
California sagebrush	*Artemisia californica*		x		X	x	X
Mugwort	*Artemisia douglasiana*		x	x			
Douglas' baccharis	*Baccharis glutinosa*			x			
Coyote brush	*Baccharis pilularis*		x		X	x	X
Blue blossom ceanothus	*Ceanothus thyrsiflorus*				X		
California goldenbush	*Ericameria ericoides*		x				X
Seaside daisy	*Erigeron glaucus*		x			x	
Coast buckwheat	*Eriogonum latifolium*		x			x	X
Lizardtail	*Eriophyllum staechadifolium*		x			x	X
Oceanspray	*Holodiscus discolor*				x	x	X
Deerweed	*Acmispon glaber*	X					X
Yellow bush lupine	*Lupinus arboreus*		x		x	x	
Bush monkeyflower	*Diplacus aurantiacus*		x		x	x	X
Wax myrtle	*Morella californica*				x		X
Coffeeberry	*Frangula californica*				x		X
California wild rose	*Rosa californica*	X		x		x	X
California blackberry	*Rubus ursinus*			x		x	X
Red elderberry	*Sambucus racemosa* var. *racemosa*			x	x	x	X
Forbs							
Yarrow	*Achillea millefolium*		x	x		x	X
Sea pink	*Armeria maritima*		x				
California aster	*Symphyotrichum chilense*	X	x	x			
Fat hen	*Atriplex prostrata*			x			
Beach saltbush	*Atriplex leucophylla*			x			

Common Name	*Scientific Name*	*Coastal Prairie/ Erosion Control*	*Coastal Bluff*	*Wetland/ Riparian*	*Wildlife Corridor*	*Upland Buffer*	*Coastal Scrub*
Sun cup	*Taraxia ovata*	X					
Wight's indian paintbrush	*Castilleja affinis ssp. affinis*		x				X
Soap plant	*Chlorogalum pomeridianum*	X					X
Brownie thistle	*Cirsium quercetorum*	X	x				
American wild carrot	*Daucus pusillus*	X	x				
Sand lettuce	*Dudleya caespitosa*		x				
Sea lettuce	*Dudleya farinosa*		x				
Western goldenrod	*Euthamia occidentalis*		x				
Beach strawberry	*Fragaria chiloensis*		x				
Gum plant	*Grindelia stricta*		x	x			X
Cow parsnip	*Heracleum maximum*		x			x	
Douglas' iris	*Iris douglasiana*	X	x				
lHarlequin lotus	*Hosackia gracilis*	X					
Sky lupine	*Lupinus nanus*	X	x		x	x	
Varied lupine	*Lupinus variicolor*	X	x		x	x	
Wild cucumber	*Marah fabacea*					x	
Pacific oenanthe	*Oenanthe sarmentosa*			x			
California polypody	*Polypodium californicum*					x	X
Pacific silverweed	*Potentilla anserina* ssp. *pacifica*			x			
Self heal	*Prunella vulgaris*	X	x				
California buttercup, coastal form	*Ranunculus californicus*	X		x		x	
Pacific sanicle	*Sanicula crassicaulis*				x		X
California bee plant	*Scrophularia californica*			x			X
Blue-eyed grass	*Sisyrinchium bellum*	X		x			
Coast hedge nettle	*Stachys bullata*			x			
Rushes/Sedges							

Common Name	*Scientific Name*	*Coastal Prairie/ Erosion Control*	*Coastal Bluff*	*Wetland/ Riparian*	*Wildlife Corridor*	*Upland Buffer*	*Coastal Scrub*
Baltic rush	*Juncus balticus*			x			
Western rush	*Juncus occidentalis*			x			
Common rush	*Juncus patens*			x			
Brown-headed rush	*Juncus phaeocephalus*			x			
Three-square	*Schoenoplectus pungens*			x			
California bulrush	*Schoenoplectus californicus*			x			
Low bulrush	*Isolepis cernua*			x			

Grasses

Bent grass	*Agrostis pallens*	X	x	x	x	x	
California brome	*Bromus carinatus*	X		x	x	x	x
California oatgrass	*Danthonia californica*	X		x			x
Tufted hairgrass	*Deschampsia cespitosa*	X		x			
Saltgrass	*Distichlis spicata*		x				
Western ryegrass	*Elymus glaucus*				x		
Meadow barley	*Hordeum brachyantherum*			x			
Creeping wildrye	*Elymus triticoides*			x	x	x	
Foothill needlegrass	*Stipa lepida*	X			x	x	
Purple needlegrass	*Stipa pulchra*	X	x		x	x	x

Plants will be installed approximately 12 to 36 inches (30 to 90 cm) on center, depending on species. Smaller stature plants will be grouped and spaced closer together, while larger stature plants will be spaced further apart. In general, plants will be placed in non-linear arrangements to mimic plant distribution patterns observed in nature.

Seeds will be collected from local sources and grown by UCSC staff and students at the UCSC Arboretum, UCSC Teaching Greenhouses, and YLR. Some species may be grown by local restoration contractors.

With the exception of trees, all plants will be grown in Ray Leach 'Conetainers' or similar sized pots. Trees will be grown in 'tree pots'. These containers will maximize utilization of greenhouse space and minimize per plant costs while producing relatively large plants with well developed root systems. Installation will begin after the first winter rains.

Erosion control

Because the Terrace Lands are essentially flat erosion is not likely to be a concern. If following planting or weeding efforts erosion control is required, appropriate materials (e.g. wood-chip mulch, jute netting, wattles, etc.) will be installed.

Irrigation

Ideally, plant installation will commence after the first winter rain and end well before the rains stop, ensuring that plants are naturally watered in and established before the summer drought. However, if supplemental irrigation is needed, plants will be watered using one or all of the following methods: hand application, vehicle application, drip hose, and/or overhead sprinkling. Water will be obtained from CSC infrastructure.

Remediation (maintenance / replacement plantings)

It is anticipated that plant mortality will likely be in the 10-40% range due to herbivory, desiccation, and/or trampling (by volunteers during planting and monitoring). Thus, plants will be installed at relatively high densities. If mortality is lower than anticipated, plants will be removed as necessary to ensure successful growth and reproduction and future planting densities will be adjusted. If a particular planting effort fails, plants will either be replanted that season or the following year if failure occurs after the rainy / planting season. Additionally, an alternative planting palate may be considered.

REPORTING ON IMPLEMENTATION ACTIVITIES (SRP 5)

A plan for documenting and reporting the physical and biological "as built" condition of the site will be prepared at the completion of the initial plan implementation activities. This report will describe the field implementation of the approved resource plan in narrative and photographs and report any problems in the implementation and their resolution.

The YLR manager will be on-site during restoration activities to take notes, photos, and to direct crews. After the end of the busy spring/summer restoration project season, she/he will compile notes and photos into a simple report describing the physical and biological "as built" condition of the site areas. This report will be submitted annually as part of the YLR annual report.

INTERIM MONITORING AND MAINTENANCE (SRP 6)

Monitoring of restored areas on the Terrace Lands will provide data on coverage and richness of native species and thus gauge the "success" of restoration efforts. Specific monitoring methodologies, timing, and discussion of performance standards are included below in sections SRP 7 and SRP 8. Timing and methods for planting and weeding (maintenance) are detailed in sections SRP 4 and SRP 5 above. Data from annual monitoring efforts will be used to assess whether restoration efforts are proceeding in the desired trajectory (e.g. increased coverage and richness of natives and decreased coverage of non-natives). Interim success criteria and remediation measures are specified in Tables 3-6 for each habitat type. A report on the progress towards both interim and final success criteria (as per SRP 7 below) will be compiled.

Data compiled from monitoring and maintenance activities will be included in an annual report that will be provided to the UC Santa Cruz Planning Director and the SAC by December 31st of each year following year one of the project period in which monitoring has been conducted. Each report will be cumulative (building upon previous efforts), will summarize monitoring results, and include a "Performance Evaluation" section where data will be summarized and used to evaluate restoration efforts. In order to remedy potential deficiencies in meeting success criteria each report will also include a "Recommendations" section that will discusses solutions and/or adaptive strategies to tackle unforeseen circumstances or new findings that require a change in restoration practices, maintenance, monitoring, or success criteria.

SUCCESS CRITERIA FOR HABITAT TYPES (SRP 7)

The SAC has defined final success criteria for species richness and coverage as well as remediation actions if criteria are not met. Success criteria will be evaluated by the SAC and may be changed if need be. Final success criteria will be evaluated only after a period of at least 3 years wherein the study site has been subject to no remediation or maintenance activities other than weeding. This section provides information on success criteria for each habitat type and a general overview of methods used to achieve these goals. Specific details regarding planting, site preparation, and weeding are included in sections SRP 2 (restoration and weeding goals), SRP 3 (site preparation), and SRP 4 (planting plan) above.

Ruderal, coyote brush scrub, and coastal prairie areas

Enhancement and protection goals for ruderal, coyote brush scrub, and coastal prairie are to maintain open space areas, protect and enhance the ruderal, coyote brush scrub and coastal prairie areas through eliminating priority one weeds, controlling to the extent possible lower priority weeds, promoting the abundance and diversity of native plant species (through weed abatement and phased revegetation), and preventing unauthorized trail development. Interim and long-term goals for restoration of ruderal, coyote brush scrub, and coastal prairie are included in Table 3.

Table 3. Summary of restoration activities, success criteria, and implementation actions for ruderal, coyote brush scrub, and coastal prairie areas.

Feature	*Goal*	*Time Period*	*Result*	*Action*
RMP PS 1 Priority 1 weeds	Eliminate on Terrace Lands	Year 3 and annually thereafter	No priority 1 weeds surviving to reproduction each year	Continue weed monitoring and control
			Priority 1 weeds reproducing on site	Increase frequency of monitoring and weed control; consider alternative control methods
RMP PS 2 Priority 2 Weeds	Reduce weedy seed set after planting efforts are initiated.	Timed to correspond with planting efforts.	Planted plants are established	Continue weeding program
			Annual weeds out-competing native plants.	Change weeding schedule or evaluate alternative methods.
RMP PS 3 Native plant species richness in Phase 1 ruderal, coyote brush scrub, and coastal prairie areas	8 native plant species appropriate for habitat established in restoration areas. 40% cover of shrubs in ruderal and coyote brush scrub where coyote brush scrub is the primary target. 25% cover of non-shrubs (grasses, herbs, etc.) in coastal	2 years after planting	6 or more native plant species established. *and* ≥10% cover (shrubs), ≥5% cover (non-shrubs), and evidence of natural recruitment present.	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
	prairie areas where coastal prairie restoration is the primary target.		Fewer than 6 native plant species present. *or* < 10% cover (shrubs), < 5% (non-shrubs) or no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met
		4 years after planting	6 or more native plant species established. *and* $\geq$ 25% cover (shrubs) $\geq$15% cover (non-shrubs) and evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 6 native plant species *or* < 25% cover (shrubs) and <15% cover (non-shrubs) *or* no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met
		6 years post planting and every 5 years thereafter	8 or more native plant species present comprising ≥ 40% cover (shrubs) and ≥25% cover (non-shrubs) *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 8 native plant species or < 40% cover (shrubs) and <25% cover (non-shrubs) of native species *or* no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods. Monitor annually until success criteria are met Consult SAC.
RMP PS 4 Native plant richness in Phase 2 and Phase 3 ruderal, coyote brush scrub, and coastal prairie areas	Same criteria as for Phase 1 as adjusted by SAC.	Same criteria as for Phase 1.	Same criteria as for Phase 1.	Same criteria as for Phase 1 as adjusted by SAC: Monitor sites falling below performance standards annually until success criteria are met
RMP PS 5 Protection of revegetation in progress	No disturbance to revegetation plantings	Ongoing until revegetation is successful	Plantings undisturbed	Continue monitoring until revegetation is successful

Feature	Goal	Time Period	Result	Action
			Plantings disturbed (plants broken, trampled, dislodged, removed)	Install signs or low fencing as appropriate and consistent with the CLRDP.

Coastal bluff

Enhancement and protection of coastal bluff habitat will be achieved by eliminating priority one weeds, promoting the abundance and diversity of native plant species through plantings, preventing unauthorized trail development, and increasing the extent of coastal bluff vegetation. Interim and long-term goals for restoration of coastal bluff habitats are provided in Table 4.

Table 4. Summary of restoration activities, success criteria, and implementation actions for coastal bluff habitat.

Feature	Goal	Time Period	Result	Action
RMP PS 6 Priority 1 weeds except iceplant	Eliminate on coastal bluff	Year 3 and annually thereafter	No priority 1 weeds surviving to reproduction	Continue weed monitoring and control
			Priority 1 weeds reproducing on site	Use different species weed abatement methods or frequency
RMP PS 7 Iceplant	Eliminate on coastal bluff	Prior to first rainy season following	No iceplant on coastal bluff	Continue monitoring and control

Feature	*Goal*	*Time Period*	*Result*	*Action*
removal		initiation of construction for first development project in Lower Terrace development zone	Iceplant growing on coastal bluff	Use different species, weed abatement methods or frequency
RMP PS 8 Native plant revegetation	8 native plant species appropriate for coastal bluff habitat. 40% cover of native species.	2 years after planting	4 or more native plant species established comprising ≥ 20% cover within bluff areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 4 native plant species or < 20% cover of native species in bluff areas *or* no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met
		4 years after planting	8 or more native plant species established comprising ≥ 30% cover within bluff areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 8 native plant species or < 30% cover of native species in bluff areas *or* no evidence of natural recruitment present	Perform supplementa l planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met
		6 years after planting and every 5 years thereafter	8 or more native plant species established comprising ≥ 40% cover within bluff areas *and* evidence of natural recruitment present	Continue monitoring
			Fewer than 8 native plant species or < 40% cover of native species in bluff areas *or*	Perform supplementa l planting using different species, propagule type, soil

Feature	*Goal*	*Time Period*	*Result*	*Action*
			no evidence of natural recruitment present	preparation methods, irrigation, and/or weed abatement methods. Monitor annually until success criteria are met. Consult SAC.
RMP PS 9 Protection of coastal bluff vegetation	No disturbance to coastal bluff vegetation	Ongoing	Vegetation undisturbed	Continue monitoring
			Vegetation disturbed (plants broken, trampled, dislodged, removed)	Install additional signs or low fencing as appropriate

Wetlands

Enhancement and protection goals for wetlands include increasing surface water flow, controlling weeds, promoting the abundance and diversity of native plant species, creating buffers, and controlling access by humans and non-native animals. Table 5 highlights the performance standards and enhancement activities for wetlands across the entire project area and for the 20-year duration. The primary focal areas for wetland restoration during Phase 2 of the project will include PS 12, 13, 14, 15, 16, and 17 (as per Table 5) as well as planting in the core areas of wetlands 4 and 5.

Table 5. Summary of restoration activities, success criteria, and implementation actions for wetland areas.

Feature	*Goal*	*Time Period*	*Result*	*Action*
RMP PS 10. Wetland 2 - flow diversion from Wetland 1	Wetland functioning as expected per design	1, 2, and 3 years after diversion completed	Structure remains intact Water diversion functioning as expected	Continue monitoring
			Structure fails	Fix with better structure
			Water diversion not functioning as expected	Develop and implement plans to correct functioning; continue monitoring
RMP PS 11. Combined Wetland W1/W2 – creation of willow riparian corridor and restoration plantings west and east of the	3 native plant species appropriate for habitat established in planted areas to comprise 30% cover (e.g. Coyote brush, willow, etc.).	2 years after planting	3 or more native plant species established comprising ≥ 10% cover within planted areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
combined W1/W2 hydrologic corridor			Fewer than 3 native plant species *or* < 10% cover of native species established within planted areas or no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met.
		4 years after planting	3 or more native plant species established comprising ≥ 20% cover within planted areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 3 native plant species *or* < 20% cover of native species established within planted areas or no evidence of natural recruitment present	Perform supplementa l planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met.
		6 years after planting** and every 5 years thereafter	3 or more native plant species established comprising ≥ 30% cover within planted areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 3 native plant species *or* < 30% cover of native species established within planted areas *or* no evidence of natural recruitment present	Perform supplementa l planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods. Monitor annually until success criteria are met Consult SAC.
RMP PS 12. Priority 1 weeds	Eliminate in wetlands	Year 3 and annually thereafter	No priority 1 weeds surviving to reproduction	Continue weed monitoring and removal as necessary
			Priority 1 weeds reproducing on site	Increase frequency of monitoring and weed removal efforts; consider alternative control methods

Feature	*Goal*	*Time Period*	*Result*	*Action*
RMP PS 13 Priority 2 Weeds	Reduce weedy seed set after planting efforts are initiated.	Timed to correspond with planting efforts.	Planted plants are not established	Continue weeding program
			Annual weeds out-competing native plants.	Change weeding schedule or evaluate alternative methods.
RMP PS 14. Native plant revegetation	4 native plant species appropriate for habitat established in planted areas to comprise 30% cover within selected areas	2 years after planting	4 or more native plant species established comprising ≥ 10% cover within planted areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 4 native plant species *or* <20% cover of native species established in planted areas *or* no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met
		4 years after planting	4 or more native plant species established comprising ≥ 20% cover within planted areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 4 native plant species *or* <20% cover of native species established in planted areas *or* no evidence of natural recruitment present	Perform supplementa l planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods Monitor annually until success criteria are met
		6 years after planting** and every 5 years thereafter	4 or more native plant species established comprising ≥ 30% cover within planted areas *and* evidence of natural recruitment present	Continue monitoring

Feature	*Goal*	*Time Period*	*Result*	*Action*
			Fewer than 4 native plant species *or* < 25% cover of native species established in planted areas *or* no evidence of natural recruitment present	Perform supplementa l planting using different species, propagule type, soil preparation methods, irrigation, and/or weed abatement methods. Monitor annually until success criteria are met Consult SAC.
RMP PS 15. Protection of revegetation in progress	No disturbance to revegetation plantings	Ongoing until revegetation is successful	Plantings undisturbed	Continue monitoring until revegetation is successful
			Plantings disturbed (plants broken, trampled, dislodged, removed)	Determine cause; develop appropriate solution

Feature	*Goal*	*Time Period*	*Result*	*Action*
RMP PS 16. Protection of wetlands	No unauthorized human disturbance to wetlands	Ongoing	Wetlands undisturbed	Continue monitoring
			Vegetation disturbed (plants broken, dislodged, trampled, removed); soils disturbed or compacted; other signs of trespass present	Install additional signs or low fencing as appropriate and per CLRDP specifications
RMP PS 17. Minimize anthropogenic changes to existing surface drainage patterns in open space areas (except for W1/W2 hydrologic integration)	Minimal changes to surface topography from management activities; no changes to surface topography due to unauthorized activities	Ongoing	Wetlands undisturbed	Continue monitoring
			Substantial changes to surface topography and/or drainage patterns evident	Determine cause; correct as necessary

Wetland buffers

Enhancement and protection goals for wetland buffer areas (Figure 5 and 7) are to protect wetlands from adverse impacts due to weeds, noise, human and non-native animal intrusion, lighting, predation, and sedimentation. During Phase 2, restoration of wetland buffer habitat will be conducted primarily in the Wetlands 4 and 5 buffers, but will also occur throughout other wetland buffer areas at a less intensive effort. Wetland buffers are delineated as 100 ft (30.5 m) beyond classified wetland habitat (with the exception of Wetland 5 which has a 150 ft [45.7 m] buffer area). Because conditions within wetland buffer areas vary, within and among wetlands, plant species used in revegetation efforts will be largely dependent upon soil conditions. In order to achieve the goal of "insulating" wetland habitat from noise and intrusion (both physical and visual) by people, planting efforts will include shrubs near the outer edge of the wetland buffer areas and adhere to interim and long-term goals for restoration of ruderal, coyote brush scrub, and coastal prairie (see Tables 3 and 6).

Table 6. Summary of restoration activities, success criteria, and implementation actions for wetland buffer areas.

Feature	*Goal*	*Time Period**	*Result*	*Action*
RMP PS 18. Reduce disturbance from automobile traffic	Construct new campus access road that diverts traffic between the Delaware Avenue/Shaffer Road intersection and the CDFG facility and abandon former access road (see management measures above)	See Table A.12 of CLRDP.	Roadway realigned and former roadway improved/restored	Maintain new roadway and trail/restoration areas of former roadway thereafter. Breaking up and removing pavement and then planting with native shrubs will enhance corridor along wetland 1.
RMP PS 19. Priority 1 weeds	Eliminate in buffer areas	Year 3 and annually thereafter	No priority 1 weeds surviving to reproduction	Continue weed monitoring and removal as necessary
			Priority 1 weeds reproducing on site	Increase frequency of monitoring and weed removal efforts; consider alternative control methods

Feature	*Goal*	*Time Period**	*Result*	*Action*
RMP PS 20 Priority 2 Weeds	Reduce weedy seed set after planting efforts are initiated.	Timed to correspond with planting efforts.	Planted plants are not established	Continue weeding program
			Annual weeds out-competing native plants.	Change weeding schedule or evaluate alternative methods.
RMP PS 21. Creation of vegetated berm at periphery of the buffer for wetland W5 (seasonal pond); see also management measures above	Establish vegetated berm (note: weed removal and planting requirements for the berm shall be the same as for the remainder of the weed removal and planting performance standards specified in this table)	See Table A.12 of CLRDP.	Vegetated berm established *and* weed control/planting successful per this table	Monitor and maintain in its design state thereafter
			Vegetated berm not established *and/or* weed control/planting not successful per this table)	Establish berm, and pursue remedial planting actions per this table.

Feature	*Goal*	*Time Period**	*Result*	*Action*
RMP PS 22. Native plant revegetation	8 native plant species appropriate for habitat established in restoration areas. 40% cover within buffer areas that will be planted with shrubs. 25% cover within buffer areas that will be planted with grasses and herbaceous plants.	2 years after planting	6 or more native plant species established. *and* ≥ 10% cover (shrubs), ≥ 5% cover (non-shrubs) *and* evidence of natural recruitment present.	Continue monitoring
			Fewer than 6 native plant species present. *or* < 10% cover (shrubs), < 5% cover (non-shrubs) *or* no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, and/or soil preparation methods Monitor annually until success criteria are met

Feature	*Goal*	*Time Period**	*Result*	*Action*
		4 years after planting	6 or more native plant species established. *and* ≥ 25% cover (shrubs), ≥ 15% cover (non-shrubs) *and* evidence of natural recruitment present.	Continue monitoring
			Fewer than 6 native plant species present. *or* < 25% cover (shrubs), < 15% cover (non-shrubs) *or* no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, and/or soil preparation methods Monitor annually until success criteria are met.

Feature	*Goal*	*Time Period**	*Result*	*Action*
		6 years after planting and every 5 years thereafter	8 or more native plant species established. *and* ≥ 40% cover (shrubs), ≥ 25% cover (non-shrubs) *and* evidence of natural recruitment present.	Continue monitoring
			Fewer than 6 native plant species present. *or* < 40% cover (shrubs), < 25% cover (non-shrubs) *or* no evidence of natural recruitment present	Perform supplemental planting using different species, propagule type, and/or soil preparation methods Monitor annually until success criteria are met. Consult SAC.
RMP PS 23. Protection of revegetation in progress	No human disturbance to revegetation plantings	Ongoing until revegetation is successful	Plantings undisturbed	Continue monitoring until revegetation is successful

Feature	*Goal*	*Time Period**	*Result*	*Action*
			Plantings disturbed (plants broken, trampled, dislodged, removed)	Install signs or low fencing as appropriate
RMP PS 24. Protection of buffer areas	No unauthorized human disturbance to buffer areas	Ongoing	Buffer areas undisturbed	Continue monitoring
			Buffer areas disturbed (plants broken, dislodged, trampled, removed); soils disturbed or compacted; other signs of damage present	Install additional signs or low fencing as appropriate and per the CLRDP requirements .
RMP PS 25. Minimize anthropogenic changes to existing surface drainage patterns (except for those contemplated by and consistent with the CLRDP, including the Drainage Concept Plan (Appendix B).	Minimal changes to surface topography from management activities; no changes to surface topography due to unauthorized activities	Ongoing	Wetlands/buf fers undisturbed	Continue monitoring and work with Campus Planning, Developmen t and Operations to ensure potential temporary impacts from construction are not having long-term impacts on wetland buffer habitats.

<u>SUCCESS CRITERIA (SRP 8)</u>

Detailed success criteria for each habitat type are described in SRP 7 above. These criteria set an initial threshold of species richness and cover for specific habitat types throughout the restoration area. These criteria are based on CLRDP recommendations, and have been further refined by the SAC based on: 1) species richness and cover data that were collected for coastal prairie, scrub, and wetland habitats at "Reference Sites," and 2) results from Phase 1 of Restoration. The criteria are the same as for Phase 1, except for the addition of an annual monitoring requirement for sites that fall below success criteria in order to allow for more responsive, adaptive management. If success criteria are not achieved, the SAC will discuss potential causes for the lack of success and recommend future adaptive management strategies to obtain desired goals.

<u>MONITORING (SRP 9)</u>

This section of the SRP defines the monitoring approach that will be used to evaluate whether success criteria for native plant cover and richness is being met. In order to assess the progress towards meeting defined success criteria, monitoring efforts will focus on Phase 1 and Phase 2 target restoration/enhancement areas. The ultimate goal of Phase 2 is to meet success criteria for 2/3 of the Terrace Lands (approximately 24 ac [10 ha]). Monitoring will occur in the spring when species are blooming and readily identifiable. Percent cover and species richness will be calculated as described below; data will be compared to success criteria outlined in Tables 3-6.

Hydrological monitoring

Water levels in each major wetland (1, 2, 4, and 5) will be recorded weekly throughout the rainy season at a series of staff plates (1, 2, 4, and 5) and piezometers (4 and 5) positioned strategically throughout the wetlands. Rainfall data will be collected at the Younger Lagoon Reserve weather station, located at the Long Marine Laboratory.

Coyote brush scrub, coastal bluff, willow riparian, and ruderal areas

These areas are dominated by shrub species. The line intercept method will be used to assess cover in Coyote brush scrub, coastal bluff, willow riparian, and ruderal areas. Each transect will be 164 ft (50 m) in length and distributed throughout the restoration areas within each habitat type. The first starting point will be randomly selected within each specific habitat type and additional transects will be established at fixed intervals of 246 ft (75 m) in a north south direction. Specific start locations of each transect will be permanently established; however, orientation of every transect will be randomly selected each time a transect is surveyed (i.e. in different years). This method establishes random transect points while ensuring adequate coverage of the entire restoration area. If transects extend beyond the target habitat type into either developed areas or different habitats, the random orientation or starting point will be reselected in order to ensure sampling occurs within the target habitat. Shrub cover will be quantified by recording the length each shrub species is observed under the transect tape to the nearest 2 in (5 cm); herbaceous and grass cover will not be quantified in areas where shrubs intersect with the transect.

For areas within Coyote brush scrub, coastal bluff, willow riparian, and ruderal areas that lack shrubs (i.e. interstitial open areas), herbaceous plants and grasses will be quantified using 2.69 ft^2 (0.25 m^2) rectangular quadrats 0.82 x 3.28 ft (0.25 m x 1.0 m). Quadrats will be placed every 16.4 ft (5 m) perpendicular to the transect with the first quadrat placed randomly between (0-5 m). Quadrats will alternate between the right and left side of the transect (first placement selected randomly) unless only one side contains an open grassy area, in those cases the open area will be chosen. Percent cover of native and non-native species will be determined by estimating total cover of each guild within each quadrat.

To adequately survey species richness, all native species that are observed in a 13 ft (4 m) wide belt transect along the line transect (6.5 ft [2 m] to either side of the line) will be recorded. Natural recruitment of native species will be noted in the line intercept and quadrat surveys by noting the presence or absence of recruits along the belt transect.

Coastal Prairie Areas

These areas are dominated by grasses and forbs. Transects will be established as per methodologies described above in Coyote-brush scrub, coastal bluff, willow riparian, and ruderal areas and serve as a backbone for quadrat surveys. Grasses and herbaceous cover will be quantified using 2.69 ft^2 (0.25 m^2) rectangular quadrats (0.82 x 3.28 ft [0.25 m x 1.0 m]). Quadrats will be placed every 16.4 ft (5 m) perpendicular to the transect with the first quadrat placed randomly between (0-5 m). Quadrats will alternate between the right and left side of the transect (first placement selected randomly) unless only one side contains an open grassy area, in those cases the open area will be chosen. Percent cover of native and non-native guilds will be determined by estimating total cover of each species within each quadrat.

To adequately survey species richness, all native species that are observed in a 13 ft (4 m) wide belt transect along the line transect (6.5 ft [2 m] to either side of the line) will be recorded. Natural recruitment of native species will be noted in the line intercept and quadrat surveys by noting the presence or absence of recruits along the belt transect.

Wetland Vegetation

Rectangular quadrats 2.69 ft^2 (0.25 m^2) will be used to evaluate cover of grass, forb, sedge, and rush species in the wetland areas. Quadrat size will be 0.82 x 3.28 ft (0.25 m × 1.0 m). A series of sampling locations will be determined by randomly assigning starting points at the edge of each wetland (determined by vegetation). At each starting point a transect tape will be extended across the wetland at a randomly chosen orientation to the opposite edge of the wetland. If the random orientation results in the transect being outside of the wetland area another orientation will be randomly selected. Quadrats will alternate between the right and left side of the transect (first placement selected randomly) falls within the wetland, in those cases the wetland area will be chosen. Percent cover of native and non-native species will be determined by estimating total cover of each species within each quadrat.

To adequately survey species richness, all native species that are observed in a 13 ft (4 m) wide belt transect along the line transect (6.5 ft [2 m] to either side of the line) will be recorded.

Natural recruitment of native species will be noted in the line intercept and quadrat surveys by noting the presence or absence of recruits along the belt transect.

GIS and GPS Vegetation Surveys

Beyond on-the-ground transect and quadrat surveys described above, percent cover of select species across the entire site will be calculated by digitizing the perimeters of identifiable species occurring throughout the Terrace Lands using GIS of recent aerial imagery. Once plants are digitized, area and percent coverage can be calculated using spatial analysis, thus providing an additional measure of cover for some species. Aerial imagery analysis and on-the-ground GPS mapping will provide a thorough estimate of total coverage of patchily distributed species such as coyote brush, creeping wild rye, Douglas' baccharis, and wetland species (rushes, and sedges) that can be accurately identified from aerial imagery. Aerial imagery will be digitized when orthoimagery is updated and available (likely every 2-5 years).

Photo monitoring

On-the-ground photo monitoring will be conducted annually and be timed to correspond when plants are blooming and more easily identified (spring/early summer). Photos will be oriented to capture large scale changes over time and taken at permanent photo points established throughout the project area. Figure 12 identifies several photo points; however, additional points will likely be created over time in order to capture specific areas within the restoration site and ensure growing vegetation does not preclude adequate coverage. Each point has a coordinate and bearing in order to ensure repeatability over time. Monitoring information collected for each photo point will include:

1. Photo point number
2. Date
3. Name of photographer
4. Bearing

5. Camera and lens size
6. Coordinates
7. Other comments

All on-the-ground photos will be included in the monitoring reports.

Figure 7. Photo monitoring points.

Monitoring study report and schedule

Results from monitoring efforts will be included in the reports (as per SRP 6) that will be submitted by December 31^{st} of each year to UCSC, CCC, and the SAC. Reports will include a summary of restoration activities as well as an evaluation of whether success criteria are being achieved. The report will also discuss any corrective actions or adjusted protocols that may be required.

FINAL MONITORING REPORT (SRP 10)

The final monitoring report will be submitted to the UCSC Planning Director, Scientific Advisory Committee, and California Coastal Commission at the end of the final monitoring period of Phase 2. The report will evaluate whether the site area conforms to the goals and success criteria set forth in the approved final resource plan.

PROVISION FOR POSSIBLE FURTHER ACTION (SRP 11)

If the final report (SRP 10) indicates that the project has been unsuccessful, in part or in whole, based on the approved success criteria, then the final report shall identify remediation measures to be implemented to compensate for those portions of the original plan that did not meet the approved success criteria.

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LITERATURE CITED

Bossard, C. C., J.M. Randall, and M. C. Hoshovsky. 2000. Invasive Plants of California's Wildlands. University of California Press. Berkeley, CA

California Native Plant Society. 1996. Policy on Exotic Invasive Plants. Adopted September 1996.

DiTomaso, J.M. 2000. Invasive weeds in rangelands: species, impacts, and management. Weed Science 48:255-265.

EcoSystems West. 2002. Biological Resources. Text and appendices. In Environmental Science Associates (ESA) Environmental Impact Report (EIR) for the University of California, Santa Cruz Coastal Long Range Development Plan.

Elzinga, C.L., D.L. Salzer, J.W. Willoughby and J.P. Gibbs. 2001. Monitoring plant and animal populations, Blackwell Scientific, Malden, MA.

John Gilchrist & Associates (JGA) and Environmental Hydrology (EH). 1997. Draft Wetland and Open Space Management Plan, Santa Cruz Coastal Marine Research Center at Terrace Point. Prepared for ATC Realty Sixteen, Inc. December.

John Gilchrist & Associates (JGA) and Environmental Hydrology (EH). 1998. Landscape, Habitat and Open Space Management Plan, Santa Cruz Coastal Marine Research Center at Terrace Point. Revised Draft. Prepared for ATC Realty Sixteen, Inc. May.

Hayes, G. F. and K. D. Holl. 2003a. Site-specific responses of native and exotic species to clipping frequency, litter accumulation and soil disturbance in a mesic grassland community. Applied Vegetation Science 6: 235-244.

Hayes, G. F. and K. D. Holl. 2003b. Cattle grazing impacts on vegetation composition and structure of mesic grasslands in California. Conservation Biology 17: 1694-1702.Hickman, J.C. (Ed.), 1993. The Jepson Manual, Higher Plants of California

Huffman-Broadway Group, Inc. 2004. Investigation of the Presence of Wetlands and Other Environmentally Sensitive Habitat Areas on the Terrace Point Site, University of California, Santa Cruz. Prepared for University of California, Santa Cruz, Campus and

Community Planning. (*HUFFMAN-BROADWAY GROUP, INC. 2004 proposed CCC Wetlands boundary was updated during 2007 based on field data obtained from (1) an interagency (Corps and USEPA) peer review requested by the CCC, (2) CCC staff, and (3) HBG during the during the winter and spring of 2007*).

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. The National Wetland Plant List: 2016 wetland ratings. Phytoneuron 2016-30: 1-17. Published 28 April 2016. ISSN 2153 733X

Mori, B. 1997. Terrace Point California Red-legged Frog Site Assessment, Santa Cruz, California. Prepared for ATC Realty Sixteen, Inc.

The National Invasive Species Council. 2008. 2008-2012 National Invasive Species Management Plan. 35 pp. Available at: www.invasivespecies.gov

National Resources Conservation Service. 1992. Hydric Soil List for Santa Cruz County, California. United States Department of Agriculture. Available at: http://www.ca.nrcs.usda.gov/mlra02/stcruz/

Soil Conservation Service. 1980. Soil Survey of Santa Cruz County. United States Department of Agriculture and University of California Agriculture.

Stromberg, M. R., J. Corbin, and C. D'Antonio. 2007. California Grasslands: Ecology and Management. University of California Press, Berkeley, CA.

U.S. Fish and Wildlife Service. 1988. National list of vascular plant species that occur in wetlands. U.S. Fish & Wildlife Service Biological Report 88 (26.9).

University of California at Santa Cruz. 2008. Marine Science Campus Coastal Long Range Development Plan. Prepared for the California Coastal Commission, March 2008.

UCSC Natural Reserves Staff. 2015. Younger Lagoon Reserve Annual Report 2014-2015. Plan prepared for the Younger Lagoon Reserve Scientific Advisory Committee and the California Coastal Commission.

UCSC Natural Reserves Staff. 2016. Younger Lagoon Reserve Annual Report 2015-2016. Plan prepared for the Younger Lagoon Reserve Scientific Advisory Committee and the California Coastal Commission.

UCSC Natural Reserves Staff. 2017. Younger Lagoon Reserve Annual Report 2016-2017. Plan prepared for the Younger Lagoon Reserve Scientific Advisory Committee and the California Coastal Commission.

APPENDICES

Appendix 1. CLRDP A.6.1: Specific Resource Plan Requirements

A.6.1 Specific Resource Plans Required

The RMP provides a fairly broad outline with general recommendations and specific guidelines for resource protection, enhancement, and management on the Coastal Science Campus site. The intent is that the Scientific Advisory Committee (SAC) uses the RMP as the initial framework for development of more detailed and specific resource plans for RMP implementation. These may be adapted to address the current physical and ecological conditions, current understanding of biological and ecological processes, and current approaches to habitat revegetation, restoration, and enhancement, provided that the overall intent of the RMP is carried out, including the level of resource protection and the timing guidelines. For example, the RMP performance standards provide suggestions for standards of biodiversity and vegetative cover, but these might be altered in a detailed plan based on new research or revegetation experience at this site. Adjustments to the performance standards that are more protective of the resources and more responsive to the site conditions based on management experience over time are encouraged.

Therefore, implementation of the requirements of this RMP shall be based on more detailed resource plans. Some of these more detailed resource plans will be developed during the course of projects that emanate from the CLRDP building program that require certain mitigations and capital improvements as part of them, but others may be developed irrespective of the building program (see also Approvals section below). Implementation of the RMP shall be guided by the SAC composed of three to four native restoration professionals and academicians appointed by the UCSC Chancellor and selected in consultation with the Executive Director of the California Coastal Commission. This committee shall meet on an annual basis at a minimum (more frequently as needed), and provide overall direction for resource plan preparation, revegetation installation, long-term maintenance and monitoring.

Appendix 1: Specific Resource Plan Requirements

Specific Resource Plans shall be prepared per 1M 3.2.10 by a qualified restoration ecologist under the guidance of the SAC, and will follow the guidelines below, as appropriate:

1. A baseline assessment, including photographs, of the current physical and ecological condition of the proposed restoration, enhancement, and/or management site area. As appropriate, this may be based on available historical information or include current surveys addressing wetland delineation (conducted according to the definitions in the Coastal Act and the Coastal Commission's Regulations), a description and map showing the area and distribution of vegetation types, and a map showing the distribution and abundance of sensitive species, if any. Existing vegetation, wetlands, and sensitive species shall be depicted on a map that includes the footprint of the proposed site area.

2. A description of the goals of the resource plan, including, as appropriate, topography, hydrology, vegetation, sensitive species, and wildlife usage.

3. A description of planned site area preparation and invasive plant removal.

4. A planting plan including the planting palette (seed mix and container plants), planting design, source of plant material, plant installation, erosion control, irrigation, and remediation. Except for the planting of Monterey cypress, the planting palette shall be made up exclusively of native taxa that are appropriate to the habitat and region. Seed and/or vegetative propagules shall be obtained from local natural habitats so as to protect the genetic makeup of natural populations. Horticultural varieties shall not be used. Materials should be collected from coastal habitats that are located within approximately one mile of the Coastal Science Campus and seaward of Highway 1 (Morgan 2002).

5. A plan for documenting and reporting the physical and biological "as built" condition of the site area within 30 days of completion of the initial plan implementation activities. This simple report will describe the field implementation of the approved resource plan in narrative and photographs, and report any problems in the implementation and their resolution.

6. A plan for interim monitoring and maintenance, including:

   a. A schedule.

   b. Interim performance standards keyed to final success criteria (#7, below).

   c. A description of field activities, including monitoring studies (#8, below).

   d. The monitoring period.

   e. Provision for submission of annual reports of monitoring results to the Planning Director for the duration of the required monitoring period, beginning the first year after submission of the "as-built" report. Each report shall be cumulative and shall summarize all previous results. Each report shall document the condition of the site area with photographs taken from the same fixed points in the same directions. Each report shall also include a "Performance Evaluation" section where information and results from the monitoring program are used to evaluate the status of the project in relation to the interim performance standards and final success criteria. To allow for an adaptive approach to management, each report shall also include a "Recommendations" section to address changes that may be necessary in light of study results or other new findings.

7. Final success criteria for each habitat type, including, as appropriate:

    a. Species diversity, including total number of taxa, number of native taxa, and number of invasive non-native taxa.

    b. Vegetation coverage, including total vegetation, native vegetation, invasive non-native taxa, and dominant species.

    c. Wildlife usage.

    d. Erosion control and functional hydrology.

    e. Control of invasive non-native plant taxa.

    f. Maintenance of suitable habitat, and presence/abundance, for sensitive species or other individual "target" species.

    g. A requirement that success be determined after a period of at least three years wherein the study site has been subject to no remediation or maintenance activities other than weeding.

8. The method by which "success" will be judged, including, as appropriate:

    a. Type of comparison. Possibilities include comparing a census of the site area to a fixed standard derived from literature or observations of natural habitats, comparing a census of the site area to a sample from a reference site, comparing a sample from the site area to a fixed standard, or comparing a sample from the site area to a sample from a reference site.

    b. Identification and description, including photographs, of any reference sites that will be used.

    c. Test of similarity. This could simply be determining whether the result of a census was above a predetermined threshold. Generally, it will entail a one- or two-sample t-test.

    d. The field sampling design to be employed, including a description of the randomized placement of sampling units and the planned sample size.

e. Detailed field methods; not simply a citation of a publication or standard methodology.

f. Specification of the maximum allowable difference between the restoration value and the reference value for each success criterion.

g. Where a statistical test will be employed, a statistical power analysis to document that the planned sample size will provide adequate statistical power to detect the maximum allowable difference. Generally, sampling should be conducted with sufficient replication to provide 90% power with alpha=0.10 to detect the maximum allowable difference. This analysis will require an estimate of the sample variance based on the literature or a preliminary sample of a reference site.

h. A statement that final monitoring for success will occur after at least 3 years with no remediation or maintenance activities other than weeding.

9. Monitoring study design for each habitat type, including, as appropriate:

   a. Goals and objectives of the study.

   b. Field sampling design.

   c. Study sites, including experimental/revegetation sites and reference sites.

   d. Field methods, including specific field sampling techniques to be employed. Photomonitoring of experimental/revegetation sites and reference sites shall be included.

   e. Data analysis methods, including descriptive and inferential statistics with specified acceptable variance and significance levels to examine sample size, univariate and multivariate comparisons, and/or other param as appropriate and necessary to assess progress toward and meeting of success criteria.

   f. Presentation of results.

   g. Assessment of progress toward meeting success criteria.

   h. Recommendations.

   i. Monitoring study report content and schedule.

10. Provision for submission of a final monitoring report to the UCSC Planning Director and Scientific Advisory Committee at the end of the final monitoring period. The final report must be prepared by a qualified restoration ecologist. The report must evaluate whether the site area conforms to the goals and success criteria set forth in the approved final resource plan.

11. Provision for possible further action. If the final report indicates that the project has been unsuccessful, in part or in whole, based on the approved success criteria, then

the final report shall identify remediation measures to be implemented to compensate for those portions of the original plan that did not meet the approved success criteria.