University California, Santa Cruz

Younger Lagoon Reserve

Annual Report 2022-2023

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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 100 undergraduate students who were involved with research, education, and stewardship. The majority of interns were involved in hands-on restoration and monitoring activities on the Terrace Lands engaging in a wide range of projects. Younger Lagoon Reserve continued to support use by other groups such as Cabrillo College, San Jose State University, Humboldt State University, the Santa Cruz Bird Club, local K-12 programs, and other community groups.

Restoration activities in FY 2022-2023 included weed control, planting of approximately 2 acres, and seed collection. 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 12th year of CLRDP compliance monitoring. Habitats monitored in 2023 included coastal scrub, coastal prairie, and wetland buffer areas. YLR is meeting or exceeding restoration targets for all monitored sites and is meeting the restoration goals for Phase 2. FY 2022-2023 represented the 13th full year of implementation of the CLRDP Beach Access Management Plan related activities at Younger Lagoon Reserve. The University's NOID 12 (20-1) was approved by the California Coastal Commission (CCC) in October 2020 with the continuation of five special conditions related to increased public access to Younger Lagoon Reserve beach. YLR is fulfilling all required public access requirements for the Younger Lagoon Reserve beach.

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 2022-2023 fiscal year (July 1, 2022 - June 30, 2023). 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 13 th year we had fulltime staff on site managing the Reserve. As a direct result, the level of academic and public engagement has 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 Reserves 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 14th 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), & NOID 12 (20-1) Beach Access Management Plan

This year represented the 12th 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 workload 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 1) requiring that the tours 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. Condition 5 has the potential to jeopardize 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.

The University submitted NOID 12 to the CCC in October 2020. In October 2020, the Commission approved UCSC's NOID 12 with the continuation of the five special conditions required in 2018.

A detailed report on activities under the Beach Access Management Plan is included as Appendix 1. The NOID 12 Special Conditions Implementation Reports 4 & 5 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. FY 2017-2018 marked the conclusion of the SRP for Phase 1A.

The SRP for Phase 2 of restoration (second 7 years) was submitted to the CCC as part of the 2017-2018 Annual Report.

The SRP for Phase 2 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, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, and 2021-2022 Annual Reports). Compliance monitoring for restored coastal scrub, coastal prairie, and wetland buffer areas was conducted in FY 2022-2023. All sites monitored in 2022-2023 met or exceeded restoration targets and we are on track to meet all of the Phase 2 success criteria. A detailed compliance monitoring report is included in Appendix 2.

Restoration of the Terrace Lands continued throughout FY 2022-2023. Activities included weed control, planting, and seed collection.

<u>Future Restoration Monitoring Efforts (2023-2024)</u>

During the 2023-2024 field season, UCSC graduate students under the direction of professor Dr. Karen Holl will conduct restoration compliance monitoring at restoration sites 2, 4 and 6 years post planting and 5 years thereafter 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.

SRP Phase 1B

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). SRP Phase 1B is now complete. 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.

Domesticated Animals

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 in conjunction with activities under NOID 6 (13-1), and continued in FY 2021-2022. New trail signage was installed in 2018 to educate the community and the public about the policy change.

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 with reserve staff on-site and through email/phone consultation in FY 2022-2023. Discussion topics included current and future projects under the CLRDP, restoration, research, and teaching activities at YLR.

<u>Monitoring Recommendations:</u>

Coastal prairie is notoriously difficult to restore and maintain. The SAC recommends monitoring any sites that fall below target once a year rather than every other year and replanting or changing management regimes if sites does not rebound. Following the SACs recommendations, the 2012 coastal prairie restoration site – which was impacted by construction and drought and had fallen below its success targets in FY 2019-2020, was scrapped and completely replanted in FY 2020-2021. It was monitored as a new site in FY 2022-2023 and is exceeding its restoration targets.

<u>Research Recommendations:</u>

SAC members recommend that future research include investigations into methods for increasing the success of native annual forb plantings in coastal prairie restoration.

Summaries of ongoing research projects undertaken in FY 2022-2023 by Dr. Holl, Dr. Justin Luong, and graduate students Janine Tan, Jennifer Valadez, Whitney Barnett at the direction of the SAC are below. A full report on these projects is included in Appendix 3.

Priority Effects in Annual Forb Establishment

Dr. Holl and her team initiated this experiment in the winter of 2021. They planted four species of forbs (*Clarkia davyi*, *Clarkia rubicunda*, *Phacelia malvifolia*, and *Navarretia squarrosa*) in plots in which perennial grasses (*Stipa pulchra*, *Deschampsia cespitosa*, and *Elymus glaucus*) were planted two years prior to forb planting (grass priority) and the remaining plots had forbs planted two weeks prior to any grass planting (forb priority). As reported 2021, survival was higher in forb than grass priority treatments and native annual forbs planted with *Deschampsia cespitosa* had significantly lower survival compared to those planted with *Stipa pulchra*. The treatments primarily affected the two species of Clarkia. Seed set of the annual forbs was generally much higher in the forb priority treatment.

Dr. Holl and her team monitored the number of seedlings of each of the forb species recruited in March 2022 and May 2023. In most cases, recruitment was much higher in both years in forb than grass treatment plots. Moreover, the number of recruits declined substantially from 2022 (a dry year) to 2023 (a very wet year), which may reflect high mortality and low seed set due to the drought conditions in 2022. The only exceptions to this trend were that *N. squarrosa* seedlings were much less abundant in forb than grass plots in both 2021 and 2022, although this trend reversed in 2023. Dr. Holl and her team think this may have been because there was a much thicker mulch layer in forb priority treatments, since they were mulched prior to seeding in 2021 whereas grass priority treatments were mulched two years prior; *N. squarrosa* has small seeds and, therefore, would be likely to be more strongly affected by a thick mulch layer. *C. davyi* had similar numbers in both treatments in 2022 but significantly higher recruits in 2023. Dr. Holl and her team plan to monitor seed output during summer 2023 and then will compile and fully analyze the three years of data.

Effects of Scraping and Mounding on Annual Forb Establishment

Dr. Holl and her team installed this experiment in January 2022. It described in detail in Janine Tan's senior thesis which is included Appendix 3 of this report. Two native perennial grasses (*Stipa pulchra* and *Elymus glaucus*) and six native annual forbs (*Amsinckia spectabilis, Clarkia davyi, Clarkia rubicunda, Lupinus nanus, Navarretia squarrosa,* and *Phacelia malvifolia*) were planted in three treatments: control (no manipulation), soil scraping (removing the top 3-4 cm of soil to reduce soil nutrient and the non-native seed bank), and soil mounding (creating flat topped mounds 2-3 cm higher than the surrounding area to mimic small mammal mounds). Ms. Tan monitored seedling survival in April and July 2022, and in May 2023 Dr. Holl and her team measured survival of perennial grasses and recruitment of forbs.

Forb seedling survival in April 2022 was generally similar across all treatments. By July 2022 fewer than 5% of the forbs of any species survived so it was impossible to monitor fruit and seed set. Grass survival in July 2022 was 15-30% across the treatments and did not differ significantly by treatment.

In May 2023, *Elymus glaucus* survival was 34.0% and cover was 1.8 dm^2 overall, and neither differed across treatments. *Stipa pulchra* cover showed a trend toward higher survival (Control: 16.7 ± 7.0%, Mounding: 14.6 ± 7.5%, Scraping: 22.9 ± 8.8) and cover Control: 0.5 ± 0.2 dm^2, Mounding: 0.5 ± 0.3, Scraping: 1.2 ± 0.50) in scraped plots, although the values were not significantly different given the high variability across plots within the same treatment. The number of recruiting individuals of forb species in 2023 was extremely low, which is not surprising given the poor survival the prior year. Given the low initial survival and subsequent recruitment of the annual forbs, Holl and her team have decided not to continue to monitor this experiment in future years

<u>Scientific Advisory Committee Management Recommendations:</u>
In FY 2022-2023 the SAC continued to provide input on the construction of a California Red-Legged Frog (CRLF) breeding pond in the upper terrace.

Upper Terrace CRLF Ponds
CLRDP RMP MM 9 states that the University shall "*Restore, consolidate, expand, and enhance wetlands on the northern part of the site (i.e., north of the Campus access road) to restore historic functional values lost during decades of agricultural use. The restoration program will include integrating the hydrology of Wetlands W1 and W2 to create a consolidated north-south area for wildlife movement to YLR. Hydrological surveys will be conducted by a qualified hydrologist to establish the elevations appropriate for optimizing expected wetland functioning. The area will be graded to provide a natural channel profile and gradient between the culvert at the Union Pacific Railroad tracks and the culvert outlet to Younger Lagoon on the west property*

line. The area west of the combined W1/W2 hydrologic corridor shall be restored as functioning wetland upland/transitional habitat, as shall buffer areas to the east. Maintain the CRLF potential habitat at the northern end of W-2.

During the ACoE permitting process for projects impacting wetlands on the Coastal Science Campus (including restoration work in the upper terrace), the US Fish and Wildlife Service (USFWS) was brought in for Section 7 consultation. This discussion included members of the Natural Reserves and Physical Planning and Construction. In April 2014, USFWS approved the University's project as proposed and asked the campus to explore the feasibility of building CRLF pond(s) in the upper terrace as both a benefit to the local population and a demonstration of good faith / collaboration between UCSC and USFWS.

With the support of the reserve, campus agreed to explore the possibility and staffs from both the Resource Conservation District (RCD) and USFWS Coastal Program made a site visit to discuss feasibility and conduct initial studies in the summer and fall of 2014. RCD staff completed a soil evaluation in October 2014 and found groundwater at less than 5' deep at one of the sample points (in sandy soils and in very dry conditions) and believe that CRLF ponds could be engineered on site to hold water for long enough to support breeding. The RCD was ready to move forward with putting together a proposal for designing and building the ponds (this would have needed to be evaluated by the SAC with our existing RMP obligations in mind - e.g. reconnect wetlands 1 and 2, etc.); however, due to unresolved questions including permitting (e.g. would the RCD's permits work for the site within the permitting requirements and procedures for UC) and potential impacts to future projects, PP&C staff felt there was not enough information to move forward with further RCD planning and/or construction the ponds. Subsequently, PP&C staff engaged additional outside hydrologic and biologic consultants to do a feasibility study in 2016-2017. This study confirmed initial studies by the RCD, and indicated that CRLP Ponds could be engineered on site to hold water for long enough to support breeding. However, the study also warned that factors such as nearby bullfrog and crayfish populations could hinder the success of such ponds.

In 2019, USFWS Coastal Program contacted the University about an opportunity to have a CRLF breeding pond built on-site by the RCD at little to no expense to the University under the RCD's consolidated permitting program. Staff representing UCSC Physical Planning, Development, and Operations (PPDO, formerly PP&C), the UCSC NRS, the RCD, and USFWS Coastal Program in FY 2019-2020 to discuss the opportunity further and begin the planning process. The planning process – including design, continued throughout FY 2020-2021 and extended into FY 2021-2022. The SAC provided feedback on multiple rounds of draft designs that were incorporated into the final approved project.

In 2021, the RCD was able to obtain all the necessary project permits and approvals for construction of a CRLF breeding pond on the Coastal Science Campus. In the fall of 2021, the RCD partnered with the University to build a pond to improve breeding habitat for CRLF in the upper terrace. Reserve staff and student interns began replanting the project site with native species in the fall of 2021. Reserve staff and student interns conducted extensive biological monitoring of the pond throughout the year, including nighttime visual amphibian surveys, acoustic monitoring, invertebrate sampling. In FY 2021-2022, the pond functioned as planned and was colonized by native Sierran treefrogs (*Pseudacris sierra*) and a small number of invasive American bullfrogs (*Lithobates catesbeianus*); however, no CRLF were detected during the first-year post construction. In FY 2022-2023, the pond functioned as planned and was colonized by native Sierran treefrogs, a small number of invasive American, and CRLF. In February 2023, a single CRLF egg mass was detected in the pond, and some of the eggs developed into tadpoles and metamorphosed into frogs. As the native plantings continue to establish, we anticipate that the pond will support additional CRLF breeding.

The SAC was generally supportive of the idea of CRLF pond in the upper terrace as a way to 1) increase collaboration between UCSC, YLR, and the USFWS, 2) potentially provide opportunities for CRLF teaching, research and outreach on the reserve, and 3) meet habitat restoration and wetland reconnection goals. However, some SAC members expressed concerns about 1) whether the ponds would function as expected and 2) more broadly, whether or not CRLF ponds are even necessary in our area. The SAC will continue to provide guidance on future pond management and monitoring efforts.

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 3rd and 4th, 2023. 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

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.

Younger Lagoon Reserve 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 were planted with native species during Phase 1. 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, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, and 2021-2022 Annual Reports; and SRP Phase 1 Summary Report).

SRP Phase 2

The SRP for Phase 2 of restoration (second seven years) follows the same success criteria for each of the reserve's habitat types and encompasses approximately 8.5 acres of restoration. At the time the SRP for Phase 2 of restoration was written (2017-2018), we anticipated that Phase 2 restoration efforts would focus primarily on the middle terrace with some efforts occurring in other areas. The SRP for Phase 2 discusses the possibility of the upper terrace frog pond project occurring during Phase 2; however, it was not clear at the time the SRP for Phase 2 was written that the project would receive approval in time to occur during Phase 2. With the approval and successful construction of the pond, we will be focusing more of our efforts during Phase 2 on the upper terrace that initially anticipated. The total number of acres restored during Phase 2 and success criteria will remain the same. (See 2017-2018, 2018-2019, 2019-2020, 2020-2021 and 2021-2022 Annual Reports; and SRP Phase 2).

FY 2022-2023 Restoration Activities

Restoration activities continued on the Terrace Lands 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. Undergraduate student employees transport native seedlings to the FY 2022-2023 restoration site.

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 2022-2023, 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 2023-2024, reserve staff will continue weed control projects and patrols. Due to the longlived 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.

Seed Collection and Plant Propagation

In the summer and fall of 2022, reserve staff and student interns collected seeds for restoration growing. These seeds were propagated by the UCSC Teaching Greenhouse in the fall and winter of 2022/2023.

Restoration Planting

In FY 2022-2023, approximately 2 acres of coastal prairie and scrub areas were planted with native seedlings (Figure 2).

Figure 2. 2023 Restoration Site.

Education

Instructional use at Younger Lagoon Reserve continued to be strong this year and students reported a deep sense of satisfaction in being together at the reserve. Courses encompassed a wide variety of disciplines. The steady 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 Natural History Illustration.

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

YLR's location on the UC Santa Cruz Coastal Science Campus and proximity to the UC Santa Cruz Main Campus make it an ideal setting for undergraduate teaching and research (Figure 3). In FY 2022-2023 the reserve hosted classes in Climate Change Ecology, Coastal Field Studies, Community Immersion, Ecology, Ecology and Conservation in Practice Supercourse, Environmental Field Methods, Field and Lab Methods in Aquatic Science, Field Biology in Practice, Freshwater and Wetland Ecology, Herpetology, Mammalogy, Marine Conservation Biology, Molecular Ecology, Natural History Illustration, Natural History of UC Santa Cruz, Ornithology, Plant Ecology, Restoration Ecology, Senior Seminar in Applied Mycology, Soil Science Practicum, and Systematic Botany of Flowering Plants (Table 1).

Figure 3. Students from *BIOE 143 Herpetology* practice identifying and handling reptiles and amphibians at Younger Lagoon Reserve. This course was taught in the Coastal Biology Building and students walked from their classroom to the field in minutes.

Internships

In FY2022-2023, YLR staff sponsored over 100 undergraduate interns through the UCSC Environmental Studies Internship Office. The students ranged from entering freshman to graduating seniors and spent between 6 and 15 hours a week learning about on-going restoration projects at the reserve. Interns participated in hands-on projects including invasive species removal, re-vegetation with native species, seed collection, and propagation; and virtual activities including readings, videos, and weekly online discussion sections with reserve staff and local experts. Student-interns report a deep appreciation for the opportunity to obtain experience in their field of study and build community – especially post-pandemic, with their fellow students (Figure 4).

Figure 4. Undergraduate student interns prepare for a rainy day of restoration work at reserve.

Course Title	Institution (Department)	Instructor's Name
BIO 11C - Ecology	Cabrillo Community College	Alison Gong
ENVS 189 – Coastal Field Studies	San Jose State University	Rachel Lazzeri-Aerts
BENN 2929– Community Immersion	University of Utah, Bennion Cetner	Stephanie Shin
BIOE ACCESS HBCU Summer Short Course	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Rachel Meyer
BIOE Doris Duke Conservation Scholars	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Abe Borker
BIOE 20F – Field Biology in Practice	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Ingrid Parker
BIOE 82 – Introduction to Field Research and Conservation	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Alison Gong
BIOE 107 – Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Marm Kilpatrick
BIOE 112 – Ornithology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Bruce Lyon
BIOE 114/L – Herpetology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Sean Reilly
BIOE 117/L – Systematic Botany of Flowering Plants	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Miranda Melen
BIOE 124/L – Mammalogy	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Gizelle Hurtado
BIOE 137 – Molecular Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Rachel Meyer
BIOE 145 – Plant Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Ingrid Parker
BIOE 151ABCD/ENVS109ABCD – Ecology and Conservation	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology and Dept. of Environmental Studies)	Don Croll and Gage Dayton

in Practice Supercourse		
BIOE 165 – Marine Conservation Biology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Jessie Beck
CLEI 55 - College Eight: Service Learning Practicum	University of California, Santa Cruz (Rachel Carson College)	Susan Watrus
CLEI 55 - Sustainability Internship	University of California, Santa Cruz (Rachel Carson College)	Susan Watrus
ENVS 15 – Natural History of the UCSC Campus	University of California, Santa Cruz (Dept. of Environmental Studies)	Andy Kulikowski
ENVS 18 – Natural History Illustration	University of California, Santa Cruz (Dept. of Environmental Studies)	Brett Bell
ENVS 19 – Natural History of Reptiles and Amphibians	University of California, Santa Cruz (Dept. of Environmental Studies)	Sean Reilly
ENVS 83 / 183 - Younger Lagoon Reserve Stewardship Interns	University of California, Santa Cruz (Dept. of Environmental Studies)	Katie Monsen
ENVS 84 / 184 - Younger Lagoon Reserve Stewardship Interns	University of California, Santa Cruz (Dept. of Environmental Studies)	Katie Monsen
ENVS 104A/L - Environmental Field Methods	University of California, Santa Cruz (Dept. of Environmental Studies)	Greg Gilbert
ENVS 160 - Restoration Ecology	University of California, Santa Cruz (Dept. of Environmental Studies)	Karen Holl
ENVS 167 - Freshwater / Wetland Ecology	University of California, Santa Cruz (Dept. of Environmental Studies)	Katie Monsen
ENVS 169 – Climate Change Ecology	University of California, Santa Cruz (Dept. of Environmental Studies)	Michael Loik
ENVS 196 – Senior Seminar in Applied Mycology	University of California, Santa Cruz (Dept. of Environmental Studies)	Greg Gilbert

OCEA/ESCI 150 - Field and Lab Methods in Aquatic Science	University of California, Santa Cruz (Dept. of Earth Sciences and Dept. of Ocean Sciences)	Carl Lamborg

Table 1. Younger Lagoon Courses

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 location on the Coastal Science Campus and close proximity to the residential campus makes it an ideal place for faculty to conduct pilot and our small-scale studies as well as for undergraduate research opportunities.

Last year, research conducted at Younger Lagoon Reserve resulted in the publication of two peer-reviewed articles. A list of those publication is below. The full articles are included as Appendix 6.

Smith, M. D et al. (2024). Extreme drought impacts have been underestimated in grasslands and shrublands globally. Proceedings of the National Academy of Sciences, 121(4), e2309881120.

Luong, J. C., Press, D. M., & Holl, K. D. (2023). Lessons learned from an interdisciplinary evaluation of long-term restoration outcomes on 37 restored coastal grasslands in California. Biological Conservation, 280, 109956.

In FY 2022-2023 we approved eight research applications. Examples and summaries of new and ongoing research are included below.

Undergraduate Student Research Highlight: Variation in Herpetofaunal Communities Between Habitat Types and Vegetative Cover Regimes

The distribution of animals across a landscape is defined by the interactions between biotic and abiotic factors characterizing a given area. Anthropogenic impacts resulting in increased habitat fragmentation and habitat homogeneity are among one of many environmental influences that alter the diversity of herpetofauna at local, landscape, and global scales. Doris Duke Conservation Scholar and Humboldt State University undergraduate Anthony Gomez's research makes use of the reserve's coverboard array and examines the variation in herpetofauna biodiversity between habitat types and vegetative cover regimes. Anthony presented a poster on his work at the 2023 meeting of the Ecological Society of America.

Figure 5. Doris Duke Conservation Scholar and Humboldt State University undergraduate student Anthony Gomez conducts research at the Younger Lagoon Reserve coverboard array.

Graduate Student Research Highlight: California Coast Coyote Project

The transfer of nutrients across ecological boundaries can drive pronounced ecosystem responses. This is particularly true along the 1.1 million km of global coastline, where nutrients move across the land-sea interface and cascade through adjacent food webs. These bidirectional nutrient flows—known as "spatial subsidies"—link marine and terrestrial ecosystems and are critical to biodiversity persistence and ecosystem function. Primary investigator Frankie Gerraty (UC Santa Cruz) is exploring the role that California's pinniped rookeries and the coastal coyotes who scavenge and prey on them play in influencing terrestrial ecosystem structure and function.

Public Service

Public service use at Younger Lagoon Reserve continued to rebound post-pandemic. Public service users encompassed a wide variety of groups. The rebound of public service use is a direct result of having fulltime staff on site that 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 (Table 2, Table 3).

California State Summer School for Mathematics and Science (COSMOS)

Every summer, UC Santa Cruz offers a summer program for high school youth designed to introduce students to subjects not traditionally offered in high school. Courses are offered in Biology, Robotics, Computer Science, Physics, Math, Animal Behavior and more. In FY 2022-2023, COSMOS participants participated in inquiry, observational, and stewardship activities at Younger Lagoon Reserve.

Figure 6. California State Summer School for Mathematics and Science (COSMOS) (COSMOS) program participants participate in native habitat restoration at Younger Lagoon Reserve.

Reserve Use

The greatest educational user group for YLR in FY 2022-2023 was once again undergraduate education. A breakdown of all user groups is included in Table 2. YLR was used by UC Berkeley, UC Berkeley, UC Irvine, UC San Diego, UC Santa Cruz, San Jose State University Humboldt State University, Cabrillo Community College, Duke University, Simpson University, University of Utah, Audubon Society, Black Oystercatcher Monitoring Project, Kids in Nature, Santa Cruz Bird Club, Seymour Marine Discovery Center, Santa Cruz Museum of Natural History, the City of Watsonville, and the Pacific Collegiate School (Table 3).

Table 2. Younger Lagoon Total Use

RESERVE USE DATA Fiscal year: 2022-2023

Campus: University of California, Santa Cruz
Reserve: Younger Lagoon Reserve

	UC Home		UC Other		CSU System		CA Comm College		Other CA College		Out of State College		International University		Government		NGO/Non-Profit		Business Entity		K-12 School		Other		Total	
	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs
UNIVERSITY- LEVEL RESEARCH																										
Faculty	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Research Assistant (non-student/faculty/postdoc)	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Graduate Student	1	13	2	8	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	24
Undergraduate Student	6	54	1	1	5	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	122
SUBTOTAL	7	67	3	9	8	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	151
UNIVERSITY - LEVEL INSTRUCTION (CLASS)																										
Faculty	12	26	0	0	1	1	1	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	15	30
Research Assistant (non-student/faculty/postdoc)	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
Graduate Student	27	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	46
Undergraduate Student	748	1089	25	100	24	24	18	18	0	0	11	11	0	0	0	0	0	0	0	0	0	0	0	0	826	1242
Professional	2	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	31
Volunteer	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
SUBTOTAL	791	1195	25	100	25	25	19	20	0	0	12	12	0	0	0	0	0	0	0	0	0	0	0	0	872	1352
OTHER																										
Faculty	3	4	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5
Research Scientist/Post Doc	2	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Graduate Student	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4
Undergraduate Student	96	101	0	0	0	0	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111	116
K-12 Instructor	2	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	32	34	0	0	12	13	0	0	47	50
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	145	145	0	0	145	145
Professional	18	18	0	0	0	0	0	0	0	0	0	0	0	0	1	1	30	68	0	0	0	0	1	1	50	88
Other	5	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	26	0	0	0	0	886	8116	917	8154
Docent	37	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	37
Volunteer	36	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	9	0	0	0	0	0	0	42	45
Reserve Staff	4	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	35
SUBTOTAL	205	251	0	0	0	0	16	16	1	1	1	1	0	0	1	1	94	137	0	0	157	158	887	8117	1362	8682
HOUSING																										
TOTALS	**1003**	**1513**	**28**	**109**	**33**	**100**	**35**	**36**	**1**	**1**	**13**	**13**	**0**	**0**	**1**	**1**	**94**	**137**	**0**	**0**	**157**	**158**	**887**	**8117**	**2252**	**10185**

Table 3. Younger Lagoon Group Affiliations

University of California Campus	**Non-governmental Organizations**
University of California, Berkeley	Audubon Society
University of California, Irvine	Black Oystercatcher Monitoring Project
University of California, San Diego	Kids in Nature
University of California, Santa Cruz	Santa Cruz Bird Club
	Seymour Marine Discovery Center
California State Universities	Santa Cruz Museum of Natural History
California State University, San Jose	
California State University, Humboldt	**Governmental Agencies**
	City of Watsonville
California Community College	
Cabrillo Community College	
Other Colleges and Universities	
Duke University	**K-12 Education**
Simpson University	Pacific Collegiate School
University of Utah	

Summary

FY 2022-2023 was another successful year for YLR. The reserve continued to move forward with restoration, initiated new projects and strengthened collaborations post-pandemic. The continuation of student and course use through the pandemic 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 2023-2024.

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	Greg Gilbert

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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 nearly 20 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 nearly 20 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 nearly 20 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 1. California Coastal Commission beach monitoring report

Younger Lagoon Reserve

Beach Monitoring Report

2023

Younger Lagoon Reserve staff conduct a fish seine.

Elizabeth Howard, MA
Younger Lagoon Reserve

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Overview and Executive Summary

In March 2010, the California Coastal Commission (Coastal Commission) 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 supervised 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 Coastal Commission 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, a Commissioner requested the University provide significantly more tours to the beach and that children be allowed for free. The campus withdrew NOID 9 (17-1), made changes to address these requests, and resubmitted it as NOID 9 (18-1) in August 2018.

On September 13, 2018, the Coastal Commission approved UC Santa Cruz's NOID 9 (18-1) as consistent with UCSC's approved Coastal Long Range Development Plan with the addition of five staff-recommended special conditions. These included 1) Free Beach Tours, 2) Beach Tour Outreach Plan, 3) Beach Tour Signs, 4) Beach Tour Availability and Monitoring, and 5) Beach Access Management Plan Duration. Within 30 days of the approval (i.e., by October 13, 2018), UCSC was required to submit a plan for implementation of the special conditions to the Executive Director of the California Coastal Commission. The plan for implementation of the special conditions was submitted to the Executive Director of the California Coastal Commission on October 15, 2018. UCSC received feedback from Coastal Commission staff on the plan, and a revised plan for implementation of the special conditions was submitted to the Executive Director of the California Coastal Commission on December 15, 2018. The revised plan for implementation of the special conditions was approved by the Executive Director on January 30, 2019.

NOID 9 (18-1) Special Condition 4 required that 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. UCSC's initial report on the implementation of these special conditions for the period of January 1, 2019 through June 30, 2019 was submitted on June 28, 2019. Upon review, local Coastal Commission staff requested more detail regarding the implementation of Special Condition 2. UCSC's revised report on the implementation of the special conditions for the period of January 1, 2019 through June 30, 2019 was submitted on September 5, 2019. The report for the period of July 1, 2019 through December 31, 2019 was submitted on December 23, 2019. The report for the period of January 1, 2020 through June 30, 2020 was submitted on June 30, 2020. The report for the period of July 1, 2020 through December 31, 2020 was submitted on December 22, 2020.

On October 8, 2020, the Coastal Commission approved UC Santa Cruz's NOID 12 (20-1) as consistent with UCSC's approved Coastal Long Range Development Plan with the continuation of five staff-recommended special conditions from NOID 9 (18-1), an increase in the number of participants per tour and an increase in outreach efforts. Within 30 days of the approval (i.e., by November 8, 2020), UCSC was required to submit a plan for implementation of the special conditions to the Executive Director of the California Coastal Commission. The plan for implementation of the special conditions was submitted to the Executive Director of the California Coastal Commission on November 6, 2020. The plan for implementation of the special conditions was approved by the Executive Director on November 12, 2020.

NOID 12 (20-1) Special Condition 4 requires that 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. The report for the period of January 1, 2021 through June 30, 2021 was submitted on June 25, 2021. The report for the period of July 1, 2021 through December 31, 2021 was submitted on December 13, 2021. The report for the period of January 1, 2022 through June 30, 2022 was submitted on June 30, 2022. The report for the period of July 1, 2022 through December 31, 2022 was submitted on December 21, 2022. The report for the period of January 1, 2023 through June 30, 2023 was submitted on June 30, 2023.

This document serves as both a summary report for activities under NOIDs 2 (10-1), 9 (18-1), and 12 (20-1) that have taken place since our previous report at the end of fiscal year 2022 and a summary report for the entire 13-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, likely have a negative impact on sensitive and protected species 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 supervised access that enables people to see and learn about the lagoon habitat while limiting impacts to the system. It is important to note, however that avian data collected during the 2020, 2022, and 2023 docent led beach tours indicate that the tours have a significant negative impact on birds (see NOID 9 (18-1) Special Conditions Implementation Report 4, December 23, 2020 and NOID 12 (20-1)

Special Conditions Implementation Report 1, June 25, 2021, Special Conditions Implementation Report 2, December 13, 2021, Special Conditions Implementation Report 3, June 30, 2022, Special Conditions Implementation Report 4, December 21, 2022, and Special Conditions Implementation Report 3, June 30, 2023). We recommend that the current docent-guided tour program continue while we continue to monitor the biological impacts of the tours.

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 41 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 NOIDs 2 (10-1), 9 (18-1), and 12 (20-1) during Fiscal Year (FY) 2022-2023 (July 1, 2022 – June 30, 2023) which surveyed YLR. In addition, 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 2022-2023.

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). Starting in January 2018, tours are offered 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), for a total of 38 tours per year. From 2010-2018, these tours were offered free with admission to the Seymour Center. Starting in 2019, these tours are now offered for free. In addition, all of the docent led daily tours run by the Seymour Center (prior to the COVID-19 pandemic, approximately 1,500 tours annually) include an informational stop about YLR that includes visual access to the beach.

Due to COVID-19 precautions, the Seymour Center was temporarily closed and the free beach tour program temporarily suspended in March 2020. The University restarted the free beach tour program in April 2022 (see UC Santa Cruz's Pub. Res. Code section 30611 notification letter to the Commission).

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 Overlook E along McAllister Way. 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 Overlook C. Prior to the COVID-19 pandemic, nearly 25,000 visitors annually took these tours.

In order to maintain public access and engagement during the COVID-19 pandemic, the University created a virtual bilingual beach tour that is available on the Seymour Center and Younger Lagoon Reserve websites. The virtual tour allows visitors from around the world to learn about the unique ecology and programs at the reserve in English and Spanish from the comfort of home.

The virtual tour websites feature a map of the reserve with marked locations where visitors can click to watch videos about the features of each type of habitat.

Virtual Tour Links:
English: https://arcg.is/11m1Ga
Spanish: https://arcg.is/0q0Czv

A UC Santa Cruz undergraduate student created the virtual tour websites and edited the videos as part of an internship project. This student completed all of the work on this project remotely, including learning about the reserve itself. A Younger Lagoon Reserve undergraduate student employee who assisted with the free in-person tours prior to the pandemic acts as the on-camera guide for both tours.

Public Education and Outreach Programming on the Coastal Science Campus

Seymour Marine Discovery Center

The free docent guided beach tours are part of broader public education and outreach programming on the Coastal Science Campus offered through the Seymour Center. Prior to the COVID-19 pandemic, nearly 70,000 people visited the Seymour Center, and nearly 15,000 visitors took docent-guided tours annually. 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.

Every year, dozens of children ages 7-14, enrolled in weeklong summer science sessions known as Ocean Explorers. Students actively learn about and participate in marine research at the Seymour Center and 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. After being cancelled in summer 2020 due to the COVID-19 pandemic, Ocean Explorers was restarted in the summer of 2021.

While part of UC Santa Cruz, the Seymour Center must raise its ~$1.5 million budget annually (including all operating costs, salaries, and benefits) from earned revenue, private donors and grants. Earned revenue—admissions, program fees, facility rentals, and the Ocean Discovery Shop—makes up approximately half of its general operating requirements.

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, Instagram, and bi-monthly e-blasts.

Watsonville Area Teens Conserving Habitat (WATCH)

Prior to the COVID-19 pandemic, the Seymour Center, Younger Lagoon Reserve and the Monterey Bay Aquarium partnered to support high school students in the Watsonville Area Teens Conserving Habitats (WATCH) program. WATCH students from Aptos High School design and carry out field-based research projects in Younger Lagoon Reserve on topics including endangered fish, aquatic invertebrates, and birds. These students make repeated visits to the Reserve throughout the year. This program is currently paused due to the pandemic. Find out more at: https://www.montereybayaquarium.org/for-educators/for-teens/teen-programs/watsonville-teens-conserving-habitats

Community 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 is held during the spring, and is open to 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-2020

Volunteer Stewardship Days
This year, Younger Lagoon Reserve hosted several volunteer stewardship days. These events are advertised on social media and open to the public. Volunteer stewardship days provide members of the public with the opportunity to learn about the reserve and its unique habitats, wildlife, research, restoration, and teaching programs while giving back.

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 Seymour Center, as well as research and education use of YLR, were recorded and maintained by Seymour Center 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

A wide variety of public and non-profit research and educational groups used Younger Lagoon in FY22-23 (Table 1). The greatest educational 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 members of the public visiting the overlook shelter. Those users were provided an overlook of the beach and opportunities to read interpretive material presented on signs about the reserve; however, did not access the beach. Since the start of the Seymour Center docent led beach access tours in 2010, more than 300 tours have gone out and nearly 3,000 visitors have participated. The free 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, theft, and vandalism occurred in FY 2022-2023. 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, Berkeley	Audubon Society
University of California, Irvine	Black Oystercatcher Monitoring Project
University of California, San Diego	Kids in Nature
University of California, Santa Cruz	Santa Cruz Bird Club
	Seymour Marine Discovery Center
California State Universities	Santa Cruz Museum of Natural History
California State University, San Jose	
California State University, Humboldt	**Governmental Agencies**
	City of Watsonville
California Community College	
Cabrillo Community College	
Other Colleges and Universities	
Duke University	**K-12 Education**
Simpson University	Pacific Collegiate School
University of Utah	

Table 2. Younger Lagoon Total Use.

RESERVE USE DATA Fiscal year: 2022-2023

Campus: University of California, Santa Cruz
Reserve: Younger Lagoon Reserve

	UC Home		UC Other		CSU System		CA Comm College		Other CA College		Out of State College		International University		Government		NGO/Non-Profit		Business Entity		K-12 School		Other		Total	
	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs
UNIVERSITY- LEVEL RESEARCH																										
Faculty	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3
Research Assistant (non-student/faculty/postdoc)	0	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Graduate Student	1	13	2	8	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	24
Undergraduate Student	6	54	1	1	5	67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	122
SUBTOTAL	7	67	3	9	8	75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	151
UNIVERSITY - LEVEL INSTRUCTION (CLASS)																										
Faculty	12	26	0	0	1	1	1	2	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	15	30
Research Assistant (non-student/faculty/postdoc)	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
Graduate Student	27	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27	46
Undergraduate Student	748	1089	25	100	24	24	18	18	0	0	11	11	0	0	0	0	0	0	0	0	0	0	0	0	826	1242
Professional	2	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	31
Volunteer	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
SUBTOTAL	791	1195	25	100	25	25	19	20	0	0	12	12	0	0	0	0	0	0	0	0	0	0	0	0	872	1352
OTHER																										
Faculty	3	4	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5
Research Scientist/Post Doc	2	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Graduate Student	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4
Undergraduate Student	96	101	0	0	0	0	15	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	111	116
K-12 Instructor	2	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	32	34	0	0	12	13	0	0	47	50
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	145	145	0	0	145	145
Professional	18	18	0	0	0	0	0	0	0	0	0	0	0	0	1	1	30	68	0	0	0	0	1	1	50	88
Other	5	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	26	0	0	0	0	886	8116	917	8154
Docent	37	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	37
Volunteer	36	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	9	0	0	0	0	0	0	42	45
Reserve Staff	4	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	35
SUBTOTAL	205	251	0	0	0	0	16	16	1	1	1	1	0	0	1	1	94	137	0	0	157	158	887	8117	1362	8682
HOUSING																										
TOTALS	**1003**	**1513**	**28**	**109**	**33**	**100**	**35**	**36**	**1**	**1**	**13**	**13**	**0**	**0**	**1**	**1**	**94**	**137**	**0**	**0**	**157**	**158**	**887**	**8117**	**2252**	**10185**

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 and the number of people per photo (15 minute interval standardized for area surveyed) was consistent across sampling periods (Table 3). Examples of photos captured during a typical monitoring session in 2010 are included as Figure 4.

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
Younger Lagoon	February, 2011	2	0.06

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
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
Younger Lagoon	February, 2014	1	0.01

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
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
Younger Lagoon	July, 2018	11	0.09
Younger Lagoon	November, 2018	14	0.15
Younger Lagoon	February, 2019	62	0.65
Younger Lagoon	May, 2019	0	0
Younger Lagoon	July, 2019	0	0
Younger Lagoon	November, 2019	0	0
Younger Lagoon	February, 2020	0	0
Younger Lagoon	May, 2020	0	0

Site	Month	[1]Total # of people	[1]Ave # of People / 15 minute
Younger Lagoon	August, 2020	1	.02
Younger Lagoon	November, 2020	-	-
Younger Lagoon	February, 2021	0	0
Younger Lagoon	May, 2021	0	0
Younger Lagoon	August, 2021	0	0
Younger Lagoon	November, 2021	0	0
Younger Lagoon	March, 2022	0	0
Younger Lagoon	May, 2022	0	0
Younger Lagoon	August, 2022	0	0
Younger Lagoon	November, 2022	0	0
Younger Lagoon	February 2023	0	0
Younger Lagoon	May 2023	4	.03

[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 FY2020-2021 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	
February 9, 2018			
Younger Lagoon	X	X	
May 2, 2018			
Younger Lagoon	X	X	
July 16, 2018			
Younger Lagoon	X	X	
November 18, 2018			
Younger Lagoon	X		

February 21, 2019 Younger Lagoon		
May 14, 2019 Younger Lagoon	X	X
August 15, 2019 Younger Lagoon	X	X
October 31, 2019 Younger Lagoon	X	X
February 13, 2020 Younger Lagoon	X	
May 21, 2020 Younger Lagoon	X	X
August 19, 2020 Younger Lagoon	X	X
November 17, 2020 Younger Lagoon	X	X
February 24, 2021 Younger Lagoon	X	X
Spring, 2021 Younger Lagoon	X	X
August 21, 2021 Younger Lagoon	X	X
November 17, 2021 Younger Lagoon	X	X
March 8, 2022 Younger Lagoon	X	
May 4, 2022 Younger Lagoon	X	X
August 4, 2022 Younger Lagoon	X	X
November 3, 2022 Younger Lagoon	X	X
February 9, 2023 Younger Lagoon	X	

May 4, 2023 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. Tadpoles, 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 also varied across sampling periods. Mean proportion of non-native species was consistently greatest at Natural Bridges (55%) and least at either Sand Plant Beach (31%) or Younger Lagoon (28%) (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

Site	Summer, 18	Fall, 18	Winter, 19	Spring, 19	Summer, 19	Fall, 19	Winter, 20	Spring, 20
Younger Lagoon	28	22	23	24.7	38	26	29	27

Site	Summer, 20	Fall, 20	Winter, 21	Spring, 21	Summer, 21	Fall, 21	Winter, 22	Spring, 22
Younger Lagoon	28.3	23	24	25	23.5	22.5	21.75	28

Site	Summer, 22	Fall, 22	Winter, 23	Spring, 23
Younger Lagoon	24.5	22	26.69	27.7

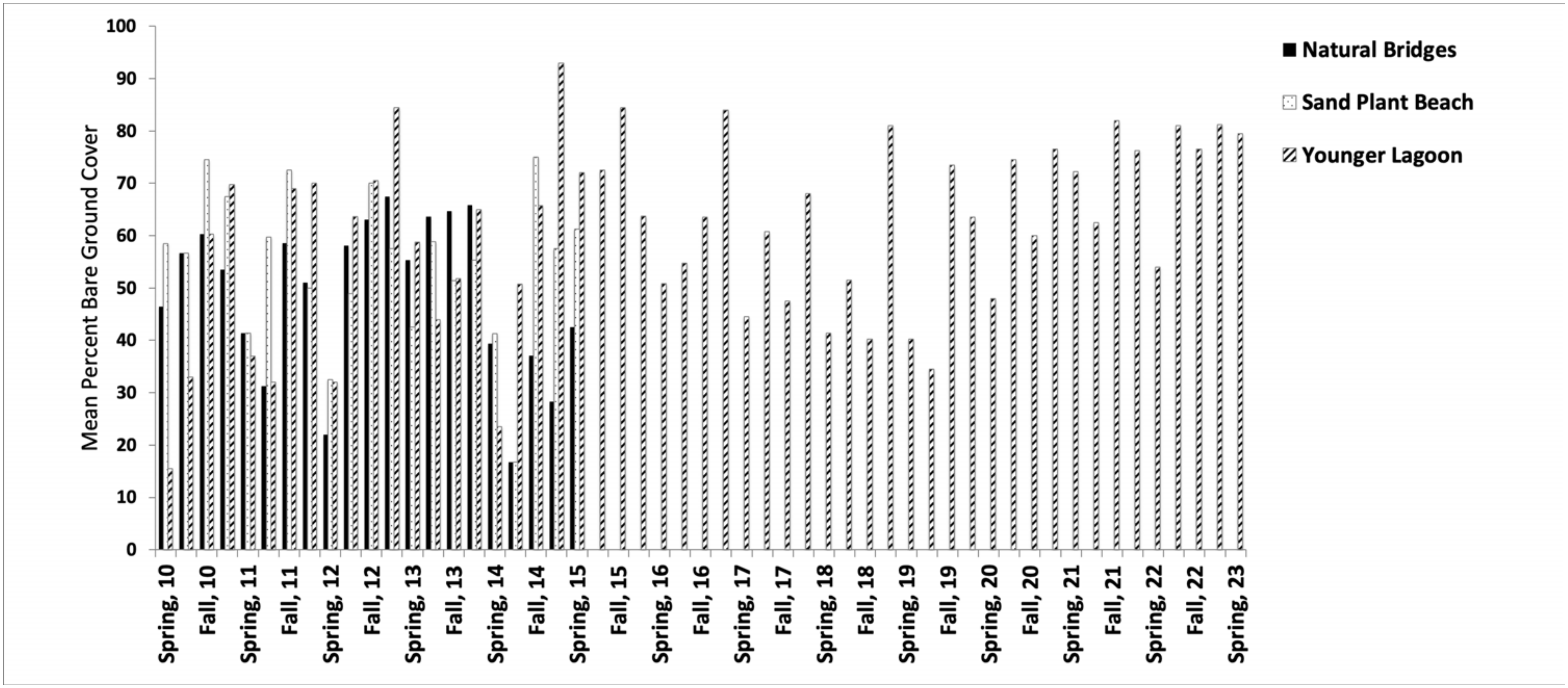

Figure 5. Mean percent bare ground encountered at each site.

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	Summer, 18	Fall, 18	Winter, 19	Spring, 19	Summer, 19	Fall, 19	Winter, 20	Spring, 20
Younger Lagoon								
Native	9 (82%)	8 (80%)	8 (80%)	9 (67%)	8 (67%)	8 (67%)	8 (57%)	9 (53%)
Non-native	2 (18%)	2 (20%)	2 (20%)	3 (33%)	4 (33%)	4 (33%)	6 (43%)	8 (47%)
Total	11	10	10	12	12	14	14	17

Site	Summer, 20	Fall, 20	Winter, 21	Spring, 21	Summer, 21	Fall, 21	Winter, 22	Spring, 22
Younger Lagoon								
Native	6 (67%)	8 (73%)	7 (58%)	7 (58%)	6 (67%)	7 (78%)	6 (75%)	6 (67%)

Non-native	3 (33%)	3 (27%)	5 (42%)	5 (42%)	3 (33%)	2 (22%)	2 (25%)	3 (33%)
Total	9	11	12	12	9	9	8	9

Site	**Summer,22**	**Fall, 22**	**Winter, 23**	**Spring, 23**
Younger Lagoon				
Native	5 (100%)	4 (80%)	4 (100%)	5 (62%)
Non-native	0 (0%)	1 (20%)	0 (0%)	3 (38%)
Total	5	5	4	8

Site	**Proportion of native and non-native species across all sample periods**
Natural Bridges	
Native	**46%**
Non-native	**55%**
Total	
Younger Lagoon	
Native	**72%**
Non-native	**28%**
Total	
Sand Plant Beach	
Native	**69%**
Non-native	**31%**
Total	

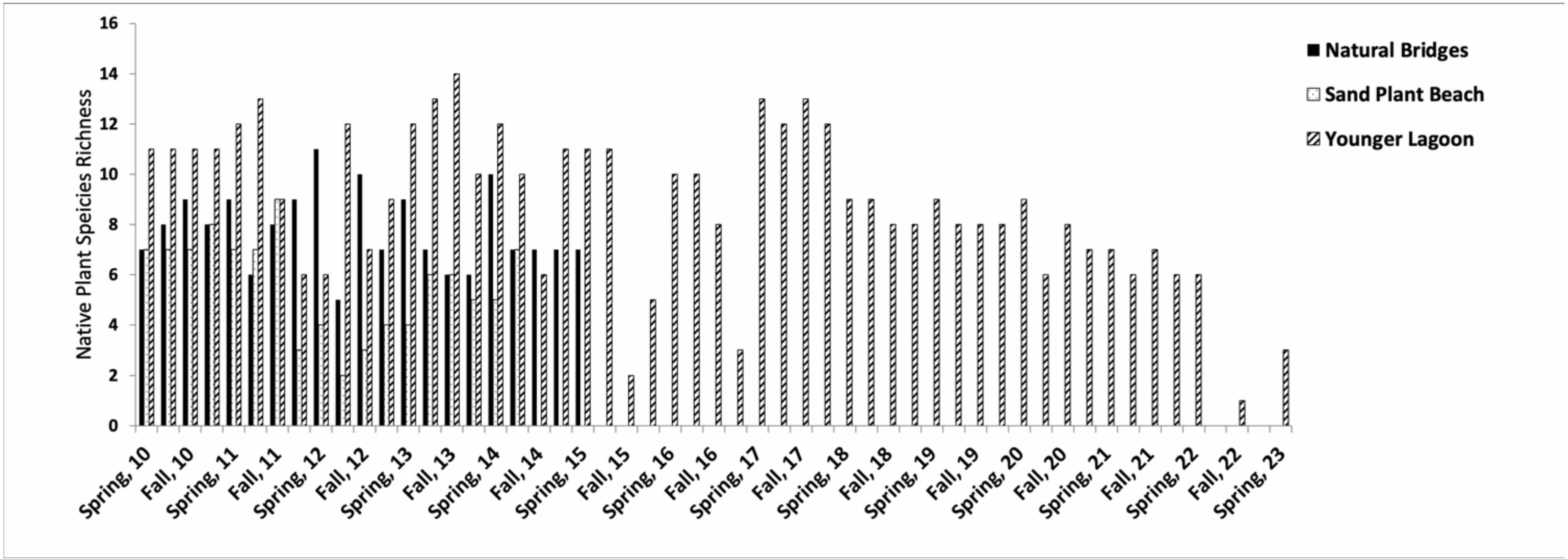

Figure 6. Number of native plant species encountered at each site.

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 equal 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									
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
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
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 Younger Lagoon		X					X		X	X			X
February 7-8, 2018 Younger Lagoon	X			X	X				X				X
May 1-2, 2018 Younger Lagoon	X								X				X
July 12-13, 2018 Younger Lagoon	X			X					X				X
November 7-8, 2018 Younger Lagoon	X	X					X		X				X
February 20-21, 2019 Younger Lagoon	X	X					X		X				
May 15-16, 2019 Younger Lagoon	X			X					X				X
July 15-16, 2019 Younger Lagoon		X											X
October 29-30, 2019 Younger Lagoon													X
February 11-12, 2020 Younger Lagoon		X							X				X
May 20-21, 2020 Younger Lagoon		X											X
August 18-19, 2020 Younger Lagoon													
Nov 16-17, 2020 Younger Lagoon				X									
February 22-23, 2021 Younger Lagoon				X		X		X					
May 4-5, 2021 Younger Lagoon				X		X		X					
August 10-11, 2021 Younger Lagoon				X				X					

Nov 16-17, 2021 Younger Lagoon		X		X									X
February 7-8, 2022 Younger Lagoon	X								X				X
May 3-4, 2022 Younger Lagoon	X								X				X
August 3-4, 2022 Younger Lagoon			X										X
Nov 1-2, 2022 Younger Lagoon													X
February 7-8, 2023 Younger Lagoon				X									
May 4-5, 2023 Younger Lagoon	X						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 2023 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	(16) 70%	(12) 52%	(4) 17%	(17) 74%	(8) 35%	(1) 4%	(4) 17%	(0) 0%	(17) 74%	(2) 9%	(1) 4%	(5) 22%	(20) 87%	8
Younger Lagoon	(21) 41%	(31) 61%	(4) 8%	(26) 51%	(7) 14%	(2) 4%	(9) 18%	(0) 0%	(32) 63%	(1) 2%	(0) 0%	(0) 0%	(23) 45%	8
Natural Bridges	(10) 48%	(16) 76%	(4) 19%	(9) 43%	(15) 71%	(0) 0%	(8) 38%	(1) 5%	(7) 33%	(1) 5%	(14) 67%	(17) 81%	(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 370 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		**3**
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					
Younger Lagoon	1		2		**3**
February 8-9, 2018					
Younger Lagoon	2				**2**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
May 1-2, 2018					
Younger Lagoon	1		2		**3**
July 12-13, 2018					
Younger Lagoon	6				**6**
November 7-8, 2018					
Younger Lagoon	7		2		**9**
February 20-21, 2019					
Younger Lagoon	5		2		**8**
May 14-15, 2019					
Younger Lagoon	4				**4**
May 14-15, 2019					
Younger Lagoon	5		2		**8**
July 15-16, 2019					
Younger Lagoon	4				**4**
October 30-31, 2019					
Younger Lagoon	1		1		**2**
February 11-12, 2020					
Younger Lagoon	2		1		**3**
May 20-21, 2020					
Younger Lagoon	1		2		**3**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
August 18-19, 2020					
Younger Lagoon	6				**6**
November 16-17, 2020					
Younger Lagoon	6		2		**8**
February 23-24, 2021					
Younger Lagoon	6		2		**8**
May 4-5, 2021					
Younger Lagoon	5				**5**
August 10-11, 2021					
Younger Lagoon	1	1			**1**
November 16-17					
Younger Lagoon	5				**5**
February 8-9, 2022					
Younger Lagoon	5				**5**
May 3-4, 2022					
Younger Lagoon	7				**7**
August 3-4, 2022					
Younger Lagoon	4	1			**5**
November 1-2, 2022					
Younger Lagoon	9	4			**13**
February 7-8, 2023					

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
Younger Lagoon	4				**4**
May 4-5, 2023					
Younger Lagoon	1				**1**
TOTAL	**218**	**56**	**92**	**4**	**370**

[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 7-8). 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

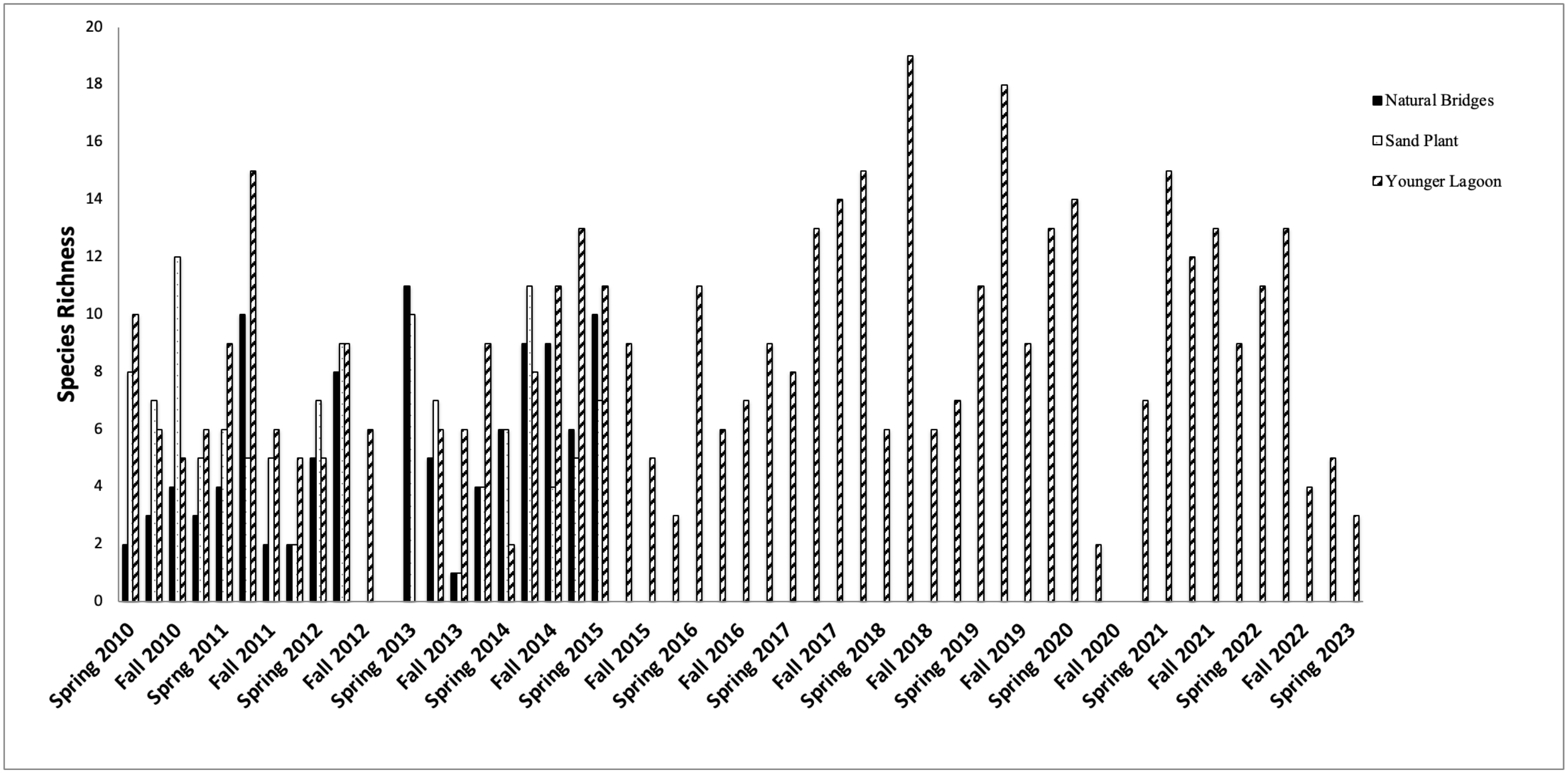

Figure 8. Total abundance of invertebrates at Natural Bridges, Sand Plant Beach, and Younger Lagoon beaches.

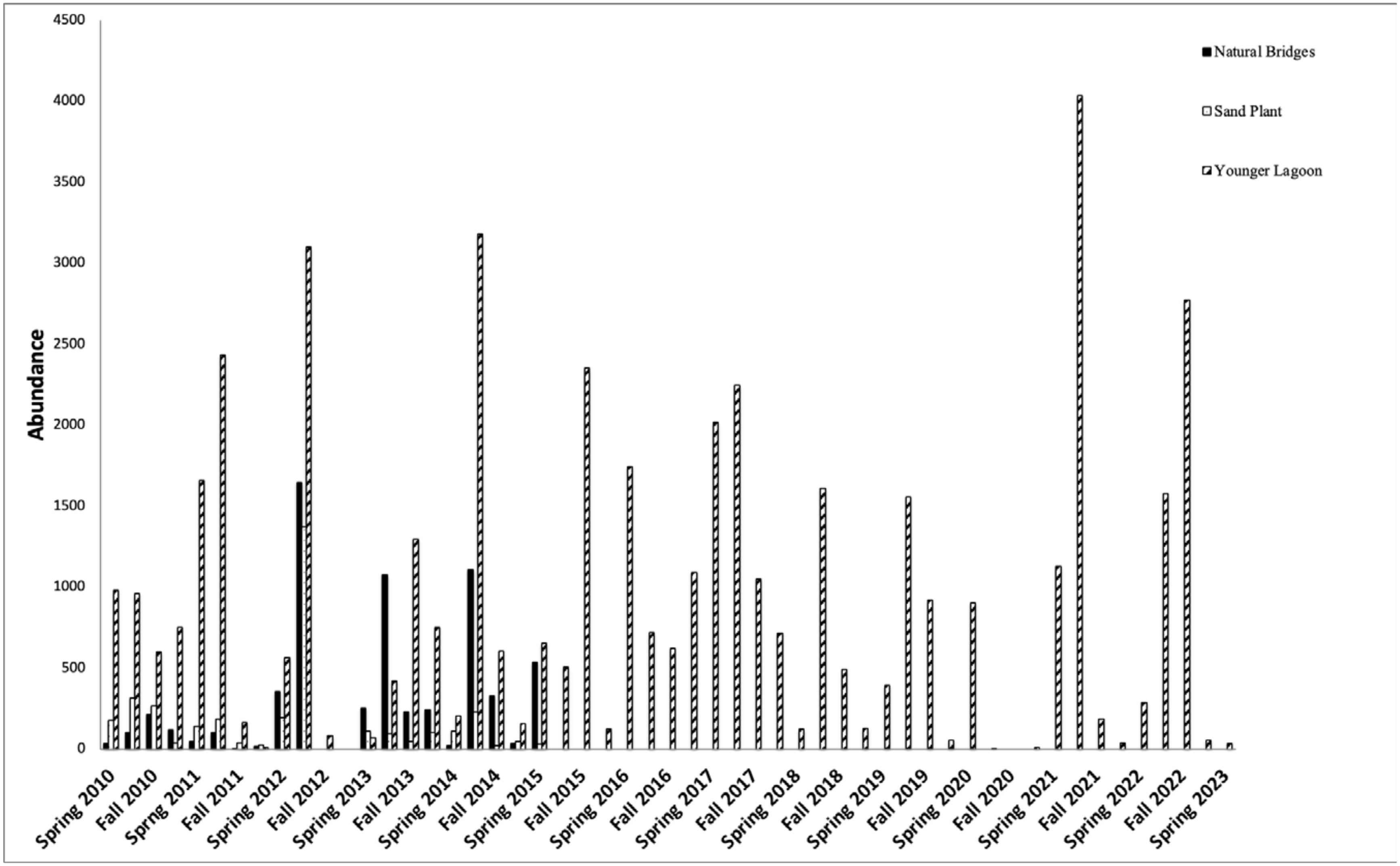

Table 10. Summary of bird surveys at Sand Plant Beach, Younger Lagoon, and Natural Bridges beaches.

Site	AMCO	AMCR	AMPE	AMWI	ANHU	BBPL	BEWR	BCNH	BASP	BASW	BLOY	BLPH	BLTU	BRAC	BRBL	BRPE	BUFF	BUSH	CAGO	CAGU	CLSW	COMU	CORA	COYE
April 24 & 26, 2010																								
Sand Plant																								
Younger Lagoon																								
Natural Bridges															2									
August 11-12, 2010																								
Sand Plant																								
Younger Lagoon											2													
Natural Bridges		2													19									
November 15-16, 2010																								
Sand Plant																								
Younger Lagoon	2												1			27								
Natural Bridges															1									
February 15-16, 2011																								
Sand Plant																								
Younger Lagoon																								
Natural Bridges		3													2		1			58				
May 3-4, 2011																								
Sand Plant		2														8								
Younger Lagoon																								
Natural Bridges		1										1								3				
July 22-23, 2011																								
Sand Plant										4		1									4			
Younger Lagoon																								
Natural Bridges		9								4					6									
March 29-30, 2012																								
Sand Plant																				1				
Younger Lagoon	3														5									
Natural Bridges													1											
May 15-16, 2012																								
Sand Plant																								
Younger Lagoon											3				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	8														4									
Natural Bridges		2																						
January 13-14, 2013																								
Sand Plant																								
Younger Lagoon	5										1						1							
Natural Bridges																							1	
May 1-2, 2013																								
Sand Plant																								
Younger Lagoon															1				2					
Natural Bridges		2																						
July 16-17, 2013																								
Sand Plant								1												1			1	
Younger Lagoon								1				2			7					2				
Natural Bridges												2			1					1				
October 22-23, 2013																								
Sand Plant																				1			2	
Younger Lagoon						3						3								2				
Natural Bridges		2				1										1				3				
February 13-14, 2014																								
Sand Plant																			6					
Younger Lagoon																								
Natural Bridges		1																						
April 27-28, 2014																								
Sand Plant		3														20								
Younger Lagoon											8					13			2					
Natural Bridges		3									2					11				7	2			
July 30-31, 2014																								
Sand Plant																				10				

Site	AMCO	AMCR	AMPE	AMWI	ANHU	BBPL	BEWR	BCNH	BASP	BASW	BLOY	BLPH	BLTU	BRAC	BRBL	BRPE	BUFF	BUSH	CAGO	CAGU	CLSW	COMU	CORA	COYE
Younger Lagoon																18								
Natural Bridges																18								
November 4-5, 2014																								
Sand Plant	2																							
Younger Lagoon	6											2				5								
Natural Bridges	10	11													2									
January 26-27, 2015																								
Sand Plant												2							2					
Younger Lagoon	9															6								
Natural Bridges		12										1				27							3	
April 14-15, 2015																								
Sand Plant	1											1							2					
Younger Lagoon	1											2												
Natural Bridges	7															6								
July 8-9, 2015																								
Younger Lagoon								2		4														
October 29-30, 2015																								
Younger Lagoon												1				4				2				
February 2-3, 2016																								
Younger Lagoon												1												
May 3-4, 2016																								
Younger Lagoon										4		2							2					
12-Jul-16																								
Younger Lagoon										3		1			12					2				
November 9-10, 2016																								
Younger Lagoon												2				1								
March 1-2, 2017																								
Younger Lagoon												1								3				
April 25-26, 2017																								
Younger Lagoon		1																			6			
August 2-3, 2017																								
Younger Lagoon										8	2	2		8										
October 25-26, 2017																								
Younger Lagoon												1		6		2								
February 7-8, 2018																								
Younger Lagoon												1		2		2								
May 2-3, 2018																								
Younger Lagoon										5	2	2		5	1									
August 13-14, 2018																								
Younger Lagoon										6					2					1				
November 7-8, 2018																								
Younger Lagoon							1					11		29		40		1						
February 20-21, 2019																								
Younger Lagoon	4											2						12	4					1
May 14-15, 2019																								
Younger Lagoon										4					2					2	52			
July 16-17, 2019																								
Younger Lagoon										4		2								6	17		1	
October 30-31, 2019																								
Younger Lagoon																								
February 12-13, 2020																								
Younger Lagoon	3											4					1	5		5				
May 20-21, 2020																								
Younger Lagoon										30									8	2	8		2	
August 18-19, 2020																								
Younger Lagoon										45		1		2							30	1		
November 16-17, 2020																								

Site	AMCO	AMCR	AMPE	AMWI	ANHU	BBPL	BEWR	BCNH	BASP	BASW	BLOY	BLPH	BLTU	BRAC	BRBL	BRPE	BUFF	BUSH	CAGO	CAGU	CLSW	COMU	CORA	COYE
Younger Lagoon												1		40										
February 23-24, 2021																								
Younger Lagoon	3			2								1		7					2					
May 3-4, 2021																								
Younger Lagoon										4									8		14		1	
August 10-11, 2021																								
Younger Lagoon												2											2	
November 16-17, 2021																								
Younger Lagoon											2	2		17									2	
February 8-9, 2022																								
Younger Lagoon	3				1						2			70			1		3				2	
May 3-4, 2022																								
Younger Lagoon									2	10		2		90		27			6	27	3		4	
August 3-4, 2022																								
Younger Lagoon												2		80									1	
November 1-2, 2022																								
Younger Lagoon												2		40										
February 7-8, 2023																								
Younger Lagoon												2							14					
May 4-5, 2023																								
Younger Lagoon									3		1	1							5		7			

Site	DOCO	DUSP	EUCD	EUST	FOSP	GCSP	GRHE	GREG	GRTE	HEGU	HETH	HOFI	KILL	LBCU	LESA	LISP	MALL	MAGO	MEGU	MODO	NOHA	OSPR	PECO	PEFA
April 24 & 26, 2010																								
Sand Plant																	2							
Younger Lagoon																	3							
Natural Bridges													1											
August 11-12, 2010																								
Sand Plant										1														
Younger Lagoon	1			1						2			2	1			10							
Natural Bridges													1											
November 15-16, 2010																								
Sand Plant							3																	
Younger Lagoon		3		1																			15	
Natural Bridges							2	2		24			4						2					
February 15-16, 2011																								
Sand Plant																	2							
Younger Lagoon	5																							
Natural Bridges														3			4						47	
May 3-4, 2011																								
Sand Plant																	4				2			
Younger Lagoon																								
Natural Bridges	6							1					7	4			4	1						
July 22-23, 2011																								
Sand Plant										8														
Younger Lagoon																								
Natural Bridges	10									48							7							
March 29-30, 2012																								
Sand Plant																	5							
Younger Lagoon				2									1				8						13	
Natural Bridges									2								10	3						
May 15-16, 2012																								
Sand Plant																								
Younger Lagoon				2									3				2						25	
Natural Bridges																	6							
August 25-26, 2012																								
Sand Plant													3											
Younger Lagoon																	4						35	
Natural Bridges													5				1							
November 5-6, 2012																								
Sand Plant																								
Younger Lagoon													5										14	
Natural Bridges													4				9							
January 13-14, 2013																								
Sand Plant																								
Younger Lagoon																							3	
Natural Bridges							1																	
May 1-2, 2013																								
Sand Plant																								
Younger Lagoon				2													3			2			9	
Natural Bridges								2									4							
July 16-17, 2013																								
Sand Plant																								
Younger Lagoon							1						2				25						8	
Natural Bridges							1			11			1											
October 22-23, 2013																								
Sand Plant																								
Younger Lagoon	1			1						300			4					1					33	
Natural Bridges										3							2							
February 13-14, 2014																								
Sand Plant																	2							
Younger Lagoon								1															8	
Natural Bridges																	2							
April 27-28, 2014																								
Sand Plant																	6							
Younger Lagoon													3				6							
Natural Bridges	8							1					1				4							
July 30-31, 2014																								
Sand Plant								1		10			4											

Site	DOCO	DUSP	EUCD	EUST	FOSP	GCSP	GRHE	GREG	GRTE	HEGU	HETH	HOFI	KILL	LBCU	LESA	LISP	MALL	MAGO	MEGU	MODO	NOHA	OSPR	PECO	PEFA
Younger Lagoon								4					2				2							
Natural Bridges										15			3											
November 4-5, 2014																								
Sand Plant										6														
Younger Lagoon																								
Natural Bridges								1		9			4											
January 26-27, 2015																								
Sand Plant																	2							
Younger Lagoon																	4							
Natural Bridges								1									2							
April 14-15, 2015																								
Sand Plant																	2							
Younger Lagoon													1											
Natural Bridges																								
July 8-9, 2015																								
Younger Lagoon													2				2							
October 29-30, 2015																								
Younger Lagoon																								
February 2-3, 2016																								
Younger Lagoon				2													3							
May 3-4, 2016																								
Younger Lagoon										1			1				3							
12-Jul-16																								
Younger Lagoon								1									3							
November 9-10, 2016																								
Younger Lagoon								1					6											
March 1-2, 2017																								
Younger Lagoon								1															1	
April 25-26, 2017																								
Younger Lagoon				2													4							
August 2-3, 2017																								
Younger Lagoon								1		2		6	1											
October 25-26, 2017																								
Younger Lagoon													6											
February 7-8, 2018																								
Younger Lagoon						1				3			6											
May 2-3, 2018																								
Younger Lagoon													4											
August 13-14, 2018																								
Younger Lagoon								3							3		1						5	
November 7-8, 2018																								
Younger Lagoon						1							6											1
February 20-21, 2019																								
Younger Lagoon												1					4			2				
May 14-15, 2019																								
Younger Lagoon				1									1				15			3			1	
July 16-17, 2019																								
Younger Lagoon								1																
October 30-31, 2019																								
Younger Lagoon													3										52	
February 12-13, 2020																								
Younger Lagoon					1						2									2	2		17	
May 20-21, 2020																								
Younger Lagoon																	3				1		2	
August 18-19, 2020																								
Younger Lagoon										1			11				4			1				
November 16-17, 2020																								

Site	DOCO	DUSP	EUCD	EUST	FOSP	GCSP	GRHE	GREG	GRTE	HEGU	HETH	HOFI	KILL	LBCU	LESA	LISP	MALL	MAGO	MEGU	MODO	NOHA	OSPR	PECO	PEFA
Younger Lagoon								1		2			8								1			
February 23-24, 2021																								
Younger Lagoon													1											
May 3-4, 2021																								
Younger Lagoon								1									5							
August 10-11, 2021																								
Younger Lagoon								3		1						1								
November 16-17, 2021																								
Younger Lagoon						2				1														
February 8-9, 2022																								
Younger Lagoon													4				2							
May 3-4, 2022																								
Younger Lagoon								1						3			5							
August 3-4, 2022																								
Younger Lagoon							1			2				1										
November 1-2, 2022																								
Younger Lagoon	1							1																
February 7-8, 2023																								
Younger Lagoon																							10	
May 4-5, 2023																								
Younger Lagoon																						1		

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

Site	PIGR	PIGU	RBME	REHA	REPH	RNDU	RWBB	RODO	SAND	SAPH	SNEG	SOSP	SPSA	SSHA	SURF	VGSW	WCSP	WEGU	WESA	WHIM	YRWA	Species Richness
Younger Lagoon		3									3							28		1		8
Natural Bridges									7									80		7		6
November 4-5, 2014																						
Sand Plant							2											3				4
Younger Lagoon									11		1							10		8		7
Natural Bridges									20		4		1					18				10
January 26-27, 2015																						
Sand Plant																		25				4
Younger Lagoon							10											27		1		7
Natural Bridges							9				2							175		3		10
April 14-15, 2015																						
Sand Plant		3																5				6
Younger Lagoon							5				2							5				6
Natural Bridges							4				3							21		9		7
July 8-9, 2015																						
Younger Lagoon		4									2							31				7
October 29-30, 2015																						
Younger Lagoon																		6				4
February 2-3, 2016																						
Younger Lagoon		2									3							9		4		7
May 3-4, 2016																						
Younger Lagoon							1						1					8				10
12-Jul-16																						
Younger Lagoon											1							2				7
November 9-10, 2016																						
Younger Lagoon							5											6				8
March 1-2, 2017																						
Younger Lagoon							6				1							2		1		10
April 25-26, 2017																						
Younger Lagoon							2											2		4		8
August 2-3, 2017																						
Younger Lagoon																						8
October 25-26, 2017																						
Younger Lagoon											1		1					10				7
February 7-8, 2018																						
Younger Lagoon							7											3				8
May 2-3, 2018																						
Younger Lagoon							9													2		8
August 13-14, 2018																						
Younger Lagoon											4							5				9
November 7-8, 2018																						
Younger Lagoon										1	1							75				11
February 20-21, 2019																						
Younger Lagoon										2	2	1						3			2	13
May 14-15, 2019																						
Younger Lagoon									1			3				5						12
July 16-17, 2019																						
Younger Lagoon		3										3										8
October 30-31, 2019																						
Younger Lagoon										1								2				4
February 12-13, 2020																						
Younger Lagoon										2	1	4										13
May 20-21, 2020																						
Younger Lagoon											1	1										10
August 18-19, 2020																						
Younger Lagoon											6	2						1				12
November 16-17, 2020																						

Site	PIGR	PIGU	RBME	REHA	REPH	RNDU	RWBB	RODO	SAND	SAPH	SNEG	SOSP	SPSA	SSHA	SURF	VGSW	WCSP	WEGU	WESA	WHIM	YRWA	Species Richness
Younger Lagoon																		5				**7**
February 23-24, 2021																						
Younger Lagoon											1							1				**8**
May 3-4, 2021																						
Younger Lagoon											3	11						1				**8**
August 10-11, 2021																						
Younger Lagoon											2			1				3				**8**
November 16-17, 2021																						
Younger Lagoon										1		3					4	21				**12**
February 8-9, 2022																						
Younger Lagoon												1						2				**11**
May 3-4, 2022																						
Younger Lagoon												3						33				**14**
August 3-4, 2022																						
Younger Lagoon											1	2						4		1		**10**
November 1-2, 2022																						
Younger Lagoon										1		1						13				**7**
February 7-8, 2023																						
Younger Lagoon									7			1						7				**7**
May 4-5, 2023																						
Younger Lagoon	5		1				1					3						5				**11**

AMCO, American Coot; AMCR, American Crow; AMPE, American White Pelican; AMWI, American Widgeon; ANHU, Anna's Hummingbird; BASP, Baird's Sandpiper; BASW, Barn Swallow; BEWR, Bewick's Wren; BLOY, Black Oystercatcher; BLPH, Black Phoebe; BLTU, Black Turnstone; BBPL, Black-bellied Plover; BCNH, Black-crowned Night Heron; BRAC, Brandt's Cormorant; BRBL, Brewer's Blackbird; BRPE, Brown Pelican; BUFF, Bufflehead; BUSH, Bushtit; CAGU, California Gull; CAGO, Canada Goose; CLSW, Cliff Swallow; COMU, Common Murre; CORA, Common Raven; COYE, Common Yellowthroat; DOCO, Double-Crested Cormorant; DUSP, Dunlin; EUCD, Eurasian Collared-Dove; EUST, European Starling; FOSP, Fox Sparrow; GCSP, Golden-crowned Sparrow; GREG, Great Egret; GRHE, Green Heron; GRTE, Green-Winged Teal; HEGU, Heerman's Gull; HETH, Hermit Thrush; HOFI, House Finch; KILL, Killdeer; LESA, Least Sandpiper; LISP, Lincoln's Sparrow; LBCU, Long-billed Curlew; MALL, Mallard; MAGO, Marbled Godwit; MEGU, Mew Gull; MODO, Mourning Dove; NOHA, Northern Harrier; PECO, Pelagic Cormorant; PEFA, Peregrine Falcon; PIGU, Pigeon Guillemot; PIGR, Pine Grosbeak; REPH, Red Phalarope; RBME, Red-breasted Merganzer; Red-tailed Hawk; RWBB, Red-Winged Blackbird; RNDU, Ring-necked Duck; RODO, Rock Dove; SAND, Sanderling; SAPH, Say's Phoebe; SSHA, Sharp-shinned Hawk; SNEG, Snowy Egret; SOSP, Song Sparrow; SPSA, Spotted Sandpiper; SURF, Surfbird; VGSW, Violet-green Swallow; WEGU, Western Gull; WESA, Western Sandpiper; WHIM, Whimbrel; WCSP, White-crowned Sparrow; YRWA, Yellow-rumped Warbler

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 9). 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 relatively small. Additionally, authorized 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. It is likely that increased unauthorized overnight human use of the beach prior to the pandemic had a negative impact on native mammals such as bobcats. Reserve staff will continue their public outreach and education efforts, continue to partner with UCSC campus police to ensure the security of the reserve and protect sensitive resources and ongoing research, and continue to report back to the Commission on the negative impacts of unauthorized beach use. 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 free Seymour Center docent led tours, provides an appropriate level of supervised 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.

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Appendix 1. Younger Lagoon Photos.


YLR Beach Photopoint #1 (W). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #1 (NW). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).

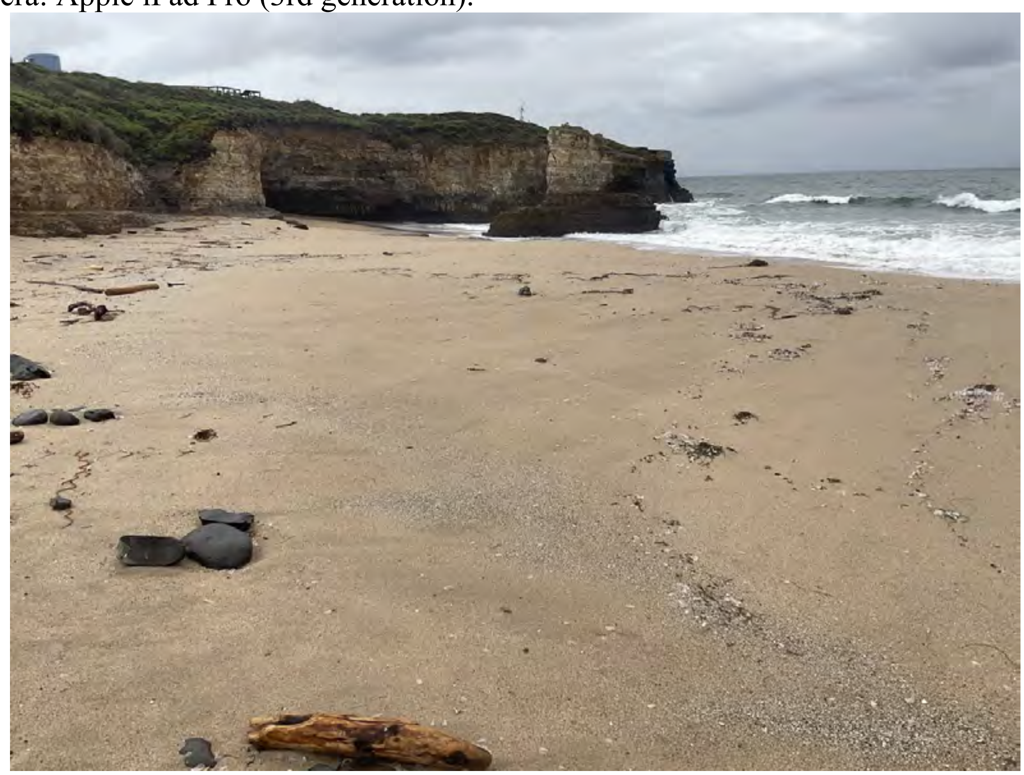
YLR Beach Photopoint #1 (N). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #2 (S). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #2 (SW). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #2 (W). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #2 (NW). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).



YLR Beach Photopoint #3 (SE). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #3 (E). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #3 (NE). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #3 (N). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #3 (NW). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #3 (W). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #4 (N). May 4th, 2023. Photographer: Vaughan Williams
Camera: Apple iPad Pro (3rd generation).

Appendix 2. Restoration compliance monitoring report

Compliance Monitoring Report for Coastal Prairie and Coastal Scrub Restoration Sites at Younger Lagoon Reserve – Spring 2023

Georgia L. Vasey

Introduction

In keeping with the goals of the restoration plans for the Younger Lagoon Reserve Terrace Lands prepared for the California Coastal Commission (UCNRS 2010, UCNRS 2018), reserve employees, interns, and volunteers have continued to perform native plant community restoration activities. This report presents the results of the 2023 monitoring data for the 2012 wetland 6 buffer plantings, 2017 coastal scrub plantings, and the 2019 and 2021 coastal prairie plantings. Monitoring efforts begin two years post-planting. If a site meets restoration targets, monitoring is then conducted every other year for the first six years post-planting, and then every five years after that. If a site does not meet restoration targets, the site is monitored annually until it reaches restoration targets (UCNRS 2018). The 2012 coastal prairie habitat was monitored and did not meet compliance standards in 2018 or 2019, therefore it was re-planted in 2021 with monitoring beginning this year.

Methods

Planting

Seeds for the coastal prairie planting projects were collected from local reference sites in coastal regions of Santa Cruz and San Mateo counties. The seeds were grown in Ray Leach stubby (SC7) conetainers^{TM} for several weeks in the UC Santa Cruz Jean H. Langenheim Greenhouses before being planted at the site. Site preparation prior to planting typically involved the hand removal of large weeds (e.g., *Carpobrotus edulis, Raphanus sativus, Cirsium vulgare*) and tarping to reduce non-native species cover. Subsequently, a heavy layer of wood chip mulch (~10-15 cm) was applied to all restoration sites prior to planting to suppress non-native weed emergence. Teams of volunteers, interns, and staff planted the native plugs primarily between December and February using dibblers. Sites received supplemental irrigation through spot watering during the first year following planting to help improve establishment. After the first year, there was no supplemental irrigation. Follow up management included hand removal and targeted herbicide application for emerging non-native species 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 seed set from nonnative species prior to native perennial species began to reproductively develop. Sites that did not reach compliance goals in the year monitored, received additional follow up management in the subsequent year.

Sampling

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. For each transect, the quadrat was randomly placed between 1 and 5 m as the starting point. In some areas, 50-m transects did not fit the shape of the restoration area, so transects were slightly shortened or 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 of 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 length of the transect was measured. Percent shrub cover was determined from the length covered by a particular species divided by the total length of the transect. Shrub cover may exceed 100% if multiple species are overlapping on the transect. In some areas, herbaceous cover and scrub were mixed, and both shrub measurements and herbaceous cover quadrats were quantified for these transects. Along shrub transects, herbaceous cover quadrats were only taken within non-scrub dominated areas along the transect, and thus may not be sampled every 5 m.

The 2012 wetland 6 buffer plantings were measured using two transects of 25 m for a total of 10 quadrats (Figure 1, 2). The 2017 coastal scrub area was measured using four transects of 19.2, 24.8, 25.9, and 40 m (Figure 1, 2). To stay consistent with analyses from previous years (Lesage 2015, 2016, 2017, 2018; Luong 2019, 2020, 2021), four quadrats were evaluated for plant guilds other than scrub on the 25.9-m transect, which had some interspersed prairie. Percent-herbaceous cover for this transect is analyzed separately from scrub cover (Table 1). The 2019 coastal prairie was measured using two 50 m transect, for a total of 20 quadrats (Figure 1, 2). The 2021 (formerly 2012) coastal prairie planting area was measured using three transects of

25, 40, and 45 m, for a total of 22 quadrats (Figure 1, 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 wetland 6 buffer plantings are expected to meet the 5 years after planting, and every 5 years thereafter targets; the 2017 coastal prairie sites should meet six-year targets; the 2019 coastal prairie site should meet four-year targets; and the 2021 coastal prairie site 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 surpassed in all restoration areas monitored in 2023, besides the herbaceous cover in the 2017 coastal scrub planting area (Table 1). The 2012 wetland 6 buffer planting area had a native cover of 77.8 ± 9.2%, which exceeds the ≥ 30% native cover. Cover at the 2017 coastal scrub site was 92.7 ± 0.1%, which was well above the six-year target of ≥40%. However, this includes scrub mortality, which would be 59.5 ± 0.1% if adjusted for dead shrubs. Herbaceous cover within the 2017 coastal scrub areas was below the 25% native cover target (15.0 ± 9.7%), although it is close to 25% when accounting for the error margin, and only includes observations from one of four transects in the restoration area. The 2019 coastal prairie site had a native cover value of 55.3 ± 6.1%, greatly surpassing its post-year-four target of ≥ 15%. In the 2021 coastal prairie site, native cover goals of ≥ 5% were also met, with an average observed cover of 30.8 ± 3.3%.

Native species richness measurements were above defined target levels for all planted areas (Table 2). Transects in the 2012 wetland 6 buffer area had an average observed native species richness of 10 ± 1 species, with a total of 13 species across at the site level, which meets the requirement of ≥ 6 species. The 2017 coastal scrub areas met their ≥ 8 species target with an average of 8.25 ± 2 native species per transect and 13 total native species. The 2019 coastal prairie area had an average native species richness of 13.5 ± 1.5 species with a total of 19 native species observed across all transects, which meets post-four-years monitoring targets. There were 12.3 ± 4 native species on average and 23 species observed (target: ≥ 6 species) at the 2021 coastal prairie area, which exceeds compliance targets.

All planted areas showed evidence of recruitment for multiple native species.

Discussion

All restoration areas monitored in 2023 at Younger Lagoon Reserve met or exceeded the restoration targets laid out for the California Coastal Commission for their respective habitats (UCNRS 2010, UCNRS 2018). Native species cover in the 2012 wetland 6 buffer area appears to have increased compared to the 2018 report (Lesage, 2018). The 2017 coastal scrub percent cover has reduced compared to the 2021 report (121.0 ± 13.9%), although it is still above targets for six years post-planting (≥ 40%). The 2019 coastal prairie site appears to successfully have restored native species cover and richness consistent with the monitoring report from 2021, although native cover is reduced compared to two-years post-implementation (63.6 ± 13.3%; Luong, 2021). The restored 2012 area (now called the 2021 coastal prairie site) is currently achieving restoration targets.

A comparison of monitoring data from 2019, 2021, and 2023 shows interesting trends in 2017 coastal scrub plantings (Luong, 2019, 2021). In 2019, the 2017 plantings had an average scrub native cover of 103.6 ± 14.7%, which was above the target of ≥ 10% native cover. For that monitoring year, herbaceous cover was not taken, as there were not interstitial prairie habitats (Luong, 2019). These results compare to the 2021 report, four-years post implementation, in which average scrub native cover increased to 121 ± 13.9% and the herbaceous native cover was 48.3 ± 8.7%. This year (six years post-implementation), the 2017 coastal scrub planting has dramatically reduced, with an average scrub native cover at 92.7 ± 0.1% (59.5 ± 0.1% after accounting for mortality), and herbaceous native cover at 15.0 ± 9.7%. Being an exceptionally wet year, it is possible that the shrub species were in standing water for an extended period of time, increasing mortality for less tolerant species like *Artemisia californica* and *Eriophyllum staechadifolium* (this does not seem to be the case for *Baccharis pilularis*). Underneath the dead biomass of the shrub species there was high cover of *Oxalis pes-caprae*, a non-native forb which is likely outcompeting native herbaceous species. There is a slight chance that herbaceous cover was also underestimated because the phenology and germination of native species was delayed this growing season and monitoring occurred in early May. Infilling more *Baccharis pilularis* might be necessary to reduce invasive species spread.

In addition, as predicted in the 2021 report, the 2019 coastal prairie site had reduced native cover, but only by a small margin: 55.3 ± 6.1% versus 63.6 ± 13.3% (Luong, 2021).

Observed native species richness was less (19 versus 27 species), but this is probably due to differences in the monitoring year observer's plant identification skills. Overall, this restoration site is doing exceptionally well. For the newly restored 2021 coastal prairie site, observed native species richness was high (23 species), although the average native species per transect was 12.3 ± 4. This suggests that continual weeding of the area may be necessary to maintain restoration targets, especially given its site history (formerly the 2012 planting area) which suffered from invasive plant competition with non-native forbs.

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, and wetland buffer habitats. Only the 2017 coastal prairie scrub planting did not meet their herbaceous native species cover, although this is not a priority for coastal scrub planting areas. Replanting more scrub species might be necessary in the future to replace dead shrubs.

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Tables and Figures

Figure 1. Overview map of locations for compliance monitoring in 2023 which includes the wetland buffer, coastal scrub and prairie transects and planting areas.

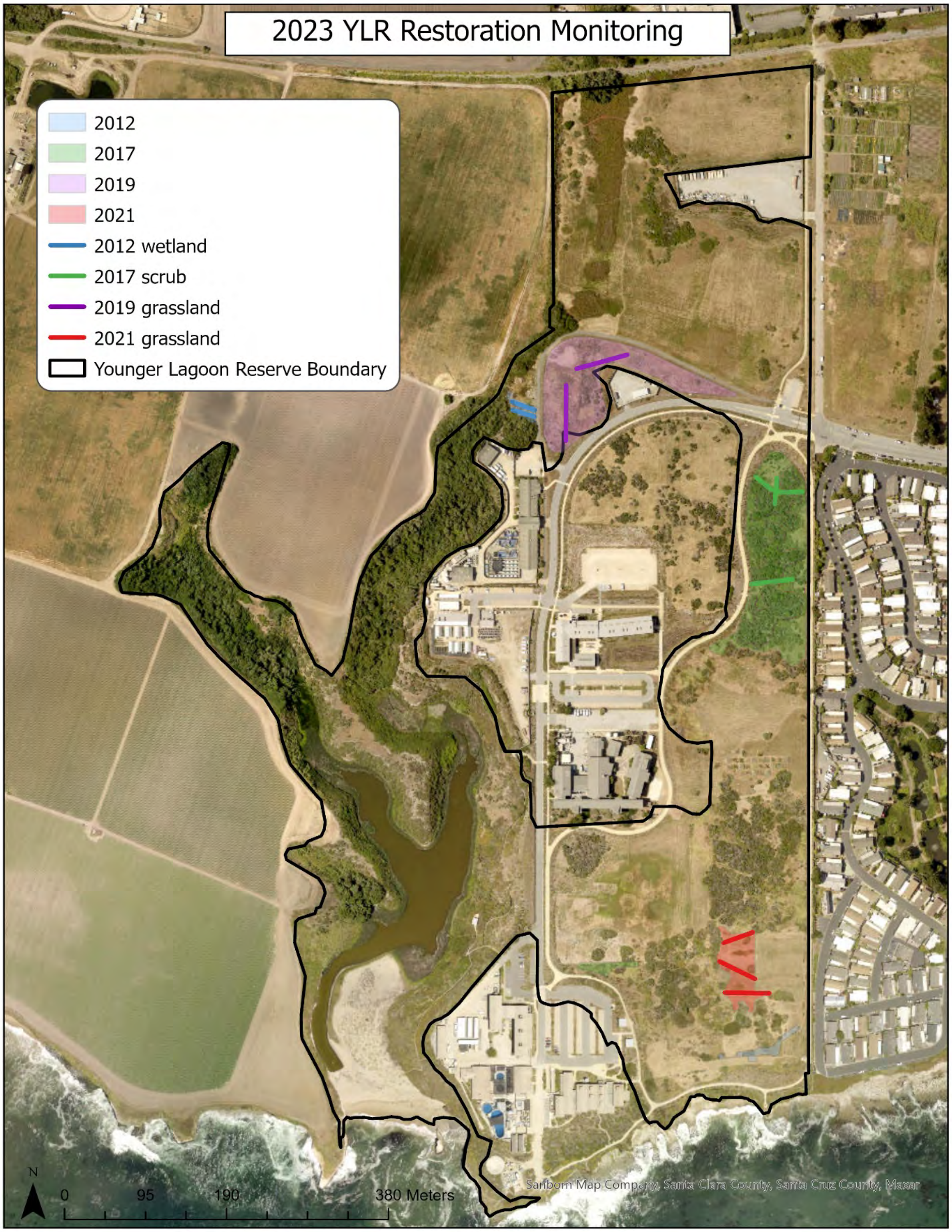

Figure 2. Map of locations for northern area in compliance monitoring in 2023.

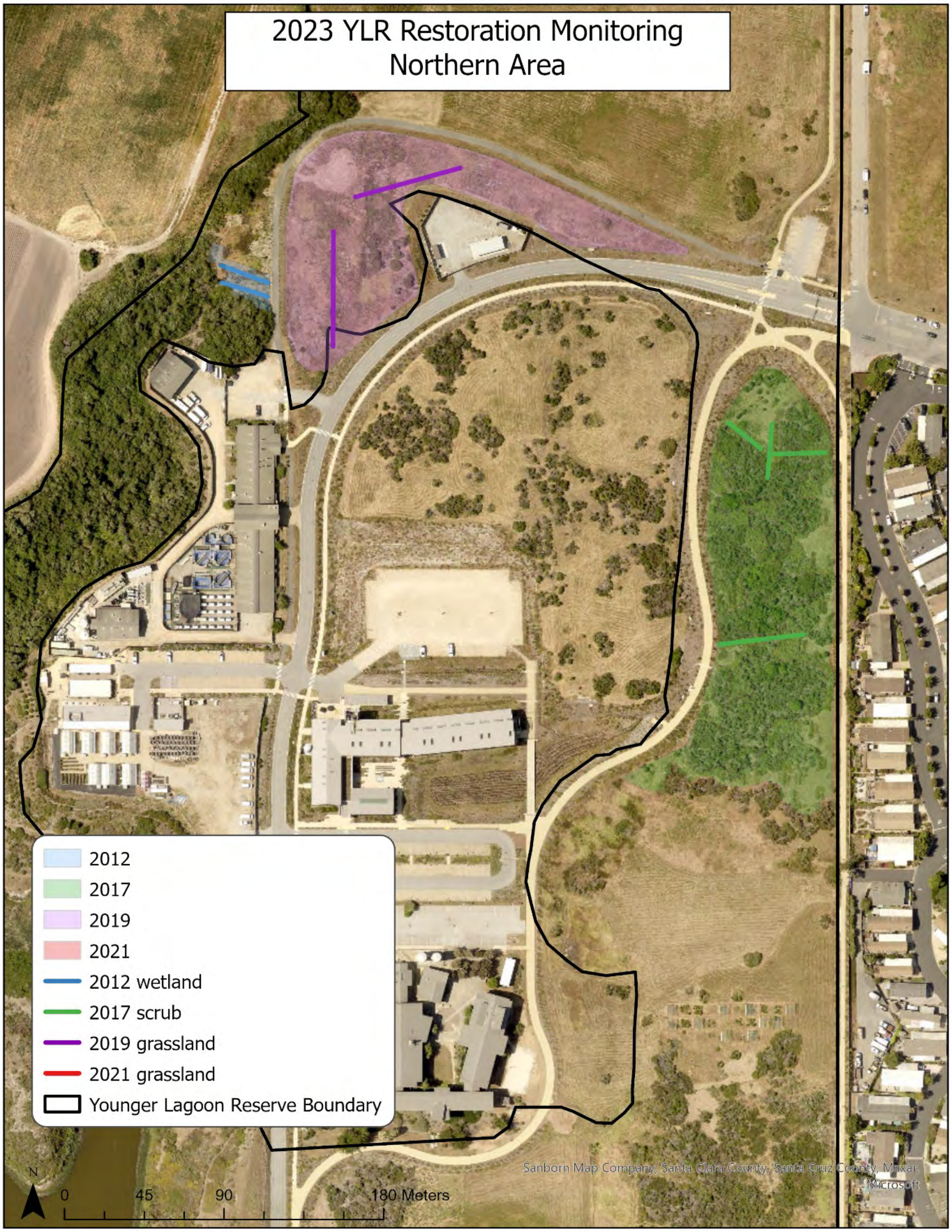

Figure 3. Map of locations for southern area in compliance monitoring in 2023.

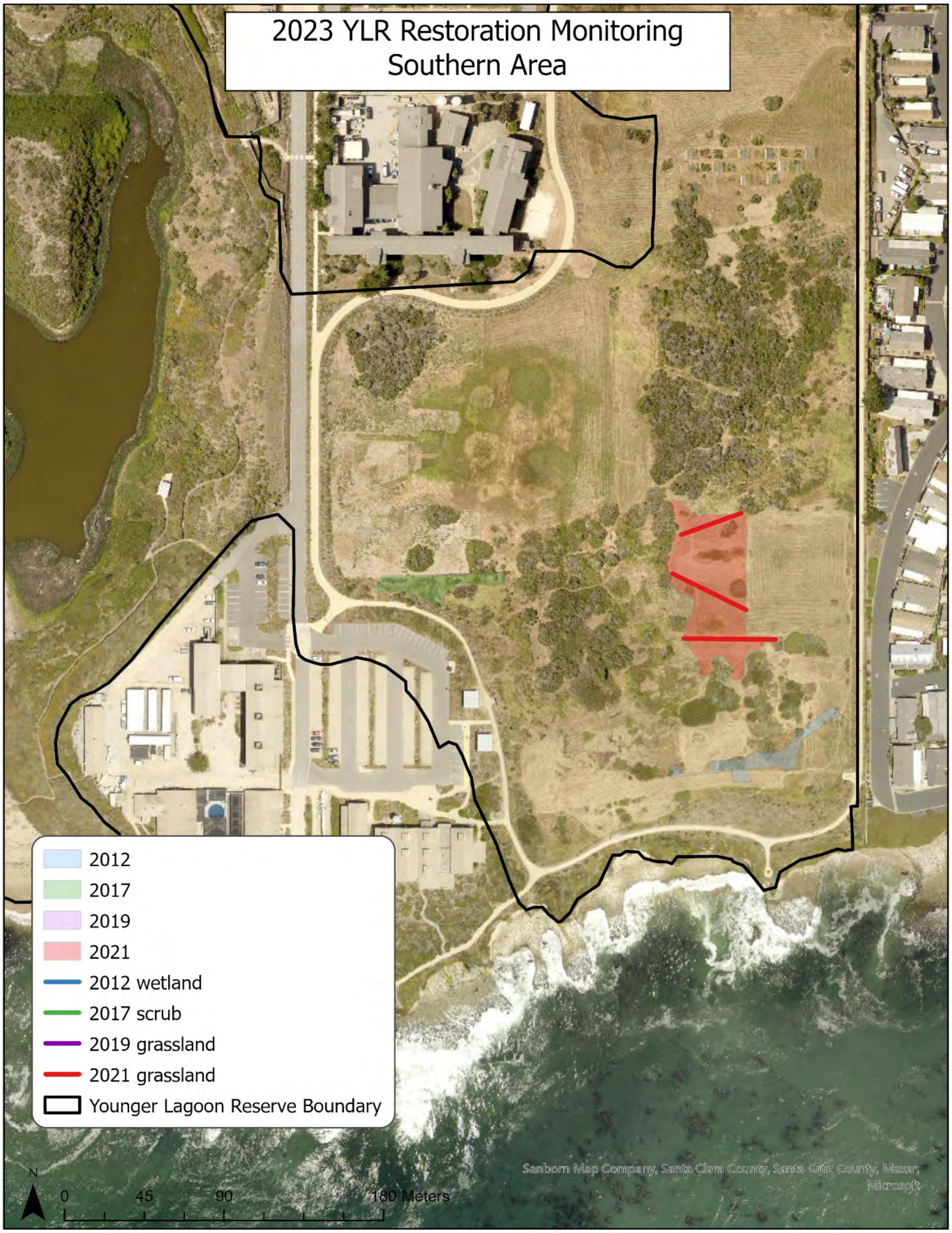

Table 1. Table of native species cover and richness targets and observed values (± SE) in the 2012 wetland buffer, 2017 coastal scrub, and 2019 and 2021 coastal prairie and Younger Lagoon Reserve.

Restoration Area	Observed Native Cover (%)	Target Native Cover (%)	Observed Native Richness (# species/transect)	Target Native Richness (species/habitat)
2012 Wetland 6 Buffer	77.8 ± 9.2	≥30	10 ± 1	≥6
2017 Coastal Scrub				
Shrub Cover	92.7 ± 0.1 (without mortality) 59.5 ± 0.1 (with mortality)	≥40	8.25 ± 2	≥8
Herb Cover	15.0 ± 9.7	≥25		
2019 Coastal Prairie	55.3 ± 6.1	≥15	13.5 ± 1.5	≥6
2021 Coastal Prairie	30.8 ± 3.3	≥5	12.3 ± 4	≥6

Table 2. Table of the native species observed in the 2012 wetland buffer, 2017 coastal scrub, and 2019 and 2021 coastal prairie restoration areas at Younger Lagoon Reserve. Chart shows species found in at least one transect at each site. Blank cells are species that were observed in previous years. Growth forms abbreviated (AF=Annual Forb, PF=Perennial Forb, PG=Perennial Grass, PGRM=Perennial Graminoid, AGRM = Annual Graminoid, S=Shrub, T=Tree). Part one contains annual forbs.

Scientific Name	Common name	Growth Form	2012 Wetland	2017 Coastal Scrub	2019 Coastal Prairie	2021 Coastal Prairie
Cardamine oligosperma	western bittercress	AF				
Erigeron canadensis	Canadian horseweed	AF				
Epilobium brachycarpum	willowweed	AF				
Epilobium cilatum	willow herb	AF				
Madia gracilis	coastal tar weed	AF				
Madia sativa	Coast tarwed	AF	X		X	X

Table 2*, continued*, part two has annual forbs and perennial forbs.

Scientific Name	**Common name**	**Growth Form**	**2012 Wetland**	**2017 Coastal Scrub**	**2019 Coastal Prairie**	**2021 Coastal Prairie**
Phacelia malvifolia	stinging phacelia	AF				X
Pseudognaphalium sp.	Cudweed	AF				
Achillea millefolium	yarrow	PF	X	X	X	X
Artemisia douglasiana	Western mugwort	PF				X
Baccharis glutinosa	marsh Baccharis	PF				
Chlorogalum pomeridianum	soaproot	PF	X	X		X
Clinopodium douglasii	yerba buena	PF				
Eschscholzia californica	California poppy	PF				X
Fragaria chiloensis	beach strawberry	PF				
Grindelia stricta	gumweed	PF			X	
Heracleum maximum	Cow parsnip	PF				X
Horkelia californica	California horkelia	PF			X	X
Marah fabacea	California man-root	PF		X		
Oenthera elata	Hooker's primrose	PF				
Oxalis pilosa	California wood sorrel	PF				
Potentilla anserina	Silverweed	PF				
Prunella vulgaris	selfheal	PF				
Ranunculus californica	California buttercup	PF			X	
Rumex salcifolius	Willow dock	PF	X			
Sanicula crassicaulis	Pacific sanicle	PF				
Scrophularia californica	California bee plant	PF		X		
Sidalcea malviflora	checker-bloom	PF			X	
Sisyrinchium bellum	western blue-eyed grass	PF			X	X

***Table 2**, continued*, part three has perennial forbs, trees, perennial grasses, graminoids and shrubs.

Scientific Name	Common name	Growth Form	2012 Wetland	2017 Coastal Scrub	2019 Coastal Prairie	2021 Coastal Prairie
Symphyotrichum chilense	Pacific aster	PF	X	X	X	X
Aesculus californica	California Buckeye	T				
Frangula californica	Coffee berry	T		X		
Salix lasiolepis	Arroyo willow	T				
Agrostis pallens	Seashore bent grass	PG			X	X
Bromus carinatus	California brome	PG				X
Danthonia californica	California oatgrass	PG				X
Deschampsia cespitosa	Tufted hair grass	PG			X	X
Elymus glaucus	blue wild rye	PG			X	X
Elymus triticoides	creeping wild rye	PG	X			X
Festuca californica	California fescue	PG				X
Festca rubra	Red fescue	PG				
Hordeum brachyantherum	meadow barley	PG	X		X	X
Stipa pulchra	purple needle grass	PG				
Carex hartfordii	Monterey sedge	PGRM	X			
Cyperus eragrostis	Nutgrass	PGRM				
Juncus effusus	Soft rush	PGRM			X	
Juncus mexicanus	Mexican rush	PGRM	X		X	
Juncus patens	spreading rush	PGRM	X		X	
Juncus occidentalis	Western rush	AGRM				
Juncus bufonius	Toad rush	AGRM	X		X	
Artemisia californica	California sagebrush	S		X		X
Baccharis pilularis	coyote brush	S	X	X	X	X

Ericameria ericoides	Mock heather	S				
Eriophyllum staechadifolium	Seaside golden yarrow	S		X		X
Lupinus arboreus	Bush lupine	S				
Lupinus littoralis	Many-colored lupine	S				
Diplacus aurantiacus	sticky monkey flower	S		X		
Ribes sanguineum	flowering currant	S				
Rosa californica	California wild rose	S		X	X	X
Rubus ursinus	pacific blackberry	S	X	X		X
Toxicodendron diversilobum	Poison Oak	S		X		
Observed Native Species Richness:			13	13	19	23
Target Native Species Richness:			≥ 6	≥ 8	≥ 6	≥ 6

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 are from the Santa Cruz reporting station at California Department of Water Resources Climate Data Exchange Center.

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	130.0 cm
2017-2018	49.7cm
2018-2019	92.3 cm
2019-2020	40.1 cm
2020-2021	37.1 cm
2021-2022	51.8 cm
2022-2023	51.9 cm

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

Wetland
Performance Standard: 4 native plant species appropriate for habitat established in planted areas to comprise 25% 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
5 years after planting and every 5 years after that	6 or more native plant species established comprising > 30% 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

Appendix 3. Student reports

UNIVERSITY OF CALIFORNIA
SANTA CRUZ

NATIVE ANNUAL FORB ESTABLISHMENT ON SCRAPED AND MOUNDED SOIL

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

BACHELOR OF SCIENCE

in

PLANT SCIENCES

by

Janine Anne Tan

March 2023

ADVISORS: Karen D. Holl, Justin C. Luong

ABSTRACT: Non-native invasive plant species in California grasslands inhibit the establishment of native annual forbs. I explored whether removing topsoil by scraping increases native species' establishment since scraping may reduce invasive species' seed banks and reduce competition with native species. In a field experiment in former agricultural land at Younger Lagoon Reserve, I planted two native perennial grasses and six native annual forb species in six replicates of scraped, unscraped, and mounded soils to quantify effects on soil moisture, survival of native annual forbs, and vegetation cover. Native species survival and cover were not affected by soil scraping or mounding, but the non-native cover was significantly reduced in scraped plots. Soil moisture was lower in the unscraped soil earlier in the season, but there was no difference later in the season. These results suggest that soil scraping and soil mounding do not increase native forb survival and cover.

KEYWORDS: Coastal prairie restoration, Native annual forbs, Plant establishment, Topsoil removal, Gopher mounds

Introduction

Invasive non-native species often reduce native plant growth in former agricultural lands (Daehler, 2003; Bradford and Lauenroth, 2006). Invasive annual grasses are usually strong competitors and often outcompete natives, including perennial grasses (Lowe, Lauenroth, and Burke, 2003). Native annual forbs are sensitive to competition, even more so than native perennial grasses. Therefore, many studies have shown that annual forbs will be strongly and adversely affected by invasive species (Rees et al., 2001; Levine et al., 2003).

Native annual forbs in California are harder to establish from seed than introduced grasses because forbs are weaker competitors, and may require periodic disturbance for seed establishment (Seabloom et al., 2003). Even though native annual forbs comprise much of the biodiversity in California grasslands, they are rarely used for restoration due to high cost and lack of seed, and knowledge of their use for restoration is limited.

There are many ways that could reduce competition of non-native species, such as mowing, manual weed removal, and scraping the soil surface. A previous study found that repeated mowing can help reduce the cover of non-native annual grasses and increase the cover of native bunchgrasses such as *Stipa pulchra* (Valliere et al., 2019). However, mowing also increases the abundance of non-native forb species so it may not be the best approach to inhibit the growth of non-native species. Multiple studies have removed topsoil to potentially reset the degraded land, resulting in the re-establishment of targeted species, such as native annual forbs, in the long run (Resch et al., 2019, 2022; Emsens et al., 2015). Removing surface soil also removes much of the seed bank of invasive species, thereby reducing invasive competition for native species (Buisson et al., 2008).

Gopher mounds also may have a positive effect on native species as they bring the seed bank from deeper underground to the surface while aerating the soil (Jones, Halpern, and Niederer 2008; Reichman and Seabloom, 2002). Soil aeration may benefit native plants by increasing germination rates because of changes in physical and/or chemical soil properties that also increase soil nutrients (Qian et al., 2022). Higher nutrients can stimulate faster growth and better survival after germination. Another factor likely to influence establishment on mounds is soil moisture (Grant et al., 1980; Kyle, Kulmatiski, and Beard, 2008). Soil moisture benefits plant growth directly by improving water balance (Seneviratne et al., 2010). Soil moisture plays an important part in breaking down nutrients and allowing plants to absorb them. Since mounds made by gophers seemingly have positive effects on the establishment of native forbs, simulating these mounds may be an effective restoration strategy.

This study explored the establishment of native forbs in degraded lands, with the primary goal of determining whether removing topsoil increases the establishment of annual native forbs. I also tested using the scraped soil to create artificial mounds as an alternative restoration strategy. I used a field experiment involving two native perennial grasses and six native annual forbs. I tested the main hypothesis that removing topsoil by scraping before planting native forbs would increase their survival and cover. Other hypotheses are that scraping reduces the biomass of non-native species, thereby reducing competition, and increasing native species' performance.

Another hypothesis is that mounding increases the establishment of both native and non-native species because moisture in soil mounds will be higher than in scraped soil.

Materials and Methods

Study Site

I conducted a field experiment at Younger Lagoon Reserve (YLR), part of the UC Natural Reserve System, located in Santa Cruz, CA. YLR is made up of two areas: the 10-hectare lagoon and the 19-hectare Terrace Lands. The lagoon is one of the few relatively undisturbed wetlands remaining on the California Central Coast, and the Terrace Lands were used for agriculture for nearly 70 years. The YLR staff and interns are working to restore the Terrace Lands to native grassland, scrub, and seasonal wetland habitats. Elevation ranges from 0 to 15 m. Terrace Lands were formerly used for cattle grazing and cultivating Brussels sprouts and are now dominated by non-native species such as *Carduus pycnocephalus, Festuca bromoides, Festuca perennis, Bromus diandrus, Geranium dissectum, Raphanus sativus*, and a couple of native species such as *Baccharis pilularis*. The reserve has a Mediterranean climate with summer coastal fog and an average annual precipitation of 62 cm. Precipitation during the study year (2021-2022) was 51.8 cm, well below the average precipitation (Luong and Loik, 2021; "Younger Lagoon Reserve Annual Report", 2022).

Typical pre-restoration treatments for YLR's restoration areas include mowing accumulated biomass, installing cardboard sheet mulch, and covering the plots with 7-10 cm of locally sourced wood chip mulch, followed by planting seedlings of native species. To date, most of the species planted have been perennial grasses and forbs with relatively few annual forb species planted.

Focal Species

I conducted an experiment with two native perennial grasses (*Stipa pulchra* and *Elymus glaucus*) and six native annual forbs (*Amsinckia spectabilis, Clarkia davyi, Lupinus nanus, Clarkia rubicunda, Navarretia squarrosa, and Phacelia malvifolia*). YLR staff, student interns and I germinated seeds, in early November 2021, that were collected from previous experiments at YLR. We planted seeds directly in seed trays using Premier Pro-Mix HP inoculated with mycorrhizae at the UCSC Greenhouse with 144 seedlings for each species. The seedlings were watered every day and fertilized every other week.

Study Design

The experiment was conducted in a 20 x 20 m area that was used for a previous restoration experiment, and prepared in ways consistent with previous YLR restoration practices. However, we only used wood chip mulch but not cardboard. Within the area, 18 plots were assigned randomly among three treatments, containing six 2 x 2 m plots of each treatment (Fig. 1).

Six plots were assigned to each one of the three treatments: (1) unscraped soil (control), (2) soil scraping, and (3) soil mounding. In scraped plots, we used flathead shovels and a McLeod tool (a two-sided blade – one a flat sharpened hoe and the other a rake with coarse tines) to remove 3-4 cm (<5 cm) of topsoil and cut the grasses as short as possible. We used the removed soil to create flat-topped mounds 2-3 cm tall covering the whole plot of the "mounding" treatment.

Seedlings were transferred into the experimental plots on 8 January 2022. Seedlings in each plot were planted 25 cm apart with 8 individuals per species for a total of 64 individuals per plot. Their positions were assigned using a random number generator. All plots were planted in a standard plot design that was pre-randomized (Fig. 2). After planting, I watered plots once a week until the end of February, and then biweekly until the beginning of June.

Data collection
My research partner, Jennifer Valadez, and I measured survival (alive or dead) of each individual twice in late April and late July when the plants were establishing and flowering/fruiting. However, most of the plants had died by July sampling. We measured native and non-native cover once in early May in three 75 x 75 cm quadrats per plot. We identified individual species and assessed the percentage of the quadrat that is covered by vegetation. We measured soil moisture 7-8 cm deep in all plots using Fieldscout TDR 150 Soil Moisture Meter with a short rod immediately after planting, and biweekly until late July. Soil moisture was taken from four corners of each plot.

Data analysis
I analyzed vegetation cover and annual plant survival as a function of treatment in a one-way ANOVA in JMP 16, averaging the measurements from within the individual plots. There were six replicate plots per treatment. For cover, the individual species measurements were combined and analyzed by guild (native forbs, non-native forbs, native grass, and non-native grass) per treatment. I averaged the four soil moisture measurements from each plot and then used linear regression in JMP. I compared the treatments by visualizing the 95% confidence intervals of the three treatments.

Results
Soil Moisture
The unscraped soil had lower soil moisture than the other two treatments through most of the season (Fig. 3). Soil moisture measurements increased over time and overlapped in all treatments towards the end of the season.

Survival
The only species that differed significantly in survival across treatments in April was *Lupinus nanus* which had significantly higher survival in the unscraped plot as compared to the other two treatments (p =0.0224, Table 1). *A. spectabilis, L. nanus, C. rubicunda, and N. squarrosa* had slightly higher April survival in unscraped plots but these differences were not significantly different due to high variance among treatments. *Clarkia dayvi* had the highest survival in mounded plots. Both native grasses, *Elymus glaucus* and *Stipa pulchra*, had lower survival than native forbs across treatments in April. By July, less than 5% of each species of annual forb had survived, thus it was not possible to compare their survival across treatments. Some of the perennial grasses survived in July (Table 2). *E. glaucus* survival was marginally higher in mounded treatments, but there was no treatment effect for *Stipa pulchra.*

Vegetation Cover
The mounded treatment had a significantly lower percent cover of mulch and a marginally higher percent cover of native grass in May (p= <0.0001, Table 3). Native and non-native forb percent

cover was lowest in the scraped treatment (p=0.0017, Table 3). The unscraped treatment soil had the highest non-native grass percent cover (p=0.0372, Table 3).

Discussion

Scraping and mounding did not have an effect on seven out of eight species, *Lupinus nanus* being an exception. *Lupinus nanus* survival was highest on the unscraped plots, which shows an opposite trend than what I hypothesized. This contrasts with the results of previous studies where topsoil removal increased plant survival and species richness, particularly low-stature species (Buisson et al., 2006; Jaunatre et al., 2014). Possible reasons why I had contrasting results with this prior study were that there was not a strong effect of treatments on plant survival due to high variance among treatments, and that watering reduced the treatment effects.

Scraping has both positive and negative benefits on plant cover. It can decrease cover of non-native grasses and forbs in the first year, but it also reduces the cover of native forbs. The scraped plots had lower vegetation cover in comparison to mulch cover because scraping also removed native seed banks along with non-native seeds. This result is contradictory to previous studies where they found that topsoil removal strongly promotes the re-establishment of plant species in species-rich grasslands (Emsens et al., 2015; Resch et al., 2019, 2022).

The overall vegetation was increased in mounded plots, but mounding did not increase survival of planted native species. Mounding has the lowest mulch cover and therefore has the most vegetation. This might have been due to the seed bank of unplanted native and non-native vegetation that was stored in the soil seed bank of the scraped plots from past experiments. Pocket gopher mounds can increase plant biomass in the long term (Reichman and Seabloom, 2002). However, in another study, mounds did not increase species richness (Jones, Halpern, and Niederer, 2008).

The soil moisture for all treatments increased over time and overlapped towards the end. I hypothesized that mounding would have the lowest soil moisture because a previous study found that mounds had lower moisture content compared to the intact ground due to increased soil temperature (Simkin, 2004). However, in a previous study, they found that mounds increase the mixing of soil, resulting in an increase in water-holding capacity, and soil aeration (Hansen and Morris, 1968). Decompacted soil has more air space to hold water and therefore would have higher soil moisture. However, there is minimal difference in soil moisture between scraped and mounded plots. On the contrary, I found that unscraped soil had the lowest soil moisture. Scraped plots had higher soil moisture than I had expected possibly because of water puddling due to slightly lower topography in scraped plots. The abundance of non-native forbs in mounds might have affected the amount of water in the soil as previous studies found that exotic species can maintain soil moisture more effectively than native species in coastal habitats (Castro-Díez et al., 2016; Si et al., 2013).

This study has a few potential limitations. The experiment was done on a particularly dry, low rainfall year causing dried plants. And so, I was not able to measure final cover estimates. To prevent drying, I might have watered the plants more than I should have as California native plants thrive on drought conditions as they are water efficient, and watering could have caused non-native species to thrive as well (Daehler, 2003; Liu et al., 2017; Fahey et al., 2018; Valliere et al., 2019). Watering may have reduced significant results of the treatments on the establishment of native forbs. I was also not able to collect seeds as they dried off before July monitoring, which is an important variable for annual plants as they rely on their seeds to grow. This meant that I wouldn't be able to check seed count for the next generation of annual plants, and I wouldn't be able to measure fecundity (Seabloom et al., 2003). Last, there were herbivory activities in the plots, and many plants were eaten by insects, birds, and smaller animals, especially *Amsinckia spectabilis*. For this reason, I was not able to account for treatment effects on these plants.

Tables

Table 1. Proportion seedling survival ± 1 SE for 8 species in late April, with a separate one-way ANOVA for each species.

Species	**Unscraped (Mean % ± SE)**	**Mound (Mean % ± SE)**	**Scraped (Mean % ± SE)**	**F Ratio**	**P-value**
Amsinckia spectabilis	85.4±7.3	79.2±7.3	64.6±7.3	2.1	0.1541
Clarkia dayvi	58.3±7.2	66.7±7.2	47.9±7.2	1.7	0.2120
Lupinus nanus	89.6±7.2	79.2±7.2	58.3±7.2	4.9	**0.0224**
Clarkia rubicunda	68.8±12.4	58.3±12.4	43.8±12.4	1.0	0.3815
Navarretia squarrosa	58.3±7.1	47.9±7.1	35.4±7.1	2.6	0.1061
Phacelia malvifolia	91.7±8.8	93.8±8.8	81.3±8.8	0.6	0.5705
Stipa pulchra	29.2±10.7	33.3±10.7	35.4±10.7	0.1	0.9153
Elymus glaucus	27.1±12.9	37.5±12.9	27.1±12.9	0.2	0.8068

Table 2. Proportion seedling survival ± 1 SE for 2 native perennial grass species in late July, with a separate one-way ANOVA for each species.

Species	Unscraped (Mean % ± SE)	Mound (Mean % ± SE)	Scraped (Mean % ± SE)	F Ratio	P-value
Stipa pulchra	16.7±5.9	20.8±5.9	27.1±5.9	7.7	0.4635
Elymus glaucus	16.7±6.1	35.4±6.1	20.8±6.1	2.6	0.0804

Table 3. Vegetation percent cover ± 1 SE of native and non-native plant species across all plots, with a separate ANOVA for each classification.

Guild	Unscraped (Mean ± SE)	Mound (Mean ± SE)	Scraped (Mean ± SE)	F Ratio	P-value
Mulch	55.6±4.9	27.9±5.0	59.7±4.9	12.1	**<0.0001**
Native Forbs	19.6±2.3	18.8±1.9	10.2±1.9	6.7	**0.0017**
Non-Native Forbs	11.5±3.2	15.5±2.4	7.5±2.3	2.8	0.0638
Native Grass	10.1±2.5	15.2±2.6	10.2±2.3	1.3	0.2914
Non-Native Grass	19.7±2.8	12.2±3.2	8.0±3.9	3.4	**0.0372**

Figures

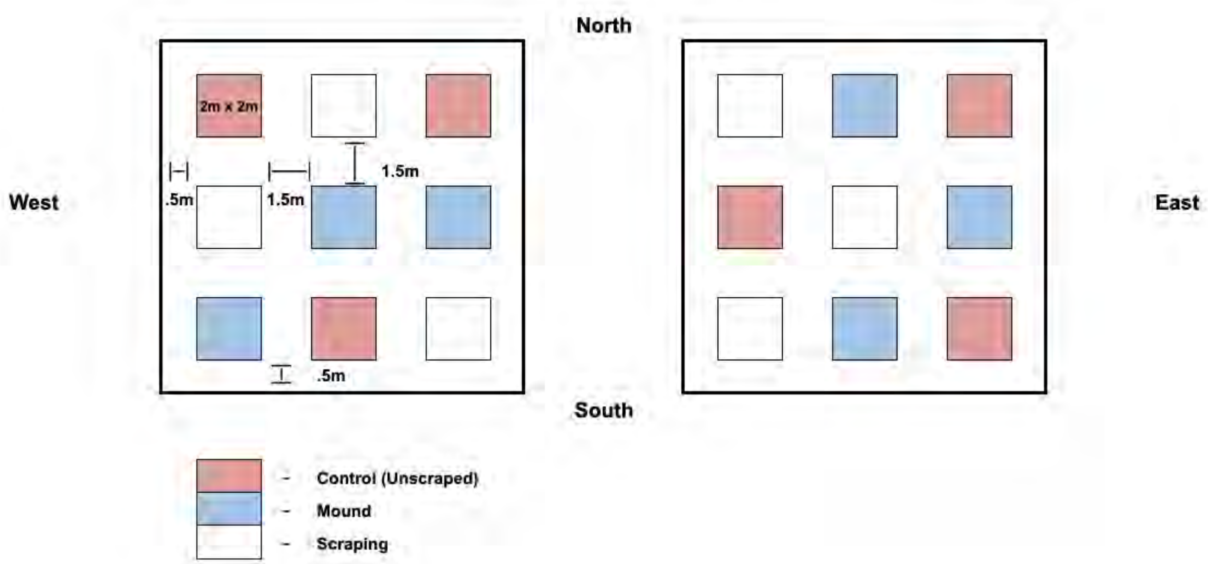

Figure 1. Experimental design. Random assignment of plots to three treatments (unscraped soil, soil scraping, and soil mounding) and 3 replicates in each area with a 1.5 m buffer in between.

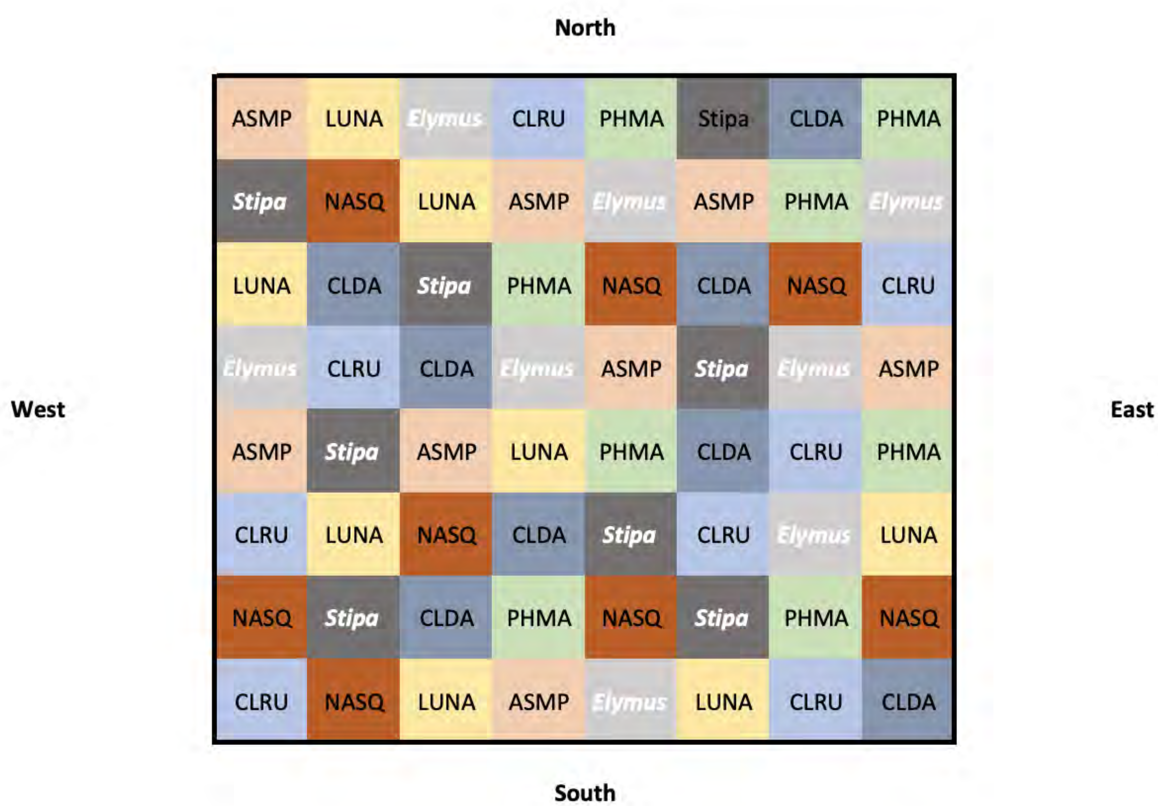

Figure 2. Pre-randomized standard plot planting design with 8 species and 8 individuals of each species.

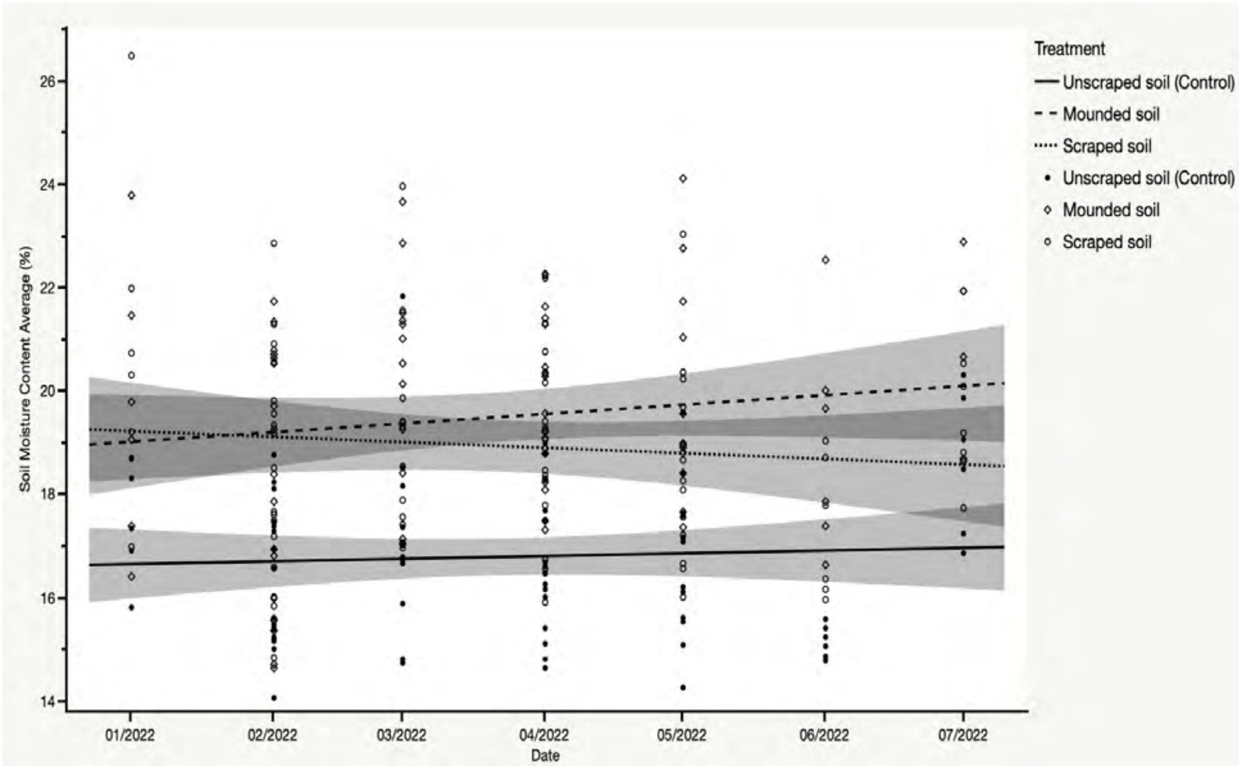

Figure 3. Moisture content in each plot of three soil treatments from January to July 2022. The linear regression lines represent the approximation of the data points in each soil treatment. The shaded area is the 95% confidence band.

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Native Annual Forb Restoration Progress Report – Summer 2023

Karen Holl, Janine Tan, Jennifer Valadez, Whitney Barnett, Justin Luong

Overview

Native annual forbs comprise a large proportion of the diversity in California grasslands, yet they have proven challenging to reintroduce, so most land managers focus on planting perennial forbs and grasses (Lesage et al. 2018). As a result, we have conducted a couple of recent experiments to test different methods for reintroducing native annual forbs.

Forb priority experiment

In first experiment, started in winter 2021 four species of forbs (*Clarkia davyi, Clarkia rubicunda, Phacelia malvifolia,* and *Navarretia squarrosa*) were planted in plots in which perennial grasses (*Stipa pulchra, Deschampsia cespitosa,* and *Elymus glaucus*) were planted two years prior to forb planting (grass priority) and the remaining plots had forbs planted two weeks prior to any grass planting (forb priority). As reported in the 2021 report, survival was higher in forb than grass priority treatments and native annual forbs planted with *Deschampsia cespitosa* had significantly lower survival compared to those planted with *Stipa pulchra*. The treatments primarily affected the two species of *Clarkia.* Seed set of the annual forbs was generally much higher in the forb priority treatment.

We monitored the number of seedlings of each of the forb species recruited in March 2022 and May 2023. In most cases, recruitment was much higher in both years in forb than grass treatment plots (Table 1). Moreover, the number of recruits declined substantially from 2022 (a dry year) to 2023 (a very wet year), which may reflect high mortality and low seed set due to the drought conditions in 2022. The only exceptions to this trend were that *N. squarrosa* seedlings were much less abundant in forb than grass plots in both 2021 and 2022, although this trend reversed in 2023. We think this may have been because there was a much thicker mulch layer in forb priority treatments, since they were mulched prior to seeding in 2021 whereas grass priority treatments were mulched two years prior; *N. squarrosa* has small seeds and, therefore, would be likely to be more strongly affected by a thick mulch layer. *C. davyi* had similar numbers in both treatments in 2022 but significantly higher recruits in 2023. We are monitoring seed output during summer 2023 and then will compile and fully analyze the three years of data.

Table 1. Number of recruits of seeded forb species in forb and grass priority treatments in March 2022 and May 2023. F and p-values are from one-way ANOVAs of log (x + 1) transformed data.

Forb Species	Year	Forb	Grass	F	p
C. davyi	22	24.6 ± 7.4	35.3 ± 9.9	0.3	0.8723
	23	8.1 ± 1.3	2.1 ± 0.9	18.2	0.0002
C. rubicunda	22	58.7 ± 14.3	15.7 ± 4.1	4.6	0.0408
	23	14.1 ± 3.5	3.3 ± 3.0	19.2	<0.0001
N. squarrosa	22	0.1 ± 0.1	25.7 ± 7.2	22.9	<0.0001
	23	12.3 ± 5.0	2.3 ± 1.3	5.3	0.0286
P. malvifolia	22	88.1 ± 17.1	0.9 ± 0.7	54.8	<0.0001
	23	32.5 ± 11.7	0.2 ± 0.2	90.6	<0.0001

Scraping and mounding experiment

The second forb experiment was installed in January 2022 and is described in detail in Janine Tan's senior thesis which is included in this report. Two native perennial grasses (*Stipa pulchra* and *Elymus glaucus*) and six native annual forbs (*Amsinckia spectabilis, Clarkia davyi, Clarkia rubicunda, Lupinus nanus, Navarretia squarrosa,* and *Phacelia malvifolia*) were planted in three treatments: control (no manipulation), soil scraping (removing the top 3-4 cm of soil to reduce soil nutrient and the non-native seed bank), and soil mounding (creating flat topped mounds 2-3 cm higher than the surrounding area to mimic small mammal mounds). Ms. Tan monitored seedling survival in April and July 2022, and in May 2023 we measured survival of perennial grasses and recruitment of forbs.

Forb seedling survival in April 2022 was generally similar across all treatments (Table 2). By July 2022 fewer than 5% of the forbs of any species survived so it was impossible to monitor fruit and seed set. Grass survival in July 2022 was 15-30% across the treatments and did not differ significantly by treatment (Table 2).

Table 2. Percent of seedlings surviving for eight forb species in late April 2022. F- and p-values a one-way ANOVA of survival values.

Species	Unscraped (Mean % ± SE)	Mound (Mean % ± SE)	Scraped (Mean % ± SE)	F Ratio	P-value
Amsinckia spectabilis	85.4±7.3	79.2±7.3	64.6±7.3	2.1	0.1541
Clarkia dayvi	58.3±7.2	66.7±7.2	47.9±7.2	1.7	0.2120
Lupinus nanus	89.6±7.2	79.2±7.2	58.3±7.2	4.9	**0.0224**
Clarkia rubicunda	68.8±12.4	58.3±12.4	43.8±12.4	1.0	0.3815
Navarretia squarrosa	58.3±7.1	47.9±7.1	35.4±7.1	2.6	0.1061
Phacelia malvifolia	91.7±8.8	93.8±8.8	81.3±8.8	0.6	0.5705
Stipa pulchra	29.2±10.7	33.3±10.7	35.4±10.7	0.1	0.9153
Elymus glaucus	27.1±12.9	37.5±12.9	27.1±12.9	0.2	0.8068

In May 2023, *Elymus glaucus* survival was 34.0% and cover was 1.8 dm^2 overall, and neither differed across treatments. *Stipa pulchra* cover showed a trend toward higher survival (Control: 16.7 ± 7.0%, Mounding: 14.6 ± 7.5%, Scraping: 22.9 ± 8.8) and cover Control: 0.5 ± 0.2 dm^2, Mounding: 0.5 ± 0.3, Scraping: 1.2 ± 0.50) in scraped plots, although the values were not significantly different given the high variability across plots within the same treatment. The number of recruiting individuals of forb species in 2023 was extremely low, which is not surprising given the poor survival the prior year. Across all three treatments we surveyed a total of 96 m^2 and found the following number of individuals per species: *Amsinckia spectabilis* = 0, *Clarkia davyi* = 5, *Clarkia rubicunda* = 10, *Lupinus nanus* = 3, *Navarretia squarrosa* = 44, *and Phacelia malvifolia* = 8). For *N. squarrosa,* 4 were in controls, 13 in mounded, and 27 in scraped plots. We have decided not to continue to monitor this experiment in future years given the low initial survival and subsequent recruitment of the annual forbs.

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Appendix 4. Photo monitoring


YLR Beach Photopoint #1 (W). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #1 (NW). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

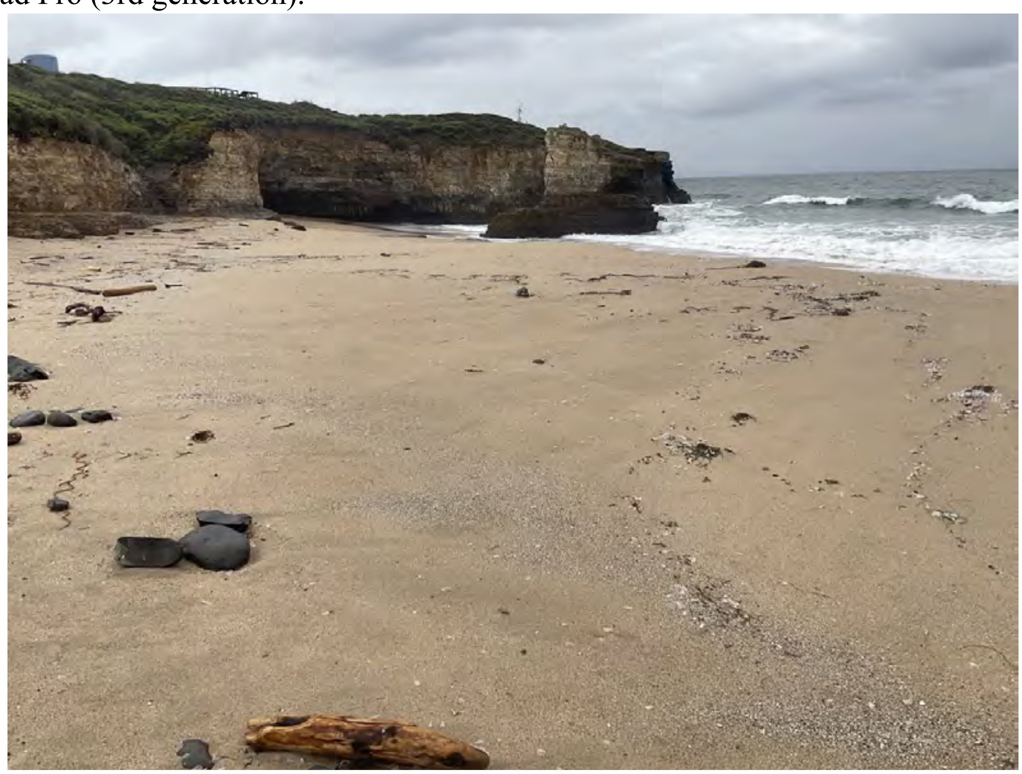

YLR Beach Photopoint #1 (N). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #2 (S). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #2 (SW). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #2 (W). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #2 (NW). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).



YLR Beach Photopoint #3 (SE). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #3 (E). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #3 (NE). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #3 (N). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Beach Photopoint #3 (NW). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #3 (W). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Beach Photopoint #4 (N). May 4th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #1 (S). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #1 (SW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #1 (W). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #1 (N). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #2 (S). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #2 (SW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #2 (W). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #2 (N). May 4h, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #3 (E). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #3 (SE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #3 (S). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #3 (SW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #3 (W). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #3 (NW). May 3th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #3 (NW). May 3th, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #4 (N). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #4 (NE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #4 (E). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

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YLR Terrace Photopoint #4 (S). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #4 (SSW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #5 (E). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #5 (SE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #5 (SSE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #5 (W). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #6 (NW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #6 (N). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #6 (NE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #6 (E). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

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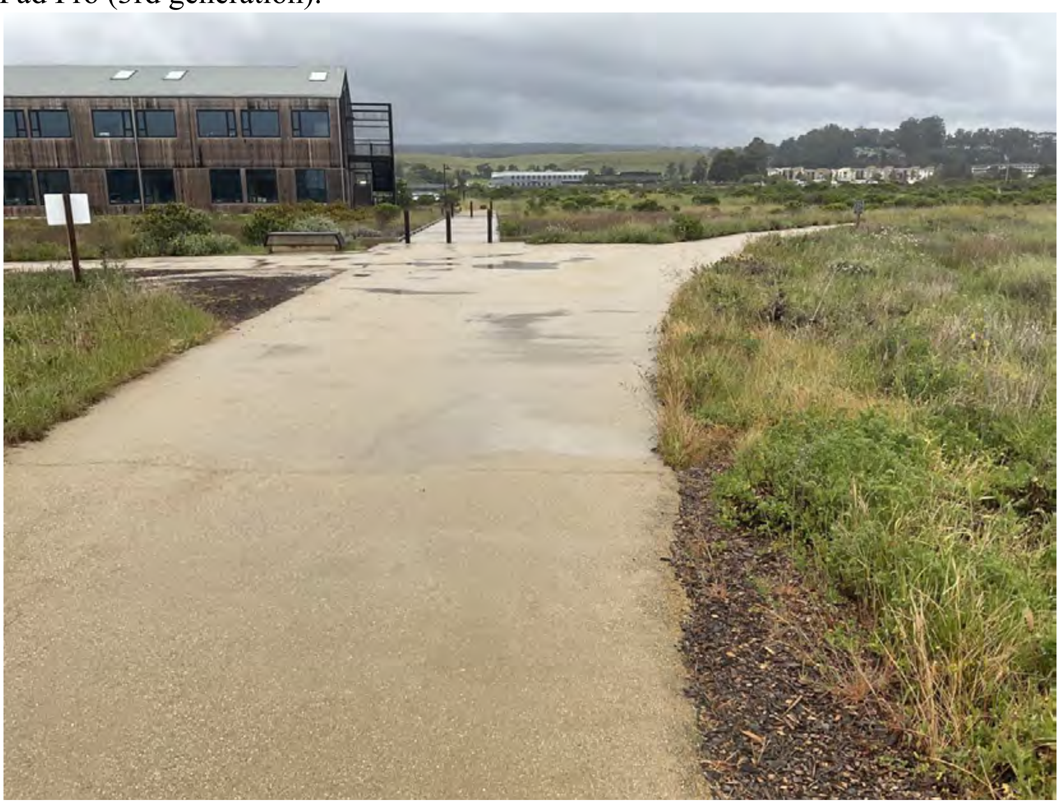
YLR Terrace Photopoint #6 (SW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #7 (S). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #7 (SW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #7 (W). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #7 (N). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).



YLR Terrace Photopoint #8 (N). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #8 (NE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #8 (SE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #8 (S). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #9 (S). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #9 (SE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

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YLR Terrace Photopoint #9 (NE). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

YLR Terrace Photopoint #9 (N). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #10 (W). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #10 (NW). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).


YLR Terrace Photopoint #10 (N). May 3rd, 2023. Photographer: Vaughan Williams Camera: Apple iPad Pro (3rd generation).

Appendix 5. NOID 12 (20-1) Special Conditions Implementation Reports

UNIVERSITY OF CALIFORNIA, SANTA CRUZ

BERKELEY • DAVIS • IRVINE • LOS ANGELES • MERCED • RIVERSIDE • SAN DIEGO • SAN FRANCISCO   SANTA BARBARA • SANTA CRUZ

December 15, 2022

Mr. Jack Ainsworth, Executive Director
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105

Re: Marine Science Campus Coastal Long Range Development Plan (CLRDP)
Notice of Impending Development (NOID) 12 20-1 Special Conditions Implementation Report #4
SCZ-NOID-0004-20

Dear Mr. Ainsworth:

On October 7, 2020, the California Coastal Commission approved University of California Santa Cruz (UCSC) Special Conditions Implementation Plan for CLRDP NOID 12 20-1 Public Access to and within Younger Lagoon Natural Reserve.

As required by the approved Special Conditions Implementation Plan, Special Condition 4 requires that at least every six months, UCSC shall submit two copies of a Beach Tour Monitoring Report documenting compliance with the special conditions for Executive Director review and approval.

Enclosed for your review and approval are two copies of UCSC's first report on the implementation of these special conditions for the period July 2022 through December 2022.

Sincerely,

DocuSigned by:
Jolie Kerns
C2472DC7A82647D...
Jolie Kerns
Director of Physical and Environmental Planning

Via email
cc: Ryan Moroney
Kiana Ford
Gage Dayton

UC Santa Cruz NOID 12 (20-1)
SCZ-NOID-0004-20
Special Conditions Implementation Report 4
July 1, 2022 – December 31, 2022

Burrowing owl on the Younger Lagoon Reserve Beach Dunes

UC Santa Cruz NOID 12 (20-1)
Special Conditions Implementation Report 4

Overview and Executive Summary

On October 7, 2020, the California Coastal Commission approved UC Santa Cruz's NOID 12 (20-1) as consistent with UC Santa Cruz's approved Coastal Long Range Development Plan with the addition of new requirements supplementing the existing (NOID 9 18-1) five staff-recommended special conditions. The five special conditions included 1) Free Beach Tours, 2) Beach Tour Outreach Plan, 3) Beach Tour Signs, 4) Beach Tour Availability and Monitoring, and 5) Beach Access Management Plan Duration. Within 30 days of the approval (i.e., by November 7, 2020), UC Santa Cruz was required to submit a plan for implementation of special condition 2 (Outreach Plan) to the Executive Director of the California Coastal Commission. The plan for implementation of the special conditions was submitted to the Executive Director of the California Coastal Commission on November 5, 2020 and approved as submitted. Special condition 4 requires that at least every six months (i.e., by June 30th and December 31st each year), UC Santa Cruz shall submit two copies of a Beach Tour Monitoring Report for Executive Director review and approval. UC Santa Cruz's report on the implementation of these special conditions for the period of July 1, 2022 through December 31, 2022 is detailed below. UC Santa Cruz has included information in this report from the previous three reporting periods covered under NOID 12 (20-1), the four reporting periods covered under NOID 9 (18-1), and one-year prior, to provide historical and cumulative reference data. This is the fourth report under NOID 12 (20-1). The next report under NOID 12 (20-1) is due by June 30, 2023.

A summary of UC Santa Cruz's compliance with the five special conditions is below. Due to the COVID-19 pandemic - and in response to UC Santa Cruz's request for a COVID-19 emergency waiver, on July 10, 2020 the Commission issued a permit waiver to UC Santa Cruz's in support of COVID-19-related temporary closures and free beach tour suspensions (see UC Santa Cruz's Pub. Res. Code section 30611 notification letter to the Commission dated July 6, 2020). The Seymour Center was temporarily closed and the free beach tour program temporarily suspended in early March 2020. As requested by Commission staff, UC Santa Cruz's notified the Commission in May 2021 and May 2022 of the University's phased reopening efforts. The Seymour Center partially reopened with some limited outdoor programming in summer 2021, the Exhibit Hall reopened in October 2021, and the free beach tour program restarted in April 2022. Despite achieving this huge accomplishment in the wake of the pandemic, the Seymour Center still faces staffing shortages and competing priorities. These challenges contributed to the breadth of outreach for the free beach tour program during this reporting period. Despite limited outreach during this reporting period due to staff shortages, the tours have been very well-attended since April 2022.

Total tour attendance during this reporting period was more than 140% higher than tour attendance during the same time period in 2019 and more than 180% higher than tour attendance during the same time period in 2018.

The Seymour Center is confident that they can continue delivering excellent attendance results in the next six months. Their recently-hired Marketing Director shall be fully responsible for all outreach, marketing, and advertising efforts, including fulfilling the outreach requirements of the free beach tours, as part of NOID 12 special conditions. Once the new full-time Marketing Director is onboarded in the coming months, UC Santa Cruz assumes all of the outreach requirements for the free beach tours shall be fulfilled.

Special Condition	Status	Notes
1) Free Beach Tours	Completed	All beach tours are offered for free without admission to the Seymour Center.
2) Beach Tour Outreach Plan	Completed & Ongoing	UC Santa Cruz's Updated Beach Tour Outreach Plan was approved by the Executive Director in November 2020 and all beach tour outreach materials now clearly state that the beach tour is free. Upon hiring of the Seymour Center Marketing Director, UC Santa Cruz's ongoing outreach efforts will include regular social media postings and calendar listings, including listings in Spanish and publications that serve inland communities.
3) Beach Tour Signs	Completed	UC Santa Cruz's Beach Tour Signage Plan under NOID 9 (18-1) was approved by the executive director in January 2019 and "Free Beach Tour" signs have been installed at all of the required locations.
4) Beach Tour Availability and Monitoring	Completed & Ongoing	Free beach tours are offered per the required schedule – a minimum of 38 times a year on weekends and weekdays, and all of the required data on tour attendees has been and will continue to be collected. UC Santa Cruz submitted all of the previously

		required biannual reports on the beach tours covered under NOID 9 (18-1) and NOID 12 (20-1) on-time. This is the fourth report under NOID 12 (20-1).
5) Beach Access Management Plan Duration	In Progress	NOID 12 (20-1) is effective through December 31, 2025. UC Santa Cruz is required to submit their next Beach Access Management Plan NOID by July 1, 2025.

Historical data from previous reports (pre special conditions and pre-COVID) are provided below for context.

Implementation of the NOID 9 (18-1) special conditions resulted in an approximately 18% increase in overall tour participation and more than 900% increase in walk-in/day-of tour participants in 2019 (first full year post special conditions) compared to 2018 (pre special conditions).

A summary of the free beach tour user data for 2018 (pre special conditions) and 2019 (first full year post special conditions) is below:

Year	Dates	Total Tours Offered	Total Participants	Total # of Walk-in / Day-of Participants	Total # of Participants with a Reservation
2018	January 1-December 31	38	224	5	219
2019	January 1-December 31	38	265	46	219

Although only six tours were offered before the Seymour Center was temporarily closed and the free beach tour program temporarily suspended in early March 2020 due to COVID-19, total tour attendance for the 2020 tours that were offered was more than 100% higher than tour attendance during the same time period in 2019 and more than 350% higher than tour attendance during the same time period in 2018. A summary of the free beach tour user data for the first six tours in 2018 (pre special conditions), 2019 (first full year post special conditions), and 2020 is below:

Year	Dates	Total Tours Offered	Total Participants	Total # of Walk-in / Day-of Participants	Total # of Participants with a Reservation
2018	January 1-March 7	6	17	2	15
2019	January 1-March 4	6	31	6	25
2020	January 1-March 8	6	60	5	55

Although the tours were still temporarily suspended during the same time period in 2022 (January-March 2022), attendance has been strong since the tours restarted in April 2022. Total tour attendance during the reporting period covered by this report (July 1, 2022 - December 31, 2022) was more than 140% higher than tour attendance during the same time period in 2019 and nearly 180% higher than tour attendance during the same time period in 2018. A summary of the free beach tour user data for the July 1-December 31 tours in 2018 (pre special conditions), 2019 (first full year post special conditions), and 2022 is below:

Year	Dates	Total Tours Offered	Total Participants	Total # of Walk-in / Day-of Participants	Total # of Participants with a Reservation
2018	July 1-Dec 31	18	129	0	129
2019	July 1-Dec 31	18	162	15	147
2022	July 1-Dec 31	18	231	11	220

In order to maintain public access and engagement during the COVID-19 pandemic while the tour program was temporarily suspended, the University created a virtual bilingual beach tour that is available on the Seymour Center and Younger Lagoon Reserve websites. Since its debut, the English language virtual tour has been viewed nearly 350 times and the Spanish language virtual tour has been viewed over 25 times. The virtual tour will continue to be offered post-pandemic and allows visitors from around the world to learn about the unique ecology and programs at the reserve in English and Spanish from the comfort of home or a mobile device.

The virtual tour websites feature a map of the reserve with 16 marked locations where visitors can click to watch videos about the features of each type of habitat. The locations of the virtual tour reflect beach tour lookouts where tour docents narrate information about the Younger Lagoon Reserve and beach habitat and wildlife, providing a virtual experience similar to the in-person free beach access tours.

Virtual Tour Links:
English: https://arcg.is/11m1Ga
Spanish: https://arcg.is/0q0Czv

A UC Santa Cruz undergraduate student created the virtual tour website and edited the videos as part of an internship project. This student completed all of the work on this project remotely, including learning about the reserve itself. A Younger Lagoon Reserve undergraduate student employee who assisted with the free in-person tours prior to the pandemic acts as the on-camera guide for both tours.

Condition 1.

FREE BEACH TOURS

All beach tours shall be offered for free, and UC Santa Cruz 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 UC Santa Cruz's Seymour Marine Discovery Center. At a minimum, beach tour sign-ups shall be provided online (e.g., at UC Santa Cruz Marine Science Campus and Seymour Marine Discovery Center websites), by phone, and at the Seymour Marine Discovery Center front desk. UC Santa Cruz 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 UC Santa Cruz 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.

Implementation Report

All beach tours were offered for free (without admission fee). Beach tour sign-ups are available online through the Seymour Marine Discovery Center (Seymour Center) website, by phone and at the Seymour Center public admissions counter. Seymour Center staff track any tour requests that are denied due to lack of tour availability or because tours are fully booked as part of their ongoing monitoring of all visitor programs. Seymour Center staff record the number of participants that were denied, the number of participants that were wait listed, as well as the date of the request, the date of the tour being requested, and how participants heard about the tour (see Condition 2). All UC Santa Cruz public materials referencing the beach at Younger Lagoon and/or beach tours, including the websites below, clearly identify that access to the beach is available for free. (Note that there is no UC Santa Cruz Marine Science Campus website; tour information has been posted to the Younger Lagoon Reserve and Seymour Marine Discovery Center websites; see website links below).

https://youngerlagoonreserve.ucsc.edu/about-us/index.html
https://youngerlagoonreserve.ucsc.edu/visit/public-tours.html
https://seymourcenter.ucsc.edu/visit/groups-and-tours/

Condition 2.

BEACH TOUR OUTREACH PLAN

Within 30 days of this approval (i.e., by November 7, 2020), UC Santa Cruz shall submit two copies of an updated 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 beach tours, including the online virtual tours. Promotional methods shall include, but are expected to not be limited to: UC Santa Cruz Marine Science Campus and Seymour Marine Discovery Center websites, press releases, calendar listings with UC Santa Cruz Events and local media (e.g., Good Times newspaper, Santa Cruz Sentinel, The Register-Pajaronian, The Half Moon Bay Review, The Monterey Herald, etc.), ads on radio (e.g., local radio stations KAZU, KRML, and others), print ads, social media (including Facebook, Twitter, and Instagram), and contacts with influential organizations in local environmental and community advocacy groups who may facilitate promotional opportunities. The Plan shall identify the language to be used in describing the virtual and free in-person 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 online viewers and potential beach tour participants as possible, including audiences beyond Santa Cruz that might not normally be reached through traditional and local means (e.g., inland communities). The Plan shall describe how UC Santa Cruz will monitor and track the Outreach Plan's execution so that UC Santa Cruz and the Coastal Commission can note the effectiveness of the plan and make changes as needed. UC Santa Cruz shall implement the updated approved Outreach Plan.

Implementation Report

Outreach was conducted according to the following plan, which was approved by the Executive Director and includes all of the measures and venues described in Condition 2:

Venue	Language	Schedule	Mechanism for Monitoring and Tracking	
Seymour Center Website	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up here*.	Permanent webpage: https://seymourcenter.ucsc.edu/visit/groups-and-tours/	Provide link to updated website and date that updates were made	Seymour Center Website is up to date. No updates needed during this reporting period.

	Virtual tours are available here**. * hyperlink to online sign-up **hyperlink to virtual tour			
YLR Website	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu**	Permanent webpage: https://youngerlagoonreserve.ucsc.edu/visit/public-tours.html	Provide link to updated website and date that updates were made	YLR Website is up to date. No updates needed during this reporting period.
Seymour Center Social Media • Facebook • Twitter • Instagram	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu**	Facebook—Monthly Twitter, Instagram ---Once a quarter	Document date that posts are made and capture a link to the post	Pending staff hiring; due to reopening staff shortages. Tours will be posted during the next reporting period.
YLR Social Media • Facebook • Instagram	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu**	Once a quarter	Document date that posts are made and capture a link to the post	Facebook posted 8/3/22 and 11/1/22. Instagram posted 8/3/22 and 11/1/22.
Calendar Listings • UC Santa Cruz Events • Good Times Newspaper	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online.	Submitted monthly (calendar listings appear at the discretion of the media outlet.)	Document date that listings are submitted, and verify that the listing ran by capturing a link to the website (if online)	• UC Santa Cruz Events: submitted and posted for the 8/18/22, 8/27/22, 9/1/22, and 9/10/22 tours.

(Santa Cruz) • Register Pajaronian Newspaper (Watsonville) • The Half Moon Bay Review • The Monterey Herald • KAZU public radio (Santa Cruz) • KRML (Monterey Bay)	Virtual tours are available online. **seymourcenter.ucsc.edu** For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**			• KAZU public radio (Santa Cruz): submitted for the 8/18/22, 8/27/22, 9/1/22, and 9/10/22 tours (submitted on 8/12/22 and 8/13/22). All other calendar listings pending staff hiring; due to reopening staff shortages. Calendar listings will be submitted when the Seymour Center's Marketing Director is onboarded and resumes outreach responsibilities.
Ads • Santa Cruz Sentinel Newspaper (Santa Cruz) • Good Times Newspaper (Santa Cruz) • KAZU public radio (Santa Cruz)	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu** For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame	Quarterly	Document date that ads ran, and verify that the ad ran by capturing a link to the website (if online)	Pending staff hiring; due to reopening staff shortages. Ads will be submitted when the Seymour Center's Marketing Director is onboarded and resumes outreach responsibilities.

	al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**			
Press Release	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu** For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**	Announce the virtual tours and resumption of free in-person beach tours post-COVID via two bilingual (English and Spanish) UC Santa Cruz press releases.	Document the date of the press releases, distribution list of media outlets and verify that the press releases were posted by capturing a link to the website (if online).	Completed 6/1/22; see NOID 12 (20-1) Special Conditions Implementation Report 3.
Contacts who may facilitate promotional opportunities • SMDC Educator Email Mailing List (815	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online.	Once a quarter	Information about the tours will be emailed to contacts once a quarter. Date of email and recipients will be documented.	Information was sent to the Seymour Center Educator, Homeschool, and E-newsletter; however, dates of emails were not tracked due to

subscribers) • Homeschool Mailing Email List (124 subscribers) • Seymour Center E-newsletter list - 10,000 email recipients from all over California and beyond • UC Santa Cruz Events Email-newsletter • Andy Carman at Enviroteers, weekly newsletter • CSUMB Outdoor Recreation Resources and Opportunities Website • Outdoor World Outdoor Resources Website: https://www.theoutdoorworld.com/info/outdoor-resources	**seymourcenter.ucsc.edu** For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**			staffing shortages. No other contacts were provided information about the tours during the reporting period due to reopening impacts. Contacts will be provided with tour information when the Seymour Center's Marketing Director is onboarded and resumes outreach responsibilities.

In addition, tour participants were surveyed to determine how they heard about the tour, as required by the special conditions. This information is tracked with sign-up information (see Condition 1). Since the Seymour Center began tracking this information and during this reporting period, the majority of tour participants learned about the free beach tour through the Seymour Center's newsletter, website and/or a friend (Figures 1 and 2).

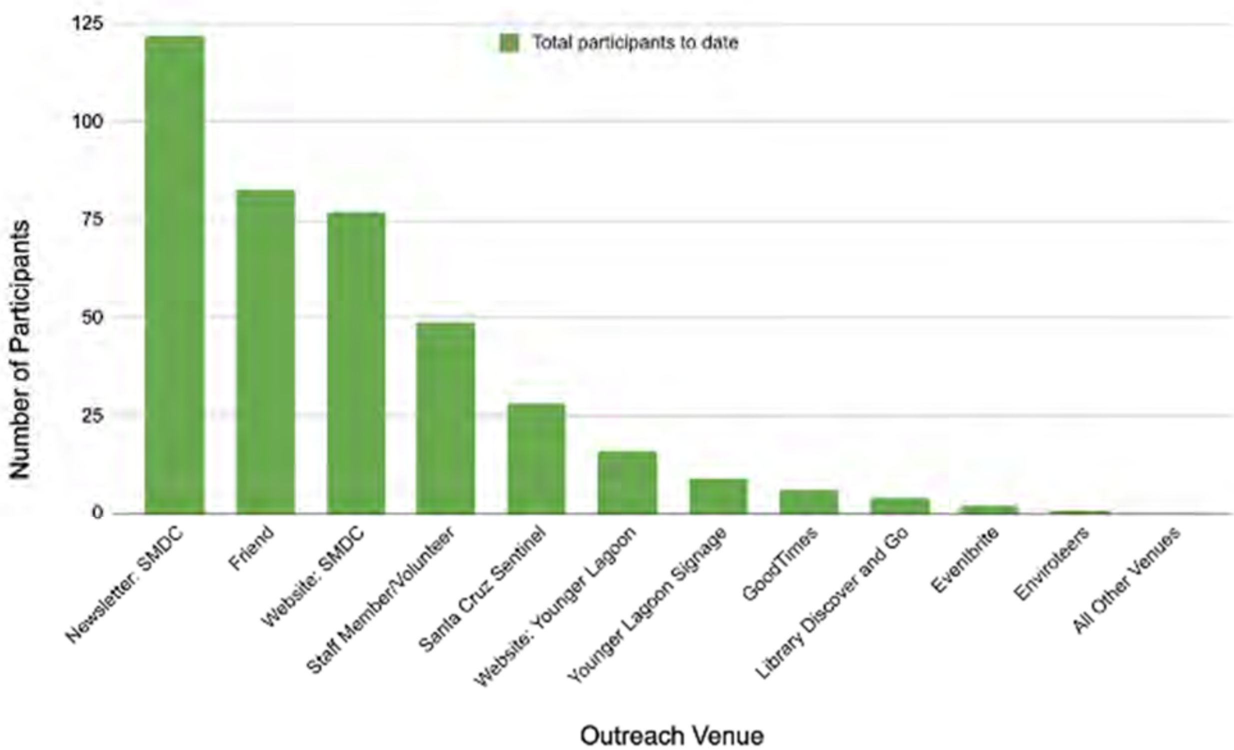


Figure 1. Cumulative outreach survey results for the free beach tours since the implementation of the user survey in April 2022 through December 2022 (N=397). The majority of participants learned about the free beach tour through the Seymour Center's newsletter, a friend, and/or the Seymour Center's website.

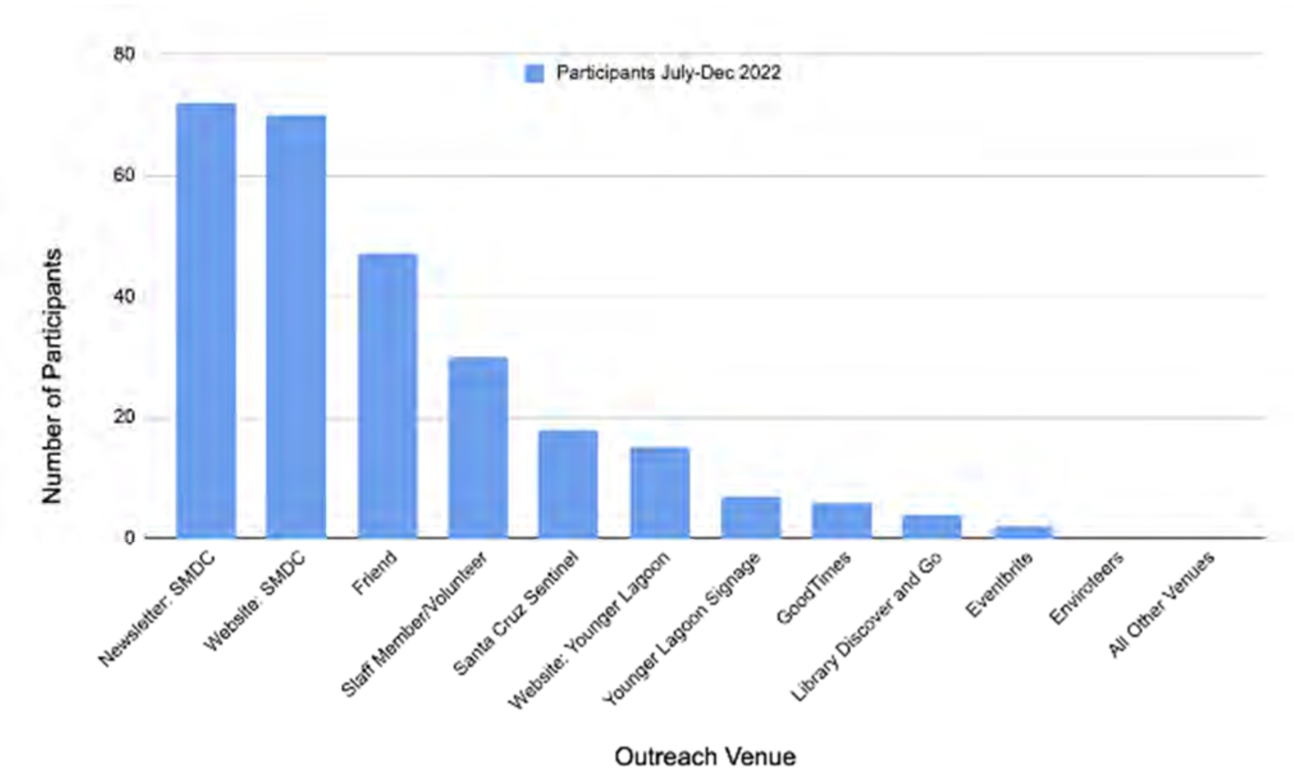


Figure 2. Outreach survey results for the free beach tours for the July 1, 2022- December 21, 2022 reporting period (N=271). The majority of participants learned about the free beach tour through the Seymour Center's newsletter, website and/or a friend.

This data shows that despite limited outreach for all required special conditions to promote and market the free beach tours, most tour sign ups and participation are derived from the Seymour Center newsletter and website, however some other special condition requirements are showing little to no nexus to tour sign ups. The success and shortcomings of the special conditions strategies will be discussed with Commission staff during development of the next 5-year beach access management plan, for Seymour Center staff to focus their limited resources on activities that drive the most free beach tour participation.

Condition 3.

BEACH TOUR SIGNS

UC Santa Cruz will continue to implement the Beach Tour Sign Plan that was previously-approved by the Executive Director under NOID 9 where such Plan has provided 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 continue to be sited and designed to be visually compatible with the area, consistent with the Campus sign program (and CLRDP sign requirements) and continue to provide clear information in a way that minimizes public view impacts. UC Santa Cruz shall continue to implement the approved Beach Tour Sign Plan from NOID 9.*

Implementation Report

Information on the free beach tours was displayed "day of" on large sign in the front window of the Seymour Center and at the public admissions counter. Admissions counter signage will continue to include the brown and white footprints on wave logo, and include the following language "Free Younger Lagoon Reserve Beach Tours Today" (Figures 4, 7, and 8). Signage will continue to be displayed at the information kiosk outside (Figure 6) of the Seymour Center and at Overlooks A-F (Figures 9-15).

Note, Overlook B was renamed Terrace Point Overlook, as shown on a new coastal access sign installed as a condition of Overlook B Path Repair and Replacement (SCZ-NOID-0004-19) (Figure 3).

Figure 3. Terrace Point Overlook coastal access sign design.

Overlooks, admissions counter, and kiosk signage includes the brown and white footprints on wave logo, and include the following language "Free Younger Lagoon Reserve Beach Tours, Call (831) 459-3800" (Figure 4).

Figure 4. "Day of" sign design.

Figure 5. Overlooks and kiosk sign design.

Figure 6. Signage installed at Seymour Center information kiosk (photo taken pre-pandemic).

Figure 7. Signage installed at Seymour Center front window (photo taken pre-pandemic).

Figure 8. Signage installed at the Seymour Center admissions desk (photo taken pre-pandemic).

Figure 9. Signage installed at Overlook A.

Figure 10. Signage installed at Overlook A (close-up).

Figure 11. Signage installed at Overlook B (Terrace Point).

Figure 12. Signage installed at Overlook C.

Figure 13. Signage installed at Overlook D.

<u>Figure 14.</u> Signage installed at Overlook E.

<u>Figure 15.</u> Signage installed at Overlook F.

Condition 4.

BEACH TOUR AVAILABILITY AND MONITORING

UC Santa Cruz 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 (totaling a minimum of 38 total beach tours per year). UC Santa Cruz may limit the number of beach tour participants to 18 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). UC Santa Cruz 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 30 and December 31 of each year), UC Santa Cruz 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 UC Santa Cruz's activities under the approved updated Beach Tour Outreach Plan (see Condition 2) and which shall include specific information regarding the dates that each advertisement for beach tours was placed in each venue/media/social media outlet, 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. Each Monitoring Report shall also include a section that describes how the beach-lagoon ecosystem has responded to beach tours. This assessment will include data and analysis useful for assessing whether the ecosystem shows any impacts from beach tours. This assessment will be used to help determine if larger tours have any impacts on the YLR ecosystem, its environmental quality, and UC Santa Cruz research opportunities at the site. UC Santa Cruz shall implement any Executive Director-approved recommendations from each Beach Tour Monitoring Report.

Implementation Report

Free beach tours were offered four times per month on select Thursdays and Saturdays from July 1, 2022 through September 30, 2022 and two times per month on select Thursdays and Saturdays from October 1, 2022 through December 31, 2022. Tours will continue to be offered at least four times per month (at least one on a weekday and two on a weekend tours) from March 1st through September 30th each year, and will be offered at least two times per month (at least one on a weekday and one on a weekend) for the remainder of the year (a minimum of 38 total beach tours per year). Beach tour participants were limited to 18 persons per tour, but this number may be exceeded per tour on a case by case basis, and beach tours did not require any minimum number of participants to be provided (i.e., if at least one person signs up, the tour is provided). UC Santa Cruz has documented 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). In addition, tour participants were surveyed to determine how they heard about the tour. This information is being tracked with sign-up information (see Conditions 1 and 2).

At least every six months (i.e., by June 30th and December 31st each year), UC Santa Cruz will submit two copies of a Beach Tour Monitoring Report for Executive Director review and approval, where the Report will at a minimum provide information regarding compliance with these conditions of approval, including a section identifying UC Santa Cruz's activities under the approved updated Beach Tour Outreach Plan (see Condition 2), as well as the required information described in the previous paragraph and Condition 4 above. This is the fourth such report under this implementation plan and has been submitted by December 31, 2022.

A total of 18 free beach tours (231 participants) were offered during this reporting period (See Appendix 1). One tour was canceled due to hazardous weather. Participants were limited to 18 persons per tour on tours and all tours had at least one participant. Two of the tours that went out included walk-in / "day-of" participants. Twelve tours were overbooked during the reporting period, illustrating the COVID-related pent up demand for outdoor activities. In addition, the virtual tour was viewed over 20 times during the reporting period.

In comparison, UC Santa Cruz offered 18 beach tours (129 participants) during the same reporting period in 2018 (Appendix 2; pre special conditions). Four tours did not go out due to lack of sign-ups. None of the tours that went out in the same reporting period of 2018 included walk-in / "day-of" participants. No tours were overbooked during the spring of 2018.

Although not required by the special conditions, in addition to tracking user data, UC Santa Cruz also collected data on the biological impacts of the tours. Beginning on April 14, 2019, Younger Lagoon Reserve staff accompanied tours, and documented impacts to avian wildlife on the beach. Staff observed birds flushing from the wet sandy beach, beach dunes, coastal stack, and lagoon in response to over 70% of the tours they attended (see Appendix 3). The average number of avian species present post-tour was significantly less than the average number of avian species pre-tour (p=.0005, paired t-test; See Figure 15).

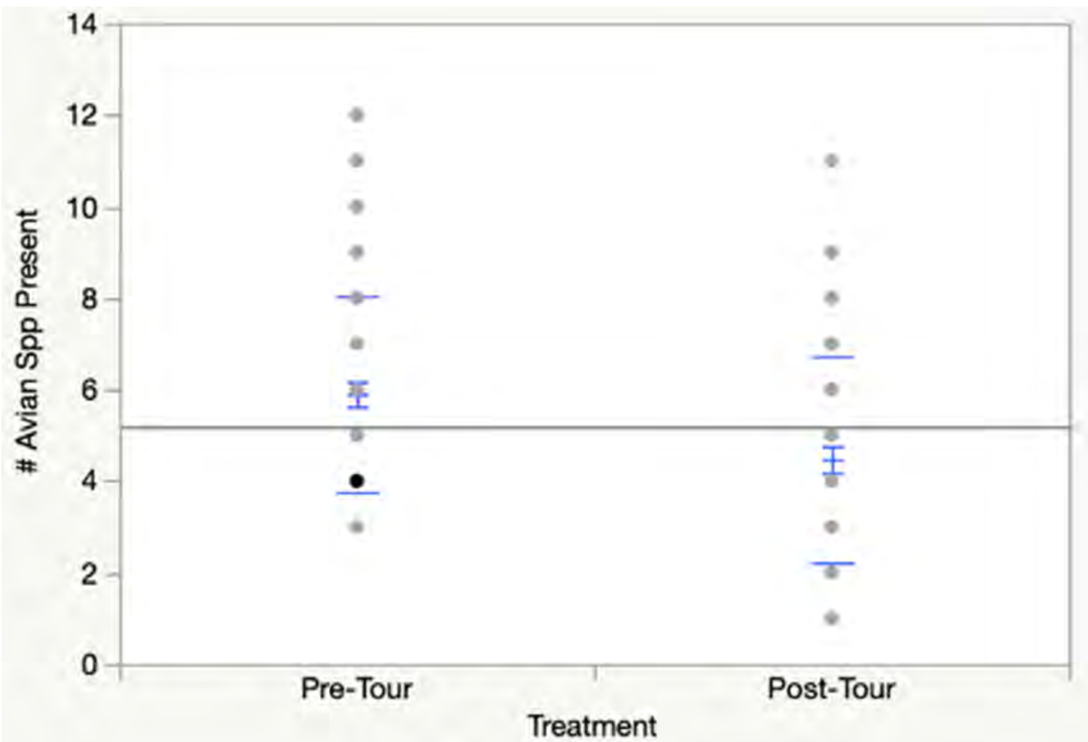


Figure 15. Effect of tours on avian species. Blue I-bars indicate mean, standard error, and standard deviation. The average number of avian species present pre-tour was 5.91 +/- 2.14 (+/- sd). The average number of avian species present post-tour was 4.47 +/- 2.25 (+/- sd). The average number of avian species present post-tour was significantly less than the average number of avian species pre-tour (p=.0005, paired t-test).

Recommendations

Although only in place for 48 months and temporarily suspended for nearly two years due to COVID-19 impacts, the beach tours as specified by UC Santa Cruz's NOIDs 9 (18-1) and 12 (20-1) special conditions appear to be meeting user demand. Total tour attendance during this reporting period was more than 140% higher than tour attendance during the same time period in 2019 and more than 180% higher than tour attendance during the same time period in 2018. During the 24 months covered by NOID 9 (18-1), just eight participants were denied a tour due to overdemand. In the first three months that the free beach tours resumed [April 2022-June 2022; reporting period covered by NOID 12 (20-1) Special Conditions Implementation Report 3], six of the 12 tours offered had a waitlist. During this reporting period, 12 of the 18 tours offered had a waitlist. All waitlisted guests are offered the opportunity to book alternative dates and are contacted in order if a spot on the tour for which they are waitlisted becomes available. The vast majority of participants who are waitlisted are accommodated on an alternate date. UC Santa Cruz staff feel the overdemand is likely a result of post-COVID pent up demand, the relative safety of this entirely outdoor offering, and the fact that the free beach tour was the first (and to date, only advertised) of the Seymour Center's docent-guided tours to restart post-pandemic. The Seymour Center's docent-guided behind the scenes research tour – which include views of the beach and lagoon, restarted in the fall of 2022. The behind the scenes research tour is currently offered four times a day to walk-in visitors only (no reservations or advertising at this time). UC Santa Cruz will continue to monitor tour demand as the pandemic wanes and Seymour Center operations and offerings ramp back up. UC Santa Cruz anticipates the volume of beach tour waitlists will diminish as the Seymour Center begins to offer and promote other facility tours, where none are currently being advertised due to staff shortages. NOID 12 (20-1) continued the five NOID 9 special conditions, increased the upper limit of tour attendees and required additional outreach efforts.

The documented negative biological impacts to avian wildlife described above, along with ongoing quarterly beach monitoring efforts indicate that open and unsupervised 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 (See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, and 2020-2021 Annual Reports).

We recommend that the balance between resource protection of the beach and lagoon area – all of which are considered Environmentally Sensitive Habitat Area (ESHA) or ESHA buffer by the Commission, and public access continue to be carefully evaluated and managed. Although similar in many ways to other local pocket beaches, Younger Lagoon beach supports a unique assemblage of flora and fauna, including rare and endangered species. As part of the UC Natural Reserve System, Younger Lagoon Reserve acts as a protected living laboratory and outdoor classroom for teaching and research and is managed in trust for the people of the State of California by the University.

<u>Condition 5.</u>

BEACH ACCESS MANAGEMENT PLAN DURATION

This approval for UC Santa Cruz's public beach access management plan at Younger Lagoon Beach shall be effective through December 31, 2025. UC Santa Cruz 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, 2026 to December 31, 2030) no later than July 1, 2025. Such a 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 UC Santa Cruz'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 UC Santa Cruz research and coastal resources. If such a complete NOID has not been submitted by July 1, 2025, then UC Santa Cruz 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.

Implementation Report

UC Santa Cruz will 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, 2026 to December 31, 2030) no later than July 1, 2025.

Appendix 1. Tour Data July 1, 2022 – December 31, 2022

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/7/22*	Thursday	15	0	18	3	15
7/9/22*	Saturday	15	0	17	2	6
7/21/22**	Thursday	15	0	18	3	8
7/23/22	Saturday	11	0	17	6	0
8/4/22***	Thursday	17	0	18	1	17
8/13/22***	Saturday	17	9	18	10	8
8/18/22***	Thursday	14	0	18	4	11
8/27/22***	Saturday	18	0	18	0	20
9/1/22***	Thursday	16	2	18	4	5
9/10/22	Saturday	10	0	12	2	0
9/15/22	Thursday	6	0	6	0	0
9/24/22***	Saturday	16	0	18	2	4
10/06/22	Thursday	14	0	15	1	0
10/15/22***	Saturday	13	0	18	5	6
11/3/22***	Thursday	15	0	18	3	1
11/12/22***	Saturday	16	0	18	2	7
12/1/22	Thursday	3	0	11	8	0
12/10/22****	Saturday	-	-	14	-	-

*7/7/22 and 7/7/22 – Denial due to overdemand; participants put on waitlist but were unable to make it in time when there were no-shows. Participants made alternate bookings.
**7/21/22 - Denial due to overdemand; participants put on waitlist and 4 were accommodated when there were advance cancelations. Participants made alternate bookings.
***8/4/22, 8/13/22, 8/18/22, 8/27/22, 9/1/22, 9/24/22, 10/15/22, 11/3/22, 11/12/22, and 12/10/22 - Denial due to overdemand; participants made alternate bookings.
****12/10/22 – Canceled due to weather.

Appendix 1 (cont.). Tour Data January 1, 2022 – June 30, 2022

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/2/22*	Thursday	-	-	-	-	-
1/8/22*	Saturday	-	-	-	-	-
2/3/22*	Thursday	-	-	-	-	-
2/12/22*	Saturday	-	-	-	-	-
3/3/22*	Thursday	-	-	-	-	-
3/12/22*	Saturday	-	-	-	-	-
3/17/22*	Thursday	-	-	-	-	-
3/26/22*	Saturday	-	-	-	-	-
4/7/22	Thursday	4	0	4	0	0
4/9/22	Sunday	4	0	4	0	0
4/21/22	Thursday	8	0	8	0	0
4/23/22	Saturday	5	0	5	0	0
5/5/22	Thursday	1	0	7	6	0
5/14/22	Saturday	18	2	16	2	0
5/19/22**	Thursday	11	0	18	7	2
5/28/22***	Saturday	13	4	18	9	3
6/2/22****	Thursday	18	0	18	0	3
6/11/22*****	Saturday	18	5	18	5	10
6/16/22******	Thursday	17	0	18	1	2
6/25/22*******	Saturday	10	0	18	8	9
2022 TOTAL	**-**	**358**	**22**	**442**	**94**	**137**

*1/6/22 - 3/26/22 – Canceled due to COVID-19 impacts.
**5/19/22 - Denial due to overdemand; participants accommodated on future date.
***5/28/22 - Denial due to overdemand; three participants signed up for the waitlist as well as a future date. Two of the three walked in on 5/28 and were able to get a spot when others no showed.
****6/2/22 - Denial due to overdemand; participants accommodated on future date.
*****6/11/22 - Denial due to overdemand; participants accommodated on future date.
******6/16/22 - Denial due to overdemand; participants were directed to the website to sign up for a future date.
*******6/25/22 - Denial due to overdemand; participants were put on the waitlist due to full reservations and were not able to make it in time to join the tour after a larger group no-showed.

Appendix 1 (cont.). Tour Data July 1, 2021 – December 31, 2021

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/1/21*	Thursday	-	-	-	-	-
7/11/21*	Sunday	-	-	-	-	-
7/15/21*	Thursday	-	-	-	-	-
7/25/21*	Sunday	-	-	-	-	-
8/5/21*	Thursday	-	-	-	-	-
8/8/21*	Sunday	-	-	-	-	-
8/19/21*	Thursday	-	-	-	-	-
8/22/21*	Sunday	-	-	-	-	-
9/2/21*	Thursday	-	-	-	-	-
9/12/21*	Sunday	-	-	-	-	-
9/16/21*	Thursday	-	-	-	-	-
9/26/21*	Sunday	-	-	-	-	-
10/7/21*	Thursday	-	-	-	-	-
10/10/21*	Sunday	-	-	-	-	-
11/4/21*	Thursday	-	-	-	-	-
11/14/21*	Sunday	-	-	-	-	-
12/2/21*	Thursday	-	-	-	-	-
12/5/21*	Sunday	-	-	-	-	-

*7/1/21 - 12/5/21 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data January 1, 2021 – June 30, 2021

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/7/21*	Thursday	-	-	-	-	-
1/10/21*	Sunday	-	-	-	-	-
2/4/21*	Thursday	-	-	-	-	-
2/14/21*	Sunday	-	-	-	-	-
3/4/21*	Thursday	-	-	-	-	-
3/14/21*	Sunday	-	-	-	-	-
3/18/21*	Thursday	-	-	-	-	-
3/28/21*	Sunday	-	-	-	-	-
4/1/21*	Thursday	-	-	-	-	-
4/11/21*	Sunday	-	-	-	-	-
4/15/21*	Thursday	-	-	-	-	-
4/25/21*	Sunday	-	-	-	-	-
5/6/21*	Thursday	-	-	-	-	-
5/9/21*	Sunday	-	-	-	-	-
5/20/21*	Thursday	-	-	-	-	-
5/23/21*	Sunday	-	-	-	-	-
6/3/21*	Thursday	-	-	-	-	-
6/13/21*	Sunday	-	-	-	-	-
6/17/21*	Thursday	-	-	-	-	-
6/27/21*	Sunday	-	-	-	-	-
2021 TOTAL	-	-	-	-	-	-

*1/7/21 - 6/27/21 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data July 1, 2020 – December 31, 2020

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/2/20*	Thursday	-	-	-	-	-
7/12/20*	Sunday	-	-	-	-	-
7/16/20*	Thursday	-	-	-	-	-
7/26/20*	Sunday	-	-	-	-	-
8/6/20*	Thursday	-	-	-	-	-
8/9/20*	Sunday	-	-	-	-	-
8/20/20*	Thursday	-	-	-	-	-
8/23/20*	Sunday	-	-	-	-	-
9/3/20*	Thursday	-	-	-	-	-
9/13/20*	Sunday	-	-	-	-	-
9/17/20*	Thursday	-	-	-	-	-
9/27/20*	Sunday	-	-	-	-	-
10/1/20*	Thursday	-	-	-	-	-
10/11/20*	Sunday	-	-	-	-	-
11/5/20*	Thursday	-	-	-	-	-
11/8/20*	Sunday	-	-	-	-	-
12/3/20*	Thursday	-	-	-	-	-
12/6/20*	Sunday	-	-	-	-	-

*7/2/20 - 12/6/20 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data January 1, 2020 – June 30, 2020

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/2/20	Thursday	15	4	20	9	0
1/12/20	Sunday	13	1	18	6	0
2/6/20	Thursday	9	0	18	9	0
2/9/20	Sunday	4	0	5	1	0
3/5/20	Thursday	8	0	8	0	0
3/8/20	Sunday	11	0	14	3	0
3/19/20*	Thursday	-	-	-	-	-
3/22/20*	Sunday	-	-	-	-	-
4/2/20*	Thursday	-	-	-	-	-
4/5/20*	Sunday	-	-	-	-	-
4/16/20*	Thursday	-	-	-	-	-
4/26/20*	Sunday	-	-	-	-	-
5/7/20*	Thursday	-	-	-	-	-
5/10/20*	Sunday	-	-	-	-	-
5/21/20*	Thursday	-	-	-	-	-
5/24/20*	Sunday	-	-	-	-	-
6/4/20*	Thursday	-	-	-	-	-
6/14/20*	Sunday	-	-	-	-	-
6/18/20*	Thursday	-	-	-	-	-
6/28/20*	Sunday	-	-	-	-	-
2020 TOTAL	**-**	**60**	**5**	**83**	**28**	**0**

*3/19/20 - 6/28/20 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data January 1, 2019 – June 30, 2019

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/3/19	Thursday	2	2	0	0	0
1/13/19	Sunday	7	0	7	0	0
2/7/19	Thursday	3	0	3	0	0
2/10/19	Sunday	6	1	5	0	0
3/3/19	Sunday	10	3	7	0	0
3/719	Thursday	3	0	4	1	0
3/1019	Sunday	9	6	3	0	0
3/2119	Thursday	3	0	4	1	0
4/4/19	Thursday	10	6	4	0	0
4/7/19	Sunday	9	4	5	0	0
4/14/19	Sunday	9	2	11	4	0
4/18/19	Thursday	5	1	5	1	0
5/2/19	Thursday	1	0	1	0	0
5/5/19*	Sunday	0	0	0	0	0
5/12/19	Sunday	2	0	2	0	0
5/16/19	Thursday	1	0	1	0	0
6/2/19	Sunday	3	0	3	0	0
6/6/19	Thursday	1	1	0	0	0
6/9/19**	Sunday	16	4	14	0	2
6/20/19	Thursday	3	1	2	0	0

*5/5/19 - No tour; no participants.

**6/9/19 - Denial due to overdemand; participants accommodated on a Seymour Center daily tour, which included vistas of the lagoon and beach, later that day.

Appendix 1 (cont.). Tour Data July 1, 2019 – December 31, 2019

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/7/19	Sunday	14	4	13	3	0
7/11/19	Thursday	14	2	12	0	0
7/14/19	Thursday	17	5	18	6	0
7/18/19	Thursday	12	2	13	3	0
8/1/19	Thursday	10	0	18	8	0
8/4/19*	Sunday	14	0	21	1	6
8/11/19	Sunday	10	0	10	0	0
8/15/19	Thursday	5	0	5	0	0
9/1/19	Sunday	13	0	14	1	0
9/5/19	Thursday	6	0	6	0	0
9/8/19	Sunday	4	0	4	0	0
9/19/19	Thursday	2	0	2	0	0
10/3/19	Thursday	7	2	5	0	0
10/13/19	Sunday	9	0	9	0	0
11/7/19	Thursday	6	0	6	0	0
11/10/19	Sunday	8	0	13	5	0
12/1/19	Sunday	2	0	11	9	0
12/9/19	Thursday	9	0	9	0	0
2019 TOTAL	**-**	**265**	**46**	**270**	**43**	**8**
2019-2022 GRAND TOTAL	**-**	**683**	**73**	**795**	**165**	**145**

*8/4/19 - Denial due to overdemand. Participants offered a Seymour Center daily tour, which includes vistas of the lagoon and beach.

Appendix 2. Tour Data January 1, 2018 – June 30, 2018 (pre special conditions)

Tour Date	Day	Participants	Walk in	Reservation	No Show
1/4/18	Thursday	3	1	2	0
1/14/18	Sunday	3	0	3	0
2/1/18	Thursday	6	0	6	0
2/11/18	Sunday	2	1	1	0
3/1/18*	Thursday	1	0	1	0
3/4/18	Sunday	2	0	2	0
3/11/18	Sunday	6	1	5	0
3/15/18	Thursday	2	2	0	0
4/5/18	Thursday	11	0	11	0
4/8/18	Sunday	2	0	2	0
4/19/18	Thursday	8	0	8	0
4/22/18	Sunday	2	0	3	1
5/3/18	Thursday	11	0	11	0
5/6/18	Sunday	7	0	7	0
5/13/18	Sunday	2	0	2	0
5/17/18**	Thursday	0	0	0	0
6/3/18	Sunday	0	0	0	0
6/7/18	Thursday	10	0	11	1
6/10/18	Sunday	7	0	7	0
6/21/18	Thursday	10	0	13	3

*3/1/18 – Canceled due to weather.
**5/17/18 – Canceled; no sign-ups.
***6/3/18 – Canceled; no sign-ups.

Appendix 2 (cont.). Tour Data July 1, 2018 – December 31, 2018 (pre special conditions)

Tour Date	Day	Participants	Walk in	Reservation	No Show
7/1/18	Sunday	9	0	11	2
7/5/18	Thursday	13	0	13	0
7/8/18	Sunday	9	0	10	1
7/19/18*	Sunday	0	0	0	0
8/2/18**	Thursday	0	0	0	0
8/5/18	Sunday	13	0	15	2
8/12/18	Sunday	2	0	2	0
8/16/18	Thursday	9	0	9	0
9/2/18	Sunday	18	0	18	0
9/6/18	Thursday	6	0	6	0
9/9/18	Sunday	5	0	5	0
9/27/28	Thursday	14	0	15	1
10/4/18	Thursday	10	0	12	2
10/14/18	Sunday	8	0	8	0
11/1/18***	Thursday	0	0	0	0
11/11/18	Sunday	7	0	7	0
12/2/18	Sunday	6	0	8	2
12/6/18****	Thursday	0	0	0	0
2018 TOTAL	**-**	**224**	**5**	**234**	**15**

*7/19/18 – Canceled; no sign-ups.
**8/2/18 – Canceled; no sign-ups.
***11/1/18– Canceled; no sign-ups.
****12/6/18– Canceled; no sign-ups.

Appendix 3. Avian Wildlife Impact Data, July 1, 2022 – December 31, 2022

Tour Date	Day	Species Present	Species Flushed
7/7/22*	Thursday	BLPH, BRCO, PECO, PIGU, WEGU	-
7/9/22*	Saturday	BLPH, BRCO, DCCO, GBHE, PECO, PIGU, SNEG, WEGU,	-
7/21/22*	Thursday	BLPH, BRCO, WEGU	-
7/23/22*	Saturday	BRCO, BLPH, HEEG, LBCU, WEGU	-
8/4/22	Thursday	BLPH, BRCO, CLSW	BRCO, WEGU
8/13/22*	Saturday	BRCO, BLPH, GREG, LBCU, SNEG, WEGU	-
8/18/22	Thursday	BLPH, BRCO, GBHE, HEEG, WEGU	LBCU, WEGU
8/27/22	Saturday	BRCO, BLPH, SNEG, WEGU, WHIM	GBHE, WEGU
9/1/22*	Thursday	BRCO, DCCO, WEGU	-
9/10/22*	Saturday	BLOY, BLPH, BRCO, PECO, SAND, WEGU, WHIM	-
9/15/22*	Thursday	BLOY, BLPH, BRCO, PECO, WEGU	-
9/24/22	Saturday	BRCO, OSPR, RNPH, SNEG, WEGU, WHIM	OSPR, SNEG, WHIM
10/06/22	Thursday	BLOY, BRCO, WEGU, WHIM	WHIM
10/15/22	Saturday	AMCR, BLPH, BRCO, OSPR, PECO	OSPR
11/3/22	Thursday	AMCR, BLPH, BRCO, SAPH, WEGU	AMCR
11/12/22	Saturday	SNEG, TUVU, BRCO, BEWR	TUVU, BEWR
12/1/22	Thursday	BRCO, PECO, WEGU	WEGU
12/10/22**	Saturday	-	-

*7/7/22, 7/9/22, 7/21/22, 7/23/22, 8/13/22, 9/1/22, 9/10/22, 9/15/22 – No birds flushed.
**12/10/22 – Canceled due to weather. No biological data collected.

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BEWR** -Bewick's wren, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **DCCO** – Double-crested cormorant, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **HEEG** - Heermann's Gull, **KILL** – Killdeer, **LBCU** – Long-billed curlew, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **OSPR** – Osprey, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WHIM** – Whimbrel, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, January 1, 2022 – June 30, 2022

Tour Date	Day	Species Present	Species Flushed
1/2/22*	Thursday	-	-
1/8/22*	Saturday	-	-
2/3/22*	Thursday	-	-
2/12/22*	Saturday	-	-
3/3/22*	Thursday	-	-
3/12/22*	Saturday	-	-
3/17/22*	Thursday	-	-
3/26/22*	Saturday	-	-
4/7/22**	Thursday	AMCO, BRCO, CAGO, CAGU, MALL	-
4/9/22**	Sunday	AMWI, BRCO, CAGO, MALL, PIGU, WEGU, WHIM	-
4/21/22**	Thursday	AMWI, BRCO, CAGO, MALL, PIGU, WEGU, WHIM	-
4/23/22**	Saturday	BARS, BRCO, BLPH, CAGO, CORA, MALL, WEGU, SNEG, WHIM	-
5/5/22**	Thursday	BLPH, BRCO, CAGO, CAGU, KILL, PECO, WEGU -	KILL
5/14/22**	Saturday	GBHE, BRCO, PECO, WEGU, RTHA, MALL, YELE, RNFA, WHIM, PIGU, WEGU	-
5/19/22**	Thursday	BARS, BLPH, BRCO, BRPE, PIGU, VGSW, WEGU	-
5/28/22	Saturday	WEGU, BRCO, PECO, BASW, TUVU, AMCR, BRPE, PIGU, BLPH	TUVU
6/2/22	Thursday	BRCO, BRPE, WEGU	BRPE, WEGU
6/11/22	Saturday	BLPH, BRCO, CAGU, CORA, DCCO, HEEG, WEGU	BLPH, CAGU, WEGU
6/16/22	Thursday	BARS, BLPH, BRCO, CAGU, CLSW, COMU, PECO, PIGU, WEGU	WEGU
6/25/22	Saturday	BARS, BLPH, BRCO, PIGU, SAPH, WEGU	WEGU

*1/6/22 - 3/26/22 – Canceled due to COVID-19 impacts. No biological data collected.
** 4/7/22, 4/9/22, 4/21/22, 4/23/22, 5/5/22, 5/14/22, 5/19/22 – No birds flushed.
AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BEWR** -Bewick's wren, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **DCCO** – Double-crested cormorant, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **HEEG** – Heermann's gull, **KILL** – Killdeer, **LBCU** – Long-billed curlew, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **OSPR** – Osprey, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WHIM** – Whimbrel, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, July 1, 2021 – December 31, 2021

Tour Date	Day	Species Present	Species Flushed
7/1/21*	Thursday	-	-
7/11/21*	Sunday	-	-
7/15/21*	Thursday	-	-
7/25/21*	Sunday	-	-
8/5/21*	Thursday	-	-
8/8/21*	Sunday	-	-
8/19/21*	Thursday	-	-
8/22/21*	Sunday	-	-
9/2/21*	Thursday	-	-
9/12/21*	Sunday	-	-
9/16/21*	Thursday	-	-
9/26/21*	Sunday	-	-
10/7/21*	Thursday	-	-
10/10/21*	Sunday	-	-
11/4/21*	Thursday	-	-
11/14/21*	Sunday	-	-
12/2/21*	Thursday	-	-
12/5/21*	Sunday	-	-
2021 TOTAL	-	-	-

*7/1/21 – 12/5/21 – Canceled due to COVID-19 impacts. No biological data collected.

Appendix 3 (cont.). Avian Wildlife Impact Data, January 1, 2021 – June 30, 2021

Tour Date	Day	Species Present	Species Flushed
1/7/21*	Thursday	-	-
1/10/21*	Sunday	-	-
2/4/21*	Thursday	-	-
2/14/21*	Sunday	-	-
3/4/21*	Thursday	-	-
3/14/21*	Sunday	-	-
3/18/21*	Thursday	-	-
3/28/21*	Sunday	-	-
4/1/21*	Thursday	-	-
4/11/21*	Sunday	-	-
4/15/21*	Thursday	-	-
4/25/21*	Sunday	-	-
5/6/21*	Thursday	-	-
5/9/21*	Sunday	-	-
5/20/21*	Thursday	-	-
5/23/21*	Sunday	-	-
6/3/21*	Thursday	-	-
6/13/21*	Sunday	-	-
6/17/21*	Thursday	-	-
6/27/21*	Sunday	-	-

*1/4/21 - 6/27/21 – Canceled due to COVID-19 impacts. No biological data collected.

Appendix 3 (cont.). Avian Wildlife Impact Data, July 1, 2020 – December 31, 2020

Tour Date	Day	Species Present	Species Flushed
7/2/20*	Thursday	-	-
7/12/20*	Sunday	-	-
7/16/20*	Thursday	-	-
7/26/20*	Sunday	-	-
8/6/20*	Thursday	-	-
8/9/20*	Sunday	-	-
8/20/20*	Thursday	-	-
8/23/20*	Sunday	-	-
9/3/20*	Thursday	-	-
9/13/20*	Sunday	-	-
9/17/20*	Thursday	-	-
9/27/20*	Sunday	-	-
10/1/20*	Thursday	-	-
10/11/20*	Sunday	-	-
11/5/20*	Thursday	-	-
11/8/20*	Sunday	-	-
12/3/20*	Thursday	-	-
12/6/20*	Sunday	-	-
2020 TOTAL	**-**	**-**	**-**

*7/2/20 - 12/6/20 – Canceled due to COVID-19 impacts. No biological data collected.

Appendix 3 (cont.). Avian Wildlife Impact Data, January 1, 2020 – June 30, 2020

Tour Date	Day	Species Present	Species Flushed
1/2/20	Thursday	AMCO, AUWA, BLPH, BRCO, GCSP, MALL, NOHA, PIGU, SAPH, WEGU	BLPH, AUWA
1/12/20*	Sunday	AMCO, BLPH, BRCO, CAGO, COHA, GREG, MALL, PECO, SAPH, SNEG, WEGU	-
2/6/20	Thursday	BRCO, SNEG, WEGU	SNEG
2/9/20*	Sunday	BRCO, GREG, WEGU	-
3/5/20	Thursday	CAGO, GREG, MALL, PECO	MALL
3/8/20	Sunday	AMCO, BRCO, CAGO, CITE, MALL, SNEG, WHIM	BRCO, CITE, MALL, SNEG
3/19/20**	Thursday	-	-
3/22/20**	Sunday	-	-
4/2/20**	Thursday	-	-
4/5/20**	Sunday	-	-
4/16/20**	Thursday	-	-
4/26/20**	Sunday	-	-
5/7/20**	Thursday	-	-
5/10/20**	Sunday	-	-
5/21/20**	Thursday	-	-
5/24/20**	Sunday	-	-
6/4/20**	Thursday	-	-
6/14/20**	Sunday	-	-

* 1/12/20 and 2/9/20 - No birds flushed.

**3/19/20 - 6/28/20 – Tours canceled due to COVID-19 impacts. No biological data collected.

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **AUWA** – Audubon's warbler, **BARS** – Barn swallow, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CITE** – Cinnamon Teal, **CLSW** – Cliff swallow, **CORA** – Common raven, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **KILL** – Killdeer, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, April 14, 2019 – June 30, 2019

Tour Date	Day	Species Present	Species Flushed
4/14/19	Sunday	AMCO, BLOY, BRCO, CCGO, GREG, MALL, SNEG, WEGU	BLOY, CCGO, MALL
4/18/19	Thursday	BLOY, BRCO, MALL, SNEG, SOSP, WEGU	BLOY, MALL, SNEG
5/2/19	Thursday	CCGO, BRBL, GREG, KILL, MALL, RSHA, WEGU	BRBL, CAGO, GREG, MALL, WEGU
5/5/19*	Sunday	No tour	No tour
5/12/19	Sunday	MALL, NOMO RNPH, WEGU, WESA	WESA
5/16/19	Thursday	BLPH, BRCO, GREG, KILL, MALL, RNPH, WEGU	MALL
6/2/19	Sunday	BARS, BLPH, MALL, PIGU, WEGU, WESA	BLPH, MALL WESA
6/6/19	Thursday	AMRO, BARS, BLPH, BRCO, BRBL, CAGO, CLSW, GREG, MALL, PECO, PIGU, WEGU	CAGO, GREG, PIGU, WEGU
6/9/19	Sunday	BARS, BLPH, BRCO, KILL, PIGU, RWBL, SOSP, WEGU	BARS, BLPH, PIGU, RWBB
6/20/19	Thursday	AMCR, BARS, BLPH, BRCO, PIGU, WEGU	BLPH, PIGU, WEGU

*5/5/19 - No tour; no participants

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **KILL** – Killdeer, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, July 1, 2019 – December 31, 2019

Tour Date	Day	Species Present	Species Flushed
7/7/19	Sunday	BARS, BHCO, BRPE, GREG, WEGU	GREG, WEGU
7/11/19	Thursday	CAGU, CORA, NOHA, PECO, PIGU, WEGU	PECO
7/14/19	Thursday	AMCR, CAGU, PECO, WEGU	WEGU
7/18/19	Thursday	AMCO, BARS, CLSW, WEGU	WEGU
8/1/19	Thursday	CORA, MALL, PECO, RNPH, SNEG	MALL, RNPH
8/4/19	Sunday	GBHE, PIGU, SNEG, WEGU	GBHE, SNEG
8/11/19	Sunday	GBHE, GREG, PECO, RNPH, SNEG, WESA	GREG, WESA
8/15/19	Thursday	BARS, GBHE, GREG, PECO, WESA	GBHE, GREG
9/1/19	Sunday	CAGU, PECO, SNEG	SNEG
9/5/19	Thursday	BLPH, GREG, PECO, SNEG, WEGU	GREG, SNEG
9/8/19	Sunday	NOHA, PECO, SAND, WEGU, WHIM	NOHA
9/19/19	Thursday	GREG, GRHE, PECO, RNPH, RTHA, SAND, WEGU	GRHE, PECO, RTHA
10/3/19	Thursday	BLPH, BRPE, CAGU, KILL, PECO, SAPH, SNEG, WHIM	BLPH, CAGU, SAPH, SNEG
10/13/19	Sunday	BLPH, NOHA, PECO, SOSH, WEGU	NOHA
11/7/19	Thursday	AMWI, BLPH, BRAN, PECO, RTHA, SAPH, WEGU	BLPH, RTHA
11/10/19*	Sunday	CLSW, PECO, TUVU	-
12/1/19**	Sunday	-	-
12/9/19	Thursday	AMWI, BLPH, BRPE, PECO, SNEG, WEGU	BLPH

* 11/10/19 – No birds flushed.
*12/1/19 – No biological data collected.

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **KILL** – Killdeer, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **PECO** – Pelagic cormorant, **HEEG** - Heermann's Gull, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WESA** – Western sandpiper

UC SANTA CRUZ
Physical Planning, Development and Operations

June 30, 2023

Mr. Jack Ainsworth, Executive Director
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105

Re: Marine Science Campus Coastal Long Range Development Plan (CLRDP)
Notice of Impending Development (NOID) 12 20-1 Special Conditions Implementation Report #5
SCZ-NOID-0004-20

Dear Mr. Ainsworth:

On October 7, 2020, the California Coastal Commission approved University of California Santa Cruz (UCSC) Special Conditions Implementation Plan for CLRDP NOID 12 20-1 Public Access to and within Younger Lagoon Natural Reserve.

As required by the approved Special Conditions Implementation Plan, Special Condition 4 requires that at least every six months, UCSC shall submit two copies of a Beach Tour Monitoring Report documenting compliance with the special conditions for Executive Director review and approval.

Enclosed for your review and approval are two copies of UCSC's report on the implementation of these special conditions for the period January 2023 through June 2023.

Sincerely,

DocuSigned by:
Jolie Kerns
C2472DC7A82647D...

Jolie Kerns
Director of Physical and Environmental Planning

Via email
cc: Rainey Graeven
Kiana Ford
Gage Dayton

UC Santa Cruz NOID 12 (20-1)
SCZ-NOID-0004-20
Special Conditions Implementation Report 5
January 1, 2023 – June 30, 2023

Burrowing owl on the Younger Lagoon Reserve Beach Dunes

UC Santa Cruz NOID 12 (20-1)
Special Conditions Implementation Report 5

Overview and Executive Summary

On October 7, 2020, the California Coastal Commission approved UC Santa Cruz's NOID 12 (20-1) as consistent with UC Santa Cruz's approved Coastal Long Range Development Plan with the addition of new requirements supplementing the existing (NOID 9 18-1) five staff-recommended special conditions. The five special conditions included 1) Free Beach Tours, 2) Beach Tour Outreach Plan, 3) Beach Tour Signs, 4) Beach Tour Availability and Monitoring, and 5) Beach Access Management Plan Duration. Within 30 days of the approval (i.e., by November 7, 2020), UC Santa Cruz was required to submit a plan for implementation of special condition 2 (Outreach Plan) to the Executive Director of the California Coastal Commission. The plan for implementation of the special conditions was submitted to the Executive Director of the California Coastal Commission on November 5, 2020 and approved as submitted. Special condition 4 requires that at least every six months (i.e., by June 30th and December 31st each year), UC Santa Cruz shall submit two copies of a Beach Tour Monitoring Report for Executive Director review and approval. UC Santa Cruz's report on the implementation of these special conditions for the period of January 1, 2023 through June 30, 2023 is detailed below. UC Santa Cruz has included information in this report from the previous four reporting periods covered under NOID 12 (20-1), the four reporting periods covered under NOID 9 (18-1), and one-year prior, to provide historical and cumulative reference data. This is the fifth report under NOID 12 (20-1). The next report under NOID 12 (20-1) is due by December 31, 2023.

A summary of UC Santa Cruz's compliance with the five special conditions is below. Due to the COVID-19 pandemic - and in response to UC Santa Cruz's request for a COVID-19 emergency waiver, on July 10, 2020 the Commission issued a permit waiver to UC Santa Cruz's in support of COVID-19-related temporary closures and free beach tour suspensions (see UC Santa Cruz's Pub. Res. Code section 30611 notification letter to the Commission dated July 6, 2020). The Seymour Center was temporarily closed and the free beach tour program temporarily suspended in early March 2020. As requested by Commission staff, UC Santa Cruz's notified the Commission in May 2021 and May 2022 of the University's phased reopening efforts. The Seymour Center partially reopened with some limited outdoor programming in summer 2021, the Exhibit Hall reopened in October 2021, and the free beach tour program restarted in April 2022. Despite the historic storms and hazardous weather during the 2022-2023 winter, the tour has been very well attended for the first six months of 2023.

Total tour attendance during this reporting period was more than 130% higher than tour attendance during the same time period in 2022, 170% higher than tour attendance during the same time period in 2019 and nearly 180% higher than tour attendance during the same time period in 2018.

The Seymour Center hired a Marketing Coordinator in November 2022 to continue the marketing efforts for these tours. This position was responsible for outreach, marketing, and advertising efforts, including fulfilling the outreach requirements of the free beach tours as part of NOID 12 (20-1) special conditions. This individual secured and designed the required paid advertisements for a year and maintained the monthly calendar entry requirements. However, as with many industries, staffing continues to be a challenge. After five months in the role, the Seymour Center's marketing coordinator resigned. However, the Seymour Center has already reassigned the marketing/outreach responsibilities and UC Santa Cruz anticipates that all marketing/outreach requirements shall continue to be fulfilled.

Special Condition	Status	Notes
1) Free Beach Tours	Completed	All beach tours are offered for free without admission to the Seymour Center.
2) Beach Tour Outreach Plan	Completed & Ongoing	UC Santa Cruz's Updated Beach Tour Outreach Plan was approved by the Executive Director in November 2020 and all beach tour outreach materials now clearly state that the beach tour is free. UC Santa Cruz's ongoing outreach efforts include regular social media postings and calendar listings, including publications that serve inland communities.
3) Beach Tour Signs	Completed	UC Santa Cruz's Beach Tour Signage Plan under NOID 9 (18-1) was approved by the executive director in January 2019 and "Free Beach Tour" signs have been installed at all of the required locations.
4) Beach Tour Availability and Monitoring	Completed & Ongoing	Free beach tours are offered per the required schedule – a minimum of 38 times a year on weekends and weekdays, and all of the required data on tour attendees has been and will continue to be collected. UC Santa Cruz submitted all of the previously

		required biannual reports on the beach tours covered under NOID 9 (18-1) and NOID 12 (20-1) on-time. This is the fifth report under NOID 12 (20-1).
5) Beach Access Management Plan Duration	In Progress	NOID 12 (20-1) is effective through December 31, 2025. UC Santa Cruz is required to submit their next Beach Access Management Plan NOID by July 1, 2025.

Historical data from previous reports (pre special conditions and pre-COVID) are provided below for context.

Implementation of the NOID 9 (18-1) special conditions resulted in an approximately 18% increase in overall tour participation and more than 900% increase in walk-in/day-of tour participants in 2019 (first full year post special conditions) compared to 2018 (pre special conditions).

A summary of the free beach tour user data for 2018 (pre special conditions) and 2019 (first full year post special conditions) is below:

Year	Dates	Total Tours Offered	Total Participants	Total # of Walk-in / Day-of Participants	Total # of Participants with a Reservation
2018	January 1-December 31	38	224	5	219
2019	January 1-December 31	38	265	46	219

Although only six tours were offered before the Seymour Center was temporarily closed and the free beach tour program temporarily suspended in early March 2020 due to COVID-19, total tour attendance for the 2020 tours that were offered was more than 100% higher than tour attendance during the same time period in 2019 and more than 350% higher than tour attendance during the same time period in 2018. A summary of the free beach tour user data for the first six tours in 2018 (pre special conditions), 2019 (first full year post special conditions), and 2020 is below:

Year	Dates	Total Tours Offered	Total Participants	Total # of Walk-in / Day-of Participants	Total # of Participants with a Reservation
2018	January 1-March 7	6	17	2	15
2019	January 1-March 4	6	31	6	25
2020	January 1-March 8	6	60	5	55

Tour attendance has been strong since the tours restarted post-pandemic in April 2022. Total tour attendance during the reporting period covered by this report (January 1, 2023 – June 30, 2023) was more than 130% higher than tour attendance during the same time period in 2022, 170% higher than tour attendance during the same time period in 2019 and nearly 180% higher than tour attendance during the same time period in 2018. A summary of the free beach tour user data for the January 1-June 30 tours in 2018 (pre special conditions), 2019 (first full year post special conditions), 2022 (post-pandemic) and 2023 is below:

Year	Dates	Total Tours Offered	Total Participants	Total # of Walk-in / Day-of Participants	Total # of Participants with a Reservation
2018	Jan 1-June 30	20	95	5	90
2019	Jan 1-June 30	20	100	31	69
2022	Jan 1-June 30*	12	127	11	116
2023	Jan 1-June 30	20	171	26	145

*First 8 tours of 2022 were canceled due to the COVID-19 pandemic.

In order to maintain public access and engagement during the COVID-19 pandemic while the tour program was temporarily suspended, the University created a virtual bilingual beach tour that is available on the Seymour Center and Younger Lagoon Reserve websites. Since its debut in November 2020, the English language virtual tour has been viewed more than 400 times and the

Spanish language virtual tour has been viewed over 30 times. The virtual tour will continue to be offered post-pandemic and allows visitors from around the world to learn about the unique ecology and programs at the reserve in English and Spanish from the comfort of home or a mobile device.

The virtual tour websites feature a map of the reserve with 16 marked locations where visitors can click to watch videos about the features of each type of habitat. The locations of the virtual tour reflect beach tour lookouts where tour docents narrate information about the Younger Lagoon Reserve and beach habitat and wildlife, providing a virtual experience similar to the in-person free beach access tours.

Virtual Tour Links:
English: https://arcg.is/11m1Ga
Spanish: https://arcg.is/0q0Czv

A UC Santa Cruz undergraduate student created the virtual tour website and edited the videos as part of an internship project. This student completed all of the work on this project remotely, including learning about the reserve itself. A Younger Lagoon Reserve undergraduate student employee who assisted with the free in-person tours prior to the pandemic acts as the on-camera guide for both tours.

Condition 1.

FREE BEACH TOURS

All beach tours shall be offered for free, and UC Santa Cruz 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 UC Santa Cruz's Seymour Marine Discovery Center. At a minimum, beach tour sign-ups shall be provided online (e.g., at UC Santa Cruz Marine Science Campus and Seymour Marine Discovery Center websites), by phone, and at the Seymour Marine Discovery Center front desk. UC Santa Cruz 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 UC Santa Cruz 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.

Implementation Report

All beach tours were offered for free (without admission fee). Beach tour sign-ups are available online through the Seymour Marine Discovery Center (Seymour Center) website, by phone and at the Seymour Center public admissions counter. Seymour Center staff track any tour requests that are denied due to lack of tour availability or because tours are fully booked as part of their ongoing monitoring of all visitor programs. Seymour Center staff record the number of participants that were denied, the number of participants that were wait listed, as well as the date of the request, the date of the tour being requested, and how participants heard about the tour (see Condition 2). Although not required to, Seymour Center staff also record home zip code information of tour participants. All UC Santa Cruz public materials referencing the beach at Younger Lagoon and/or beach tours, including the websites below, clearly identify that access to the beach is available for free. (Note that there is no UC Santa Cruz Marine Science Campus website; tour information has been posted to the Younger Lagoon Reserve and Seymour Marine Discovery Center websites; see website links below).

https://youngerlagoonreserve.ucsc.edu/about-us/index.html
https://youngerlagoonreserve.ucsc.edu/visit/public-tours.html
https://seymourcenter.ucsc.edu/visit/groups-and-tours/

Condition 2.

BEACH TOUR OUTREACH PLAN

Within 30 days of this approval (i.e., by November 7, 2020), UC Santa Cruz shall submit two copies of an updated 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 beach tours, including the online virtual tours. Promotional methods shall include, but are expected to not be limited to: UC Santa Cruz Marine Science Campus and Seymour Marine Discovery Center websites, press releases, calendar listings with UC Santa Cruz Events and local media (e.g., Good Times newspaper, Santa Cruz Sentinel, The Register-Pajaronian, The Half Moon Bay Review, The Monterey Herald, etc.), ads on radio (e.g., local radio stations KAZU, KRML, and others), print ads, social media (including Facebook, Twitter, and Instagram), and contacts with influential organizations in local environmental and community advocacy groups who may facilitate promotional opportunities. The Plan shall identify the language to be used in describing the virtual and free in-person 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 online viewers and potential beach tour participants as possible, including audiences beyond Santa Cruz that might not normally be reached through traditional and local means (e.g., inland communities). The Plan shall describe how UC Santa Cruz will monitor and track the Outreach Plan's execution so that UC Santa Cruz and the Coastal Commission can note the effectiveness of the plan and make changes as needed. UC Santa Cruz shall implement the updated approved Outreach Plan.

Implementation Report

Outreach was conducted according to the following plan, which was approved by the Executive Director and includes all of the measures and venues described in Condition 2:

Venue	Language	Schedule	Mechanism for Monitoring and Tracking	
Seymour Center Website	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up here*.	Permanent webpage: https://seymourcenter.ucsc.edu/visit/groups-and-tours/	Provide link to updated website and date that updates were made	Seymour Center Website is up to date. No updates needed during this reporting period.

	Virtual tours are available here**. * hyperlink to online sign-up **hyperlink to virtual tour			
YLR Website	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu**	Permanent webpage: https://youngerlagoonreserve.ucsc.edu/visit/public-tours.html	Provide link to updated website and date that updates were made	YLR Website is up to date. No updates needed during this reporting period.
Seymour Center Social Media • Facebook • Twitter • Instagram	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu**	Facebook—Monthly Twitter, Instagram ---Once a quarter	Document date that posts are made and capture a link to the post	Facebook posted 2/1/23, 4/5/23 and 4/21/23. Instagram posted on 4/21/23. The Seymour Center is no longer using Twitter.
YLR Social Media • Facebook • Instagram	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu**	Once a quarter	Document date that posts are made and capture a link to the post	Facebook posted 2/9/23 and 5/3/23. Instagram posted 2/9/23 and 5/3/23.
Calendar Listings • UC Santa Cruz Events • Good Times Newspaper	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online.	Submitted monthly (calendar listings appear at the discretion of the media outlet.)	Document date that listings are submitted, and verify that the listing ran by capturing a link to the website (if online)	UC Santa Cruz Events: submitted and posted on 2/8/23 for the 2/11/23 tour and all subsequent tours in this reporting period.

(Santa Cruz) • Register Pajaronian Newspaper (Watsonville) • The Half Moon Bay Review • The Monterey Herald • KAZU public radio (Santa Cruz) • KRML (Monterey Bay)	Virtual tours are available online. **seymourcenter.ucsc.edu** For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**			Good Times Newspaper submitted and posted on 2/10/23 for the 2/11/23 tour and all subsequent tours in this reporting period. Register Pajaronian Newspaper submitted and posted on 2/10/23 for the 2/11/23 tour and all subsequent tours in this reporting period. The Half Moon Bay Review submitted and posted on 2/10/23 for the 2/11/23, submitted and posted on 2/10/23 for the 2/11/23, 3/11/23, 3/16/23, 3/25/23, 4/6/23, 4/8/23, 4/20/23, and 4/22/23 tours. Submitted and posted on 4/28/23 for the 5/4/23, 5/13/23, 5/18/23, and 5/27/23 tours. Submitted and posted on 5/25/23 for the 6/1/23, 6/10/23, 6/15/23, and 6/24/23 tours. Note that HMBR postings expire after the event and thus are not linked here.

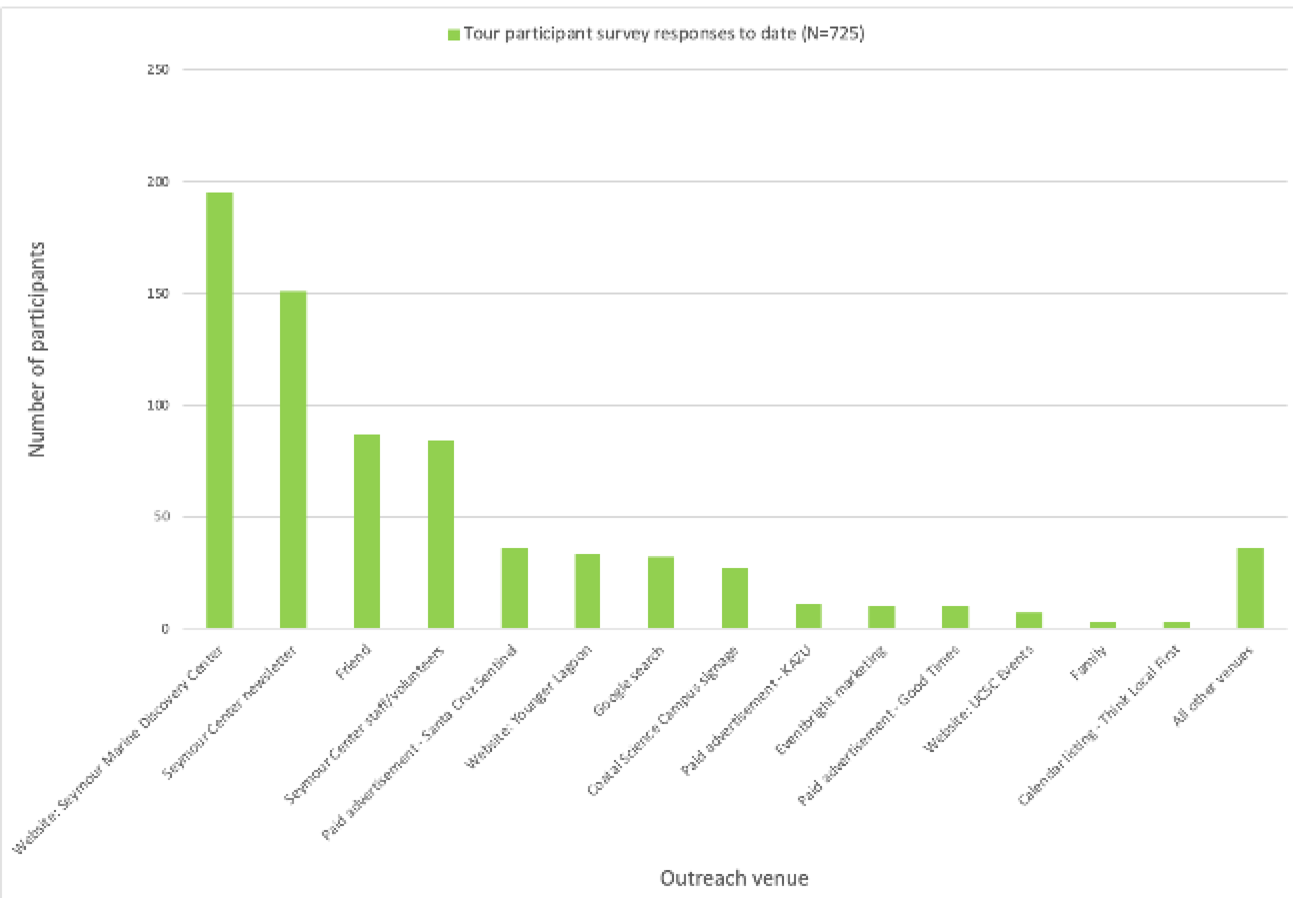
				KAZU public radio submitted on 2/10/23 for the 2/11/23 tour and all subsequent tours in this reporting period. KRML does not currently have an online portal for submitting calendar listings. Seymour Center staff have contacted KRML regarding the process for submitting calendar listings. In addition to the above required calendar listings, calendar listings were also posted to The Monterey Herald, SantaCruz.com, Vicality Monterey Bay, and the California Environmental Education Event Calendar
Ads • Santa Cruz Sentinel Newspaper (Santa Cruz) • Good Times Newspaper (Santa Cruz) • KAZU public radio	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu**	Quarterly	Document date that ads ran, and verify that the ad ran by capturing a link to the website (if online)	Ads were purchased and ran in the Sentinel on 3/2/23, 3/9/23, 3/16/23, 3/23/23, and 3/30. Ads were purchased and ran in the Good Times on 3/30/23. Ads were purchased and ran on KAZU the week of

(Santa Cruz)	For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**			6/5/23. See Appendix 4.
Press Release	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu** For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**	Announce the virtual tours and resumption of free in-person beach tours post-COVID via two bilingual (English and Spanish) UC Santa Cruz press releases.	Document the date of the press releases, distribution list of media outlets and verify that the press releases were posted by capturing a link to the website (if online).	Completed 6/1/22; see NOID 12 (20-1) Special Conditions Implementation Report 3.

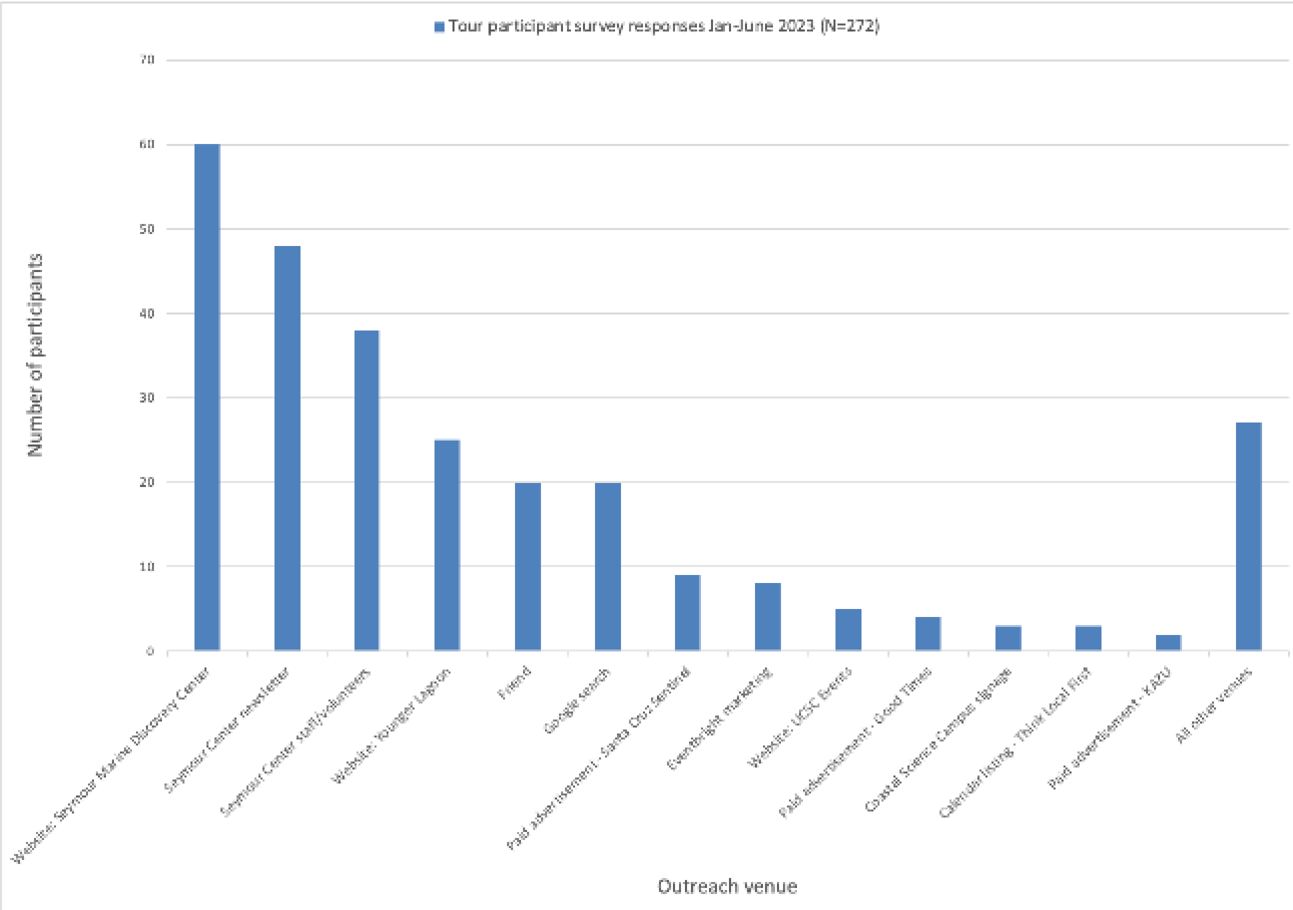
Contacts who may facilitate promotional opportunities • SMDC Educator Email Mailing List (815 subscribers) • Homeschool Mailing Email List (124 subscribers) • Seymour Center E-newsletter list - 10,000 email recipients from all over California and beyond • UC Santa Cruz Events Email-newsletter • Andy Carman at Enviroteers, weekly newsletter • CSUMB Outdoor Recreation Resources and Opportunities Website • Outdoor World	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 18 participants. Call **831-459-3800** or sign-up online. Virtual tours are available online. **seymourcenter.ucsc.edu** For Spanish language outlets: Las visitas guiadas a la reserva de la laguna Younger son gratuitas y están abiertas al público. El espacio está limitado a 18 participantes. Llame al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**	Once a quarter	Information about the tours will be emailed to contacts once a quarter. Date of email and recipients will be documented.	Information was sent to the SMDC E-newsletter on 2/1/23. Enviroteers submitted 4/28/23 and posted 5/2/23 for the 5/4/23, 5/13/23, 5/18/23, and 5/27/23 tours. Outdoor World has closed and the Outdoor Resources Website no longer exists. CSUMB Outdoor Recreation Resources and Opportunities Website is back up and running post-pandemic. Seymour Center staff have contacted CSUMB Outdoor Recreation regarding posting tour information to their site. Information was posted to Think Local First on 4/28/23 for the 5/4/23 tour and all subsequent tours in this reporting period.

Outdoor Resources Website: https://www.theoutdoorworld.com/info/outdoor-resources				

In addition, tour participants were surveyed to determine how they heard about the tour, as required by the special conditions. This information is tracked with sign-up information (see Condition 1). Since the Seymour Center began tracking this information in April 2022 and during this reporting period, the most frequent way tour participants learned about the free beach tour was through the Seymour Center's website and newsletter (Figures 1 and 2).



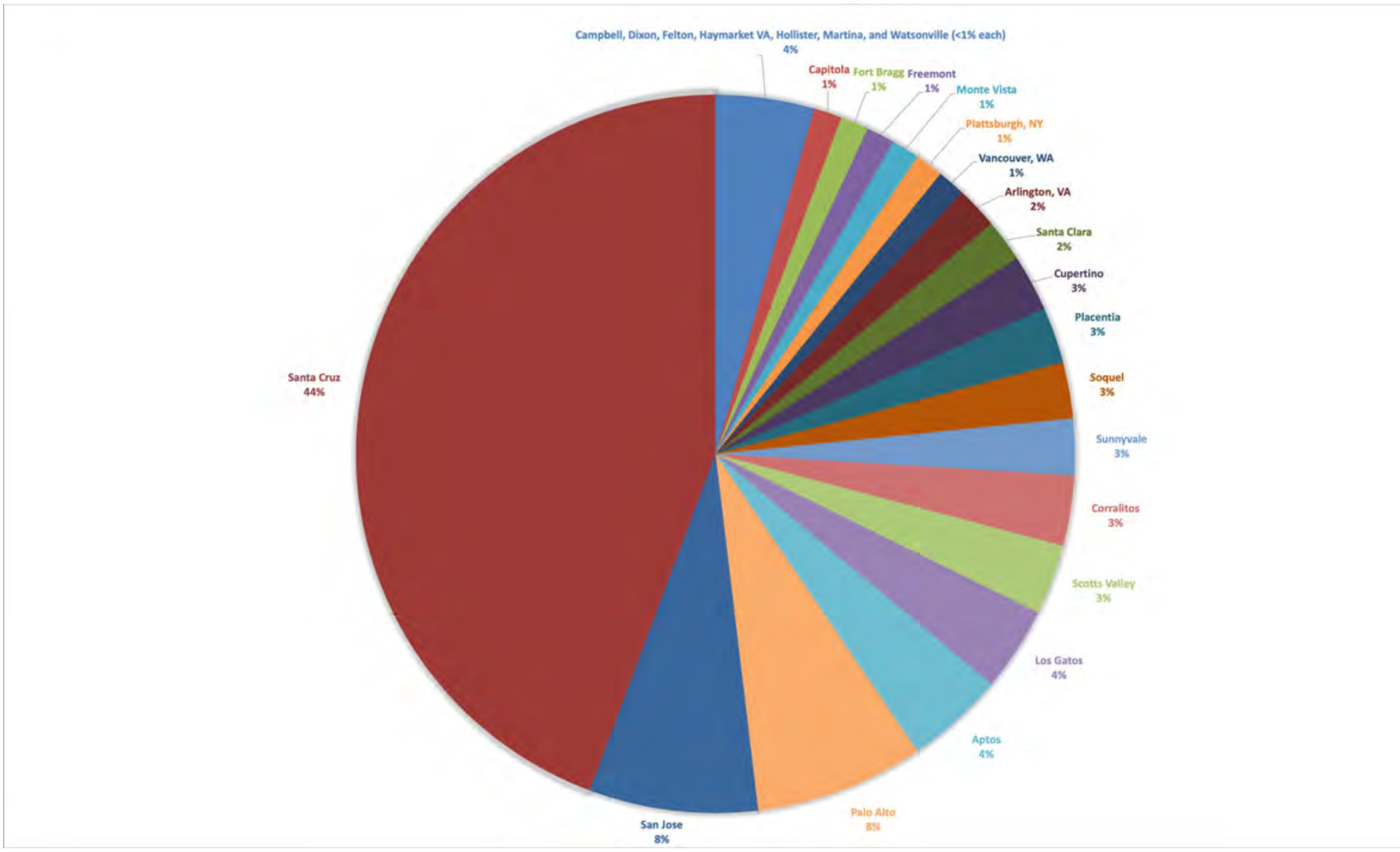
<u>Figure 1</u>. Cumulative outreach survey results for the free beach tours since the implementation of the user survey in April 2022 through June 2023 (N=725). The most frequent way tour participants learned about the free beach tour was through the Seymour Center's website and newsletter.



<u>Figure 2</u>. Outreach survey results for the free beach tours for the January - June 2023 reporting period (N=272). The most frequent way tour participants learned about the free beach tour was through the Seymour Center's website and newsletter.

This data shows that the most frequent way tour participants learned about the free beach tour was through the Seymour Center's website and newsletter. Some other special condition requirements are showing promise while others show little to no nexus to tour sign ups.

In addition, although not required to do so by NOID 12 (20-1), Seymour Center staff also began recording the home zip code information of tour participants in April 2023 in order to better understand trends in tour participation. Since April 2023, approximately 95% of free beach tour participants were from California and nearly half were from Santa Cruz (Figure 3).



<u>Figure 3</u>. Participant zip code survey results for the free beach tours from April -June 2023 (N=158). Approximately 95% of free beach tour participants were from California and nearly half were from Santa Cruz.

The success and shortcomings of the special conditions strategies will be discussed and re-evaluated with Commission staff during development of the next 5-year beach access management plan, for Seymour Center staff to focus their limited resources on activities that drive the most free beach tour participation.

<u>Condition 3.</u>

BEACH TOUR SIGNS

UC Santa Cruz will continue to implement the Beach Tour Sign Plan that was previously-approved by the Executive Director under NOID 9 where such Plan has provided 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 continue to be sited and designed to be visually *compatible with the area, consistent with the Campus sign program (and CLRDP sign requirements) and continue to provide clear information in a way that minimizes public view impacts. UC Santa Cruz shall continue to implement the approved Beach Tour Sign Plan from NOID 9.*

Implementation Report

Information on the free beach tours was displayed "day of" on large sign in the front window of the Seymour Center and at the public admissions counter. Admissions counter signage will continue to include the brown and white footprints on wave logo, and include the following language "Free Younger Lagoon Reserve Beach Tours Today" (Figures 5, 8, and 9). Signage will continue to be displayed at the information kiosk outside (Figure 7) of the Seymour Center and at Overlooks A-F (Figures 10-16).

Note, Overlook B was renamed Terrace Point Overlook, as shown on a new coastal access sign installed as a condition of Overlook B Path Repair and Replacement (SCZ-NOID-0004-19) (Figure 4).

<u>Figure 4.</u> Terrace Point Overlook coastal access sign design.

Overlooks, admissions counter, and kiosk signage includes the brown and white footprints on wave logo, and include the following language "Free Younger Lagoon Reserve Beach Tours, Call (831) 459-3800" (Figure 4).

Figure 5. "Day of" sign design.

Figure 6. Overlooks and kiosk sign design.

Figure 7. Signage installed at Seymour Center information kiosk (photo taken pre-pandemic).

Figure 8. Signage installed at Seymour Center front window (photo taken pre-pandemic).

<u>Figure 9</u>. Signage installed at the Seymour Center admissions desk.

<u>Figure 10</u>. Signage installed at Overlook A.

Figure 11. Signage installed at Overlook A (close-up).

Figure 12. Signage installed at Overlook B (Terrace Point).

Figure 13. Signage installed at Overlook C.

Figure 14. Signage installed at Overlook D.

Figure 15. Signage installed at Overlook E.

Figure 16. Signage installed at Overlook F.

<u>Condition 4.</u>

BEACH TOUR AVAILABILITY AND MONITORING

UC Santa Cruz 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 (totaling a minimum of 38 total beach tours per year). UC Santa Cruz may limit the number of beach tour participants to 18 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). UC Santa Cruz 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 30 and December 31 of each year), UC Santa Cruz 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 UC Santa Cruz's activities under the approved updated Beach Tour Outreach Plan (see Condition 2) and which shall include specific information regarding the dates that each advertisement for beach tours was placed in each venue/media/social media outlet, 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. Each Monitoring Report shall also include a section that describes how the beach-lagoon ecosystem has responded to beach tours. This assessment will include data and analysis useful for assessing whether the ecosystem shows any impacts from beach tours. This assessment will be used to help determine if larger tours have any impacts on the YLR ecosystem, its environmental quality, and UC Santa Cruz research opportunities at the site. UC Santa Cruz shall implement any Executive Director-approved recommendations from each Beach Tour Monitoring Report.

Implementation Report

Free beach tours were offered two times per month on select Thursdays and Saturdays from January 1, 2023 through February 28, 2023 and four times per month on select Thursdays and Saturdays from March 1, 2023 through June 30, 2023. Tours will continue to be offered at least four times per month (at least one on a weekday and two on a weekend tours) from March 1st through September 30th each year, and will be offered at least two times per month (at least one on a weekday and one on a weekend) for the remainder of the year (a minimum of 38 total beach tours per year). Beach tour participants were limited to 18 persons per tour, but this number may be exceeded per tour on a case by case basis, and beach tours did not require any minimum number of participants to be provided (i.e., if at least one person signs up, the tour is provided). UC Santa Cruz has documented 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). In addition, tour participants were surveyed to determine how they heard about the tour. This information is being tracked with sign-up information (see Conditions 1 and 2).

At least every six months (i.e., by June 30th and December 31st each year), UC Santa Cruz will submit two copies of a Beach Tour Monitoring Report for Executive Director review and approval, where the Report will at a minimum provide information regarding compliance with these conditions of approval, including a section identifying UC Santa Cruz's activities under the approved updated Beach Tour Outreach Plan (see Condition 2), as well as the required information described in the previous paragraph and Condition 4 above. This is the fifth such report under this implementation plan and has been submitted by June 30, 2023.

A total of 20 free beach tours (171 participants) were offered during this reporting period (See Appendix 1). Three tours were canceled due to hazardous weather. Participants were limited to 18 persons per tour on tours and all tours had at least one participant. Eleven of the tours that went out included walk-in / "day-of" participants. Just five tours were overbooked during the reporting period, a drop from twelve overbooked tours during the last reporting period, indicating that the COVID-related pent up demand for outdoor activities may be starting to ease. In addition, the virtual tour was viewed over 50 times during the reporting period.

In comparison, UC Santa Cruz offered 20 beach tours (95 participants) during the same reporting period in 2018 (Appendix 2; pre special conditions). Two tours did not go out due to lack of sign-ups.

Four of the tours that went out in the same reporting period of 2018 included walk-in / "day-of" participants. No tours were overbooked during the same reporting period in 2018.

Although not required by the special conditions, in addition to tracking user data, UC Santa Cruz also collected data on the biological impacts of the tours. Beginning on April 14, 2019, Younger Lagoon Reserve staff accompanied tours, and documented impacts to avian wildlife on the beach. Staff observed birds flushing from the wet sandy beach, beach dunes, coastal stack, and lagoon in response to over 65% of the tours they attended (see Appendix 3). The average number of avian species present post-tour was significantly less than the average number of avian species pre-tour (p=.0004, paired t-test; See Figure 17).

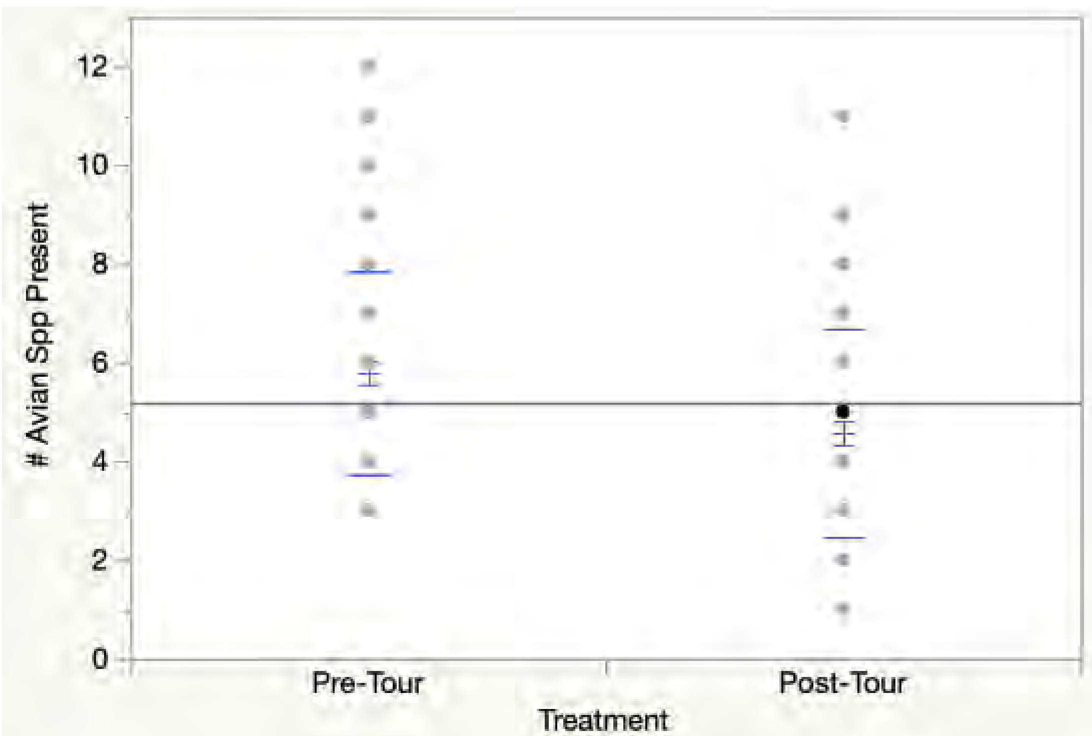


Figure 17. Effect of tours on avian species. Blue I-bars indicate mean, standard error, and standard deviation. The average number of avian species present pre-tour was 5.79 +/- 2.06 (+/- sd). The average number of avian species present post-tour was 4.57 +/- 2.12 (+/- sd). The average number of avian species present post-tour was significantly less than the average number of avian species pre-tour (p=.0004, paired t-test).

Recommendations

Although only in place for less than five years and temporarily suspended for nearly two years due to COVID-19 impacts, the beach tours as specified by UC Santa Cruz's NOIDs 9 (18-1) and 12 (20-1) special conditions appear to be meeting user demand. Total tour attendance during this reporting period was more than 170% higher than tour attendance during the same time period in 2019 and more than 180% higher than tour attendance during the same time period in 2018. During the 24 months covered by NOID 9 (18-1), just eight participants were denied a tour due to overdemand. During this reporting period, five of the 20 tours offered had a waitlist. All waitlisted guests are offered the opportunity to book alternative dates and are contacted in order if a spot on the tour for which they are waitlisted becomes available. The vast majority of participants who are waitlisted are accommodated on an alternate date. UC Santa Cruz staff feel the overdemand is likely a result of continued post-COVID pent up demand, the relative safety of this entirely outdoor offering, and the fact that the free beach tour was the first (and to date, only advertised) of the Seymour Center's docent-guided tours to restart post-pandemic. The Seymour Center's docent-guided behind the scenes research tour – which include views of the beach and lagoon, restarted in the fall of 2022. The behind the scenes research tour is currently offered four times a day to walk-in visitors only (no reservations or advertising at this time). UC Santa Cruz will continue to monitor tour demand as the pandemic wanes and Seymour Center operations and offerings ramp back up. UC Santa Cruz anticipates the volume of beach tour waitlists will diminish as the Seymour Center begins to offer and promote other facility tours, where none are currently being advertised due to staff shortages. NOID 12 (20-1) continued the five NOID 9 special conditions, increased the upper limit of tour attendees and required additional outreach efforts.

The documented negative biological impacts to avian wildlife described above, along with ongoing quarterly beach monitoring efforts indicate that open and unsupervised 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 (See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, and 2021-2022 Annual Reports).

We recommend that the balance between resource protection of the beach and lagoon area – all of which are considered Environmentally Sensitive Habitat Area (ESHA) or ESHA buffer by the Commission, and public access continue to be carefully evaluated and managed. Although similar in many ways to other local pocket beaches, Younger Lagoon beach supports a unique assemblage of flora and fauna, including rare and endangered species. As part of the UC Natural Reserve System, Younger Lagoon Reserve acts as a protected living laboratory and outdoor classroom for teaching and research and is managed in trust for the people of the State of California by the University.

Condition 5.

BEACH ACCESS MANAGEMENT PLAN DURATION

This approval for UC Santa Cruz's public beach access management plan at Younger Lagoon Beach shall be effective through December 31, 2025. UC Santa Cruz 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, 2026 to December 31, 2030) no later than July 1, 2025. Such a 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 UC Santa Cruz'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 UC Santa Cruz research and coastal resources. If such a complete NOID has not been submitted by July 1, 2025, then UC Santa Cruz 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.

Implementation Report

UC Santa Cruz will 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, 2026 to December 31, 2030) no later than July 1, 2025.

Appendix 1. Tour Data January 1, 2023 – June 30, 2023

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/5/23*	Thursday	0	0	11	0	0
1/14/23*	Saturday	0	0	14	0	0
2/2/23	Thursday	5	0	5	0	0
2/11/23	Saturday	1	0	12	11	0
3/2/23	Thursday	15	0	16	1	0
3/11/23*	Saturday	0	0	0	0	0
3/16/23**	Thursday	15	7	18	12	2
3/25/23**	Saturday	6	2	18	14	16
4/6/23**	Thursday	10	2	18	12	9
4/8/23	Saturday	16	0	16	0	0
4/20/23	Thursday	14	2	12	3	0
4/22/23	Saturday	10	0	10	0	0
5/4/23	Thursday	10	2	17	9	0
5/13/23**	Saturday	11	4	18	12	11
5/18/23**	Thursday	2	2	18	18	4
5/27/23	Saturday	6	1	13	8	0
6/01/23	Thursday	8	1	15	8	0
6/10/23	Saturday	13	0	18	5	0
6/15/23	Thursday	13	1	18	6	0
6/24/23	Saturday	16	2	16	2	0

*1/5/23, 1/14/23, and 3/11/23 - Canceled due to weather.
**3/16/23, 3/25/23, 4/6/23, 5/13/23, and 5/18/23 - Denial due to overdemand; participants made alternate bookings.

Appendix 1 (cont). Tour Data July 1, 2022 – December 31, 2022

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/7/22*	Thursday	15	0	18	3	15
7/9/22*	Saturday	15	0	17	2	6
7/21/22**	Thursday	15	0	18	3	8
7/23/22	Saturday	11	0	17	6	0
8/4/22***	Thursday	17	0	18	1	17
8/13/22***	Saturday	17	9	18	10	8
8/18/22***	Thursday	14	0	18	4	11
8/27/22***	Saturday	18	0	18	0	20
9/1/22***	Thursday	16	2	18	4	5
9/10/22	Saturday	10	0	12	2	0
9/15/22	Thursday	6	0	6	0	0
9/24/22***	Saturday	16	0	18	2	4
10/06/22	Thursday	14	0	15	1	0
10/15/22***	Saturday	13	0	18	5	6
11/3/22***	Thursday	15	0	18	3	1
11/12/22***	Saturday	16	0	18	2	7
12/1/22	Thursday	3	0	11	8	0
12/10/22****	Saturday	-	-	14	-	-

*7/7/22 and 7/7/22 – Denial due to overdemand; participants put on waitlist but were unable to make it in time when there were no-shows. Participants made alternate bookings.
**7/21/22 - Denial due to overdemand; participants put on waitlist and 4 were accommodated when there were advance cancelations. Participants made alternate bookings.
***8/4/22, 8/13/22, 8/18/22, 8/27/22, 9/1/22, 9/24/22, 10/15/22, 11/3/22, 11/12/22, and 12/10/22 - Denial due to overdemand; participants made alternate bookings.
****12/10/22 – Canceled due to weather.

Appendix 1 (cont.). Tour Data January 1, 2022 – June 30, 2022

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/2/22*	Thursday	-	-	-	-	-
1/8/22*	Saturday	-	-	-	-	-
2/3/22*	Thursday	-	-	-	-	-
2/12/22*	Saturday	-	-	-	-	-
3/3/22*	Thursday	-	-	-	-	-
3/12/22*	Saturday	-	-	-	-	-
3/17/22*	Thursday	-	-	-	-	-
3/26/22*	Saturday	-	-	-	-	-
4/7/22	Thursday	4	0	4	0	0
4/9/22	Sunday	4	0	4	0	0
4/21/22	Thursday	8	0	8	0	0
4/23/22	Saturday	5	0	5	0	0
5/5/22	Thursday	1	0	7	6	0
5/14/22	Saturday	18	2	16	2	0
5/19/22**	Thursday	11	0	18	7	2
5/28/22***	Saturday	13	4	18	9	3
6/2/22****	Thursday	18	0	18	0	3
6/11/22*****	Saturday	18	5	18	5	10
6/16/22******	Thursday	17	0	18	1	2
6/25/22*******	Saturday	10	0	18	8	9
2022 TOTAL	**-**	**358**	**22**	**442**	**94**	**137**

*1/6/22 - 3/26/22 – Canceled due to COVID-19 impacts.
**5/19/22 - Denial due to overdemand; participants accommodated on future date.
***5/28/22 - Denial due to overdemand; three participants signed up for the waitlist as well as a future date. Two of the three walked in on 5/28 and were able to get a spot when others no showed.
****6/2/22 - Denial due to overdemand; participants accommodated on future date.
*****6/11/22 - Denial due to overdemand; participants accommodated on future date.
******6/16/22 - Denial due to overdemand; participants were directed to the website to sign up for a future date.
*******6/25/22 - Denial due to overdemand; participants were put on the waitlist due to full reservations and were not able to make it in time to join the tour after a larger group no-showed.

Appendix 1 (cont.). Tour Data July 1, 2021 – December 31, 2021

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/1/21*	Thursday	-	-	-	-	-
7/11/21*	Sunday	-	-	-	-	-
7/15/21*	Thursday	-	-	-	-	-
7/25/21*	Sunday	-	-	-	-	-
8/5/21*	Thursday	-	-	-	-	-
8/8/21*	Sunday	-	-	-	-	-
8/19/21*	Thursday	-	-	-	-	-
8/22/21*	Sunday	-	-	-	-	-
9/2/21*	Thursday	-	-	-	-	-
9/12/21*	Sunday	-	-	-	-	-
9/16/21*	Thursday	-	-	-	-	-
9/26/21*	Sunday	-	-	-	-	-
10/7/21*	Thursday	-	-	-	-	-
10/10/21*	Sunday	-	-	-	-	-
11/4/21*	Thursday	-	-	-	-	-
11/14/21*	Sunday	-	-	-	-	-
12/2/21*	Thursday	-	-	-	-	-
12/5/21*	Sunday	-	-	-	-	-

*7/1/21 - 12/5/21 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data January 1, 2021 – June 30, 2021

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/7/21*	Thursday	-	-	-	-	-
1/10/21*	Sunday	-	-	-	-	-
2/4/21*	Thursday	-	-	-	-	-
2/14/21*	Sunday	-	-	-	-	-
3/4/21*	Thursday	-	-	-	-	-
3/14/21*	Sunday	-	-	-	-	-
3/18/21*	Thursday	-	-	-	-	-
3/28/21*	Sunday	-	-	-	-	-
4/1/21*	Thursday	-	-	-	-	-
4/11/21*	Sunday	-	-	-	-	-
4/15/21*	Thursday	-	-	-	-	-
4/25/21*	Sunday	-	-	-	-	-
5/6/21*	Thursday	-	-	-	-	-
5/9/21*	Sunday	-	-	-	-	-
5/20/21*	Thursday	-	-	-	-	-
5/23/21*	Sunday	-	-	-	-	-
6/3/21*	Thursday	-	-	-	-	-
6/13/21*	Sunday	-	-	-	-	-
6/17/21*	Thursday	-	-	-	-	-
6/27/21*	Sunday	-	-	-	-	-
2021 TOTAL	-	-	-	-	-	-

*1/7/21 - 6/27/21 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data July 1, 2020 – December 31, 2020

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/2/20*	Thursday	-	-	-	-	-
7/12/20*	Sunday	-	-	-	-	-
7/16/20*	Thursday	-	-	-	-	-
7/26/20*	Sunday	-	-	-	-	-
8/6/20*	Thursday	-	-	-	-	-
8/9/20*	Sunday	-	-	-	-	-
8/20/20*	Thursday	-	-	-	-	-
8/23/20*	Sunday	-	-	-	-	-
9/3/20*	Thursday	-	-	-	-	-
9/13/20*	Sunday	-	-	-	-	-
9/17/20*	Thursday	-	-	-	-	-
9/27/20*	Sunday	-	-	-	-	-
10/1/20*	Thursday	-	-	-	-	-
10/11/20*	Sunday	-	-	-	-	-
11/5/20*	Thursday	-	-	-	-	-
11/8/20*	Sunday	-	-	-	-	-
12/3/20*	Thursday	-	-	-	-	-
12/6/20*	Sunday	-	-	-	-	-

*7/2/20 - 12/6/20 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data January 1, 2020 – June 30, 2020

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/2/20	Thursday	15	4	20	9	0
1/12/20	Sunday	13	1	18	6	0
2/6/20	Thursday	9	0	18	9	0
2/9/20	Sunday	4	0	5	1	0
3/5/20	Thursday	8	0	8	0	0
3/8/20	Sunday	11	0	14	3	0
3/19/20*	Thursday	-	-	-	-	-
3/22/20*	Sunday	-	-	-	-	-
4/2/20*	Thursday	-	-	-	-	-
4/5/20*	Sunday	-	-	-	-	-
4/16/20*	Thursday	-	-	-	-	-
4/26/20*	Sunday	-	-	-	-	-
5/7/20*	Thursday	-	-	-	-	-
5/10/20*	Sunday	-	-	-	-	-
5/21/20*	Thursday	-	-	-	-	-
5/24/20*	Sunday	-	-	-	-	-
6/4/20*	Thursday	-	-	-	-	-
6/14/20*	Sunday	-	-	-	-	-
6/18/20*	Thursday	-	-	-	-	-
6/28/20*	Sunday	-	-	-	-	-
2020 TOTAL	**-**	**60**	**5**	**83**	**28**	**0**

*3/19/20 - 6/28/20 – Canceled due to COVID-19 impacts.

Appendix 1 (cont.). Tour Data January 1, 2019 – June 30, 2019

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
1/3/19	Thursday	2	2	0	0	0
1/13/19	Sunday	7	0	7	0	0
2/7/19	Thursday	3	0	3	0	0
2/10/19	Sunday	6	1	5	0	0
3/3/19	Sunday	10	3	7	0	0
3/719	Thursday	3	0	4	1	0
3/1019	Sunday	9	6	3	0	0
3/2119	Thursday	3	0	4	1	0
4/4/19	Thursday	10	6	4	0	0
4/7/19	Sunday	9	4	5	0	0
4/14/19	Sunday	9	2	11	4	0
4/18/19	Thursday	5	1	5	1	0
5/2/19	Thursday	1	0	1	0	0
5/5/19*	Sunday	0	0	0	0	0
5/12/19	Sunday	2	0	2	0	0
5/16/19	Thursday	1	0	1	0	0
6/2/19	Sunday	3	0	3	0	0
6/6/19	Thursday	1	1	0	0	0
6/9/19**	Sunday	16	4	14	0	2
6/20/19	Thursday	3	1	2	0	0

*5/5/19 - No tour; no participants.

**6/9/19 - Denial due to overdemand; participants accommodated on a Seymour Center daily tour, which included vistas of the lagoon and beach, later that day.

Appendix 1 (cont.). Tour Data July 1, 2019 – December 31, 2019

Tour Date	Day	Participants	Walk in	Reservation	No Show	Denial / Wait list
7/7/19	Sunday	14	4	13	3	0
7/11/19	Thursday	14	2	12	0	0
7/14/19	Thursday	17	5	18	6	0
7/18/19	Thursday	12	2	13	3	0
8/1/19	Thursday	10	0	18	8	0
8/4/19*	Sunday	14	0	21	1	6
8/11/19	Sunday	10	0	10	0	0
8/15/19	Thursday	5	0	5	0	0
9/1/19	Sunday	13	0	14	1	0
9/5/19	Thursday	6	0	6	0	0
9/8/19	Sunday	4	0	4	0	0
9/19/19	Thursday	2	0	2	0	0
10/3/19	Thursday	7	2	5	0	0
10/13/19	Sunday	9	0	9	0	0
11/7/19	Thursday	6	0	6	0	0
11/10/19	Sunday	8	0	13	5	0
12/1/19	Sunday	2	0	11	9	0
12/9/19	Thursday	9	0	9	0	0
2019 TOTAL	**-**	**265**	**46**	**270**	**43**	**8**
2019-2023 GRAND TOTAL	**-**	**854**	**99**	**1,078**	**286**	**187**

*8/4/19 - Denial due to overdemand. Participants offered a Seymour Center daily tour, which includes vistas of the lagoon and beach.

Appendix 2. Tour Data January 1, 2018 – June 30, 2018 (pre special conditions)

Tour Date	Day	Participants	Walk in	Reservation	No Show
1/4/18	Thursday	3	1	2	0
1/14/18	Sunday	3	0	3	0
2/1/18	Thursday	6	0	6	0
2/11/18	Sunday	2	1	1	0
3/1/18*	Thursday	1	0	1	0
3/4/18	Sunday	2	0	2	0
3/11/18	Sunday	6	1	5	0
3/15/18	Thursday	2	2	0	0
4/5/18	Thursday	11	0	11	0
4/8/18	Sunday	2	0	2	0
4/19/18	Thursday	8	0	8	0
4/22/18	Sunday	2	0	3	1
5/3/18	Thursday	11	0	11	0
5/6/18	Sunday	7	0	7	0
5/13/18	Sunday	2	0	2	0
5/17/18**	Thursday	0	0	0	0
6/3/18	Sunday	0	0	0	0
6/7/18	Thursday	10	0	11	1
6/10/18	Sunday	7	0	7	0
6/21/18	Thursday	10	0	13	3

*3/1/18 – Canceled due to weather.
**5/17/18 – Canceled; no sign-ups.
***6/3/18 – Canceled; no sign-ups.

Appendix 2 (cont.). Tour Data July 1, 2018 – December 31, 2018 (pre special conditions)

Tour Date	Day	Participants	Walk in	Reservation	No Show
7/1/18	Sunday	9	0	11	2
7/5/18	Thursday	13	0	13	0
7/8/18	Sunday	9	0	10	1
7/19/18*	Sunday	0	0	0	0
8/2/18**	Thursday	0	0	0	0
8/5/18	Sunday	13	0	15	2
8/12/18	Sunday	2	0	2	0
8/16/18	Thursday	9	0	9	0
9/2/18	Sunday	18	0	18	0
9/6/18	Thursday	6	0	6	0
9/9/18	Sunday	5	0	5	0
9/27/28	Thursday	14	0	15	1
10/4/18	Thursday	10	0	12	2
10/14/18	Sunday	8	0	8	0
11/1/18***	Thursday	0	0	0	0
11/11/18	Sunday	7	0	7	0
12/2/18	Sunday	6	0	8	2
12/6/18****	Thursday	0	0	0	0
2018 TOTAL	**-**	**224**	**5**	**234**	**15**

*7/19/18 – Canceled; no sign-ups.
**8/2/18 – Canceled; no sign-ups.
***11/1/18– Canceled; no sign-ups.
****12/6/18– Canceled; no sign-ups.

Appendix 3. Avian Wildlife Impact Data, January 1, 2023 – June 30, 2023

Tour Date	Day	Species Present	Species Flushed
1/5/23*	Thursday	-	-
1/14/23*	Saturday	-	-
2/2/23	Thursday	BLPH, BLOY, CANG, PECO, SAPH, SAND	CANG, SAPH
2/11/23	Saturday	AMOY, BLPH, BRCO, PECO, SAPH, YRWA, WEGU	-
3/2/23	Thursday	BLPH, CAGO, GREG, SAPH, WEGU	SAPH
3/11/23*	Saturday	-	-
3/16/23	Thursday	BLPH, CAGO, SAPH, WEGU	-
3/25/23	Saturday	BLPH, BLOY, CAGU, SNEG	-
4/6/23	Thursday	BRCO, CAGO, DCCO, SNEG, NRWS, WEGU	DCCO
4/8/23	Saturday	WEGU, MALL, BLOY, CAGO, BASW, SOSP, WCSP, BLPH	BLPH
4/20/23	Thursday	RTHA, CANG, BASW, WEGU, SNEG, BLPH, LBCU, MALL	BLPH
4/22/23	Saturday	CANG, GREG, WEGU, MALL, SNEG, CLSW	-
5/4/23	Thursday	BASW, SNEG, WEGU, WHIM	-
5/13/23	Saturday	WEGU, LBCU, SNEG, PECO, CAGO, CLSW, BLPH, BRPE, PIGU	BLPH
5/18/23	Thursday	BLPH, CLSW, DCCO, PIGU, WEGU	DCCO
5/27/23	Saturday	BLPH, PIGU, ROPI, WEGU	BLPH
6/01/23	Thursday	BASW, PIGU, WEGU	BLPH
6/10/23	Saturday	BASW, BLPH, CANG, PIGU, WEGU	-
6/15/23	Thursday	BASW, BLPH, CAGO, WEGU	-
6/24/23	Saturday	CANU, SOSP, TUVU, WEGU	WEGU

*1/5/23, 1/14/23, and 3/11/23 – Canceled due to weather. No biological data collected.

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BEWR** -Bewick's wren, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **DCCO** – Double-crested cormorant, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **HEEG** - Heermann's Gull, **KILL** – Killdeer, **LBCU** – Long-billed curlew, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **OSPR** – Osprey, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WHIM** – Whimbrel, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, July 1, 2022 – December 31, 2022

Tour Date	Day	Species Present	Species Flushed
7/7/22*	Thursday	BLPH, BRCO, PECO, PIGU, WEGU	-
7/9/22*	Saturday	BLPH, BRCO, DCCO, GBHE, PECO, PIGU, SNEG, WEGU,	-
7/21/22*	Thursday	BLPH, BRCO, WEGU	-
7/23/22*	Saturday	BRCO, BLPH, HEEG, LBCU, WEGU	-
8/4/22	Thursday	BLPH, BRCO, CLSW	BRCO, WEGU
8/13/22*	Saturday	BRCO, BLPH, GREG, LBCU, SNEG, WEGU	-
8/18/22	Thursday	BLPH, BRCO, GBHE, HEEG, WEGU	LBCU, WEGU
8/27/22	Saturday	BRCO, BLPH, SNEG, WEGU, WHIM	GBHE, WEGU
9/1/22*	Thursday	BRCO, DCCO, WEGU	-
9/10/22*	Saturday	BLOY, BLPH, BRCO, PECO, SAND, WEGU, WHIM	-
9/15/22*	Thursday	BLOY, BLPH, BRCO, PECO, WEGU	-
9/24/22	Saturday	BRCO, OSPR, RNPH, SNEG, WEGU, WHIM	OSPR, SNEG, WHIM
10/06/22	Thursday	BLOY, BRCO, WEGU, WHIM	WHIM
10/15/22	Saturday	AMCR, BLPH, BRCO, OSPR, PECO	OSPR
11/3/22	Thursday	AMCR, BLPH, BRCO, SAPH, WEGU	AMCR
11/12/22	Saturday	SNEG, TUVU, BRCO, BEWR	TUVU, BEWR
12/1/22	Thursday	BRCO, PECO, WEGU	WEGU
12/10/22**	Saturday	-	-

*7/7/22, 7/9/22, 7/21/22, 7/23/22, 8/13/22, 9/1/22, 9/10/22, 9/15/22 – No birds flushed.
**12/10/22 – Canceled due to weather. No biological data collected.

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BEWR** -Bewick's wren, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **DCCO** – Double-crested cormorant, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **HEEG** - Heermann's Gull, **KILL** – Killdeer, **LBCU** – Long-billed curlew, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **OSPR** – Osprey, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WHIM** – Whimbrel, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, January 1, 2022 – June 30, 2022

Tour Date	Day	Species Present	Species Flushed
1/2/22*	Thursday	-	-
1/8/22*	Saturday	-	-
2/3/22*	Thursday	-	-
2/12/22*	Saturday	-	-
3/3/22*	Thursday	-	-
3/12/22*	Saturday	-	-
3/17/22*	Thursday	-	-
3/26/22*	Saturday	-	-
4/7/22**	Thursday	AMCO, BRCO, CAGO, CAGU, MALL	-
4/9/22**	Sunday	AMWI, BRCO, CAGO, MALL, PIGU, WEGU, WHIM	-
4/21/22**	Thursday	AMWI, BRCO, CAGO, MALL, PIGU, WEGU, WHIM	-
4/23/22**	Saturday	BARS, BRCO, BLPH, CAGO, CORA, MALL, WEGU, SNEG, WHIM	-
5/5/22**	Thursday	BLPH, BRCO, CAGO, CAGU, KILL, PECO, WEGU -	KILL
5/14/22**	Saturday	GBHE, BRCO, PECO, WEGU, RTHA, MALL, YELE, RNFA, WHIM, PIGU, WEGU	-
5/19/22**	Thursday	BARS, BLPH, BRCO, BRPE, PIGU, VGSW, WEGU	-
5/28/22	Saturday	WEGU, BRCO, PECO, BASW, TUVU, AMCR, BRPE, PIGU, BLPH	TUVU
6/2/22	Thursday	BRCO, BRPE, WEGU	BRPE, WEGU
6/11/22	Saturday	BLPH, BRCO, CAGU, CORA, DCCO, HEEG, WEGU	BLPH, CAGU, WEGU
6/16/22	Thursday	BARS, BLPH, BRCO, CAGU, CLSW, COMU, PECO, PIGU, WEGU	WEGU
6/25/22	Saturday	BARS, BLPH, BRCO, PIGU, SAPH, WEGU	WEGU

*1/6/22 - 3/26/22 – Canceled due to COVID-19 impacts. No biological data collected.
** 4/7/22, 4/9/22, 4/21/22, 4/23/22, 5/5/22, 5/14/22, 5/19/22 – No birds flushed.
AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BEWR** -Bewick's wren, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **DCCO** – Double-crested cormorant, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **HEEG** – Heermann's gull, **KILL** – Killdeer, **LBCU** – Long-billed curlew, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **OSPR** – Osprey, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot,

RNPH – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WHIM** – Whimbrel, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, July 1, 2021 – December 31, 2021

Tour Date	Day	Species Present	Species Flushed
7/1/21*	Thursday	-	-
7/11/21*	Sunday	-	-
7/15/21*	Thursday	-	-
7/25/21*	Sunday	-	-
8/5/21*	Thursday	-	-
8/8/21*	Sunday	-	-
8/19/21*	Thursday	-	-
8/22/21*	Sunday	-	-
9/2/21*	Thursday	-	-
9/12/21*	Sunday	-	-
9/16/21*	Thursday	-	-
9/26/21*	Sunday	-	-
10/7/21*	Thursday	-	-
10/10/21*	Sunday	-	-
11/4/21*	Thursday	-	-
11/14/21*	Sunday	-	-
12/2/21*	Thursday	-	-
12/5/21*	Sunday	-	-
2021 TOTAL	-	-	-

*7/1/21 – 12/5/21 – Canceled due to COVID-19 impacts. No biological data collected.

Appendix 3 (cont.). Avian Wildlife Impact Data, January 1, 2021 – June 30, 2021

Tour Date	Day	Species Present	Species Flushed
1/7/21*	Thursday	-	-
1/10/21*	Sunday	-	-
2/4/21*	Thursday	-	-
2/14/21*	Sunday	-	-
3/4/21*	Thursday	-	-
3/14/21*	Sunday	-	-
3/18/21*	Thursday	-	-
3/28/21*	Sunday	-	-
4/1/21*	Thursday	-	-
4/11/21*	Sunday	-	-
4/15/21*	Thursday	-	-
4/25/21*	Sunday	-	-
5/6/21*	Thursday	-	-
5/9/21*	Sunday	-	-
5/20/21*	Thursday	-	-
5/23/21*	Sunday	-	-
6/3/21*	Thursday	-	-
6/13/21*	Sunday	-	-
6/17/21*	Thursday	-	-
6/27/21*	Sunday	-	-

*1/4/21 - 6/27/21 – Canceled due to COVID-19 impacts. No biological data collected.

Appendix 3 (cont.). Avian Wildlife Impact Data, July 1, 2020 – December 31, 2020

Tour Date	Day	Species Present	Species Flushed
7/2/20*	Thursday	-	-
7/12/20*	Sunday	-	-
7/16/20*	Thursday	-	-
7/26/20*	Sunday	-	-
8/6/20*	Thursday	-	-
8/9/20*	Sunday	-	-
8/20/20*	Thursday	-	-
8/23/20*	Sunday	-	-
9/3/20*	Thursday	-	-
9/13/20*	Sunday	-	-
9/17/20*	Thursday	-	-
9/27/20*	Sunday	-	-
10/1/20*	Thursday	-	-
10/11/20*	Sunday	-	-
11/5/20*	Thursday	-	-
11/8/20*	Sunday	-	-
12/3/20*	Thursday	-	-
12/6/20*	Sunday	-	-
2020 TOTAL	**-**	**-**	**-**

*7/2/20 - 12/6/20 – Canceled due to COVID-19 impacts. No biological data collected.

Appendix 3 (cont.). Avian Wildlife Impact Data, January 1, 2020 – June 30, 2020

Tour Date	Day	Species Present	Species Flushed
1/2/20	Thursday	AMCO, AUWA, BLPH, BRCO, GCSP, MALL, NOHA, PIGU, SAPH, WEGU	BLPH, AUWA
1/12/20*	Sunday	AMCO, BLPH, BRCO, CAGO, COHA, GREG, MALL, PECO, SAPH, SNEG, WEGU	-
2/6/20	Thursday	BRCO, SNEG, WEGU	SNEG
2/9/20*	Sunday	BRCO, GREG, WEGU	-
3/5/20	Thursday	CAGO, GREG, MALL, PECO	MALL
3/8/20	Sunday	AMCO, BRCO, CAGO, CITE, MALL, SNEG, WHIM	BRCO, CITE, MALL, SNEG
3/19/20**	Thursday	-	-
3/22/20**	Sunday	-	-
4/2/20**	Thursday	-	-
4/5/20**	Sunday	-	-
4/16/20**	Thursday	-	-
4/26/20**	Sunday	-	-
5/7/20**	Thursday	-	-
5/10/20**	Sunday	-	-
5/21/20**	Thursday	-	-
5/24/20**	Sunday	-	-
6/4/20**	Thursday	-	-
6/14/20**	Sunday	-	-

* 1/12/20 and 2/9/20 - No birds flushed.

**3/19/20 - 6/28/20 – Tours canceled due to COVID-19 impacts. No biological data collected.

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **AUWA** – Audubon's warbler, **BARS** – Barn swallow, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CITE** – Cinnamon Teal, **CLSW** – Cliff swallow, **CORA** – Common raven, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **KILL** – Killdeer, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, April 14, 2019 – June 30, 2019

Tour Date	Day	Species Present	Species Flushed
4/14/19	Sunday	AMCO, BLOY, BRCO, CCGO, GREG, MALL, SNEG, WEGU	BLOY, CCGO, MALL
4/18/19	Thursday	BLOY, BRCO, MALL, SNEG, SOSP, WEGU	BLOY, MALL, SNEG
5/2/19	Thursday	CCGO, BRBL, GREG, KILL, MALL, RSHA, WEGU	BRBL, CAGO, GREG, MALL, WEGU
5/5/19*	Sunday	No tour	No tour
5/12/19	Sunday	MALL, NOMO RNPH, WEGU, WESA	WESA
5/16/19	Thursday	BLPH, BRCO, GREG, KILL, MALL, RNPH, WEGU	MALL
6/2/19	Sunday	BARS, BLPH, MALL, PIGU, WEGU, WESA	BLPH, MALL WESA
6/6/19	Thursday	AMRO, BARS, BLPH, BRCO, BRBL, CAGO, CLSW, GREG, MALL, PECO, PIGU, WEGU	CAGO, GREG, PIGU, WEGU
6/9/19	Sunday	BARS, BLPH, BRCO, KILL, PIGU, RWBL, SOSP, WEGU	BARS, BLPH, PIGU, RWBB
6/20/19	Thursday	AMCR, BARS, BLPH, BRCO, PIGU, WEGU	BLPH, PIGU, WEGU

*5/5/19 - No tour; no participants

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **KILL** – Killdeer, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **PECO** – Pelagic cormorant, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WESA** – Western sandpiper

Appendix 3 (cont.). Avian Wildlife Impact Data, July 1, 2019 – December 31, 2019

Tour Date	Day	Species Present	Species Flushed
7/7/19	Sunday	BARS, BHCO, BRPE, GREG, WEGU	GREG, WEGU
7/11/19	Thursday	CAGU, CORA, NOHA, PECO, PIGU, WEGU	PECO
7/14/19	Thursday	AMCR, CAGU, PECO, WEGU	WEGU
7/18/19	Thursday	AMCO, BARS, CLSW, WEGU	WEGU
8/1/19	Thursday	CORA, MALL, PECO, RNPH, SNEG	MALL, RNPH
8/4/19	Sunday	GBHE, PIGU, SNEG, WEGU	GBHE, SNEG
8/11/19	Sunday	GBHE, GREG, PECO, RNPH, SNEG, WESA	GREG, WESA
8/15/19	Thursday	BARS, GBHE, GREG, PECO, WESA	GBHE, GREG
9/1/19	Sunday	CAGU, PECO, SNEG	SNEG
9/5/19	Thursday	BLPH, GREG, PECO, SNEG, WEGU	GREG, SNEG
9/8/19	Sunday	NOHA, PECO, SAND, WEGU, WHIM	NOHA
9/19/19	Thursday	GREG, GRHE, PECO, RNPH, RTHA, SAND, WEGU	GRHE, PECO, RTHA
10/3/19	Thursday	BLPH, BRPE, CAGU, KILL, PECO, SAPH, SNEG, WHIM	BLPH, CAGU, SAPH, SNEG
10/13/19	Sunday	BLPH, NOHA, PECO, SOSH, WEGU	NOHA
11/7/19	Thursday	AMWI, BLPH, BRAN, PECO, RTHA, SAPH, WEGU	BLPH, RTHA
11/10/19*	Sunday	CLSW, PECO, TUVU	-
12/1/19**	Sunday	-	-
12/9/19	Thursday	AMWI, BLPH, BRPE, PECO, SNEG, WEGU	BLPH

* 11/10/19 – No birds flushed.
*12/1/19 – No biological data collected.

AMCO – American coot, **AMCR** – American crow, **AMRO** – American robin, **AMWI** – American whimbrel, **BARS** – Barn swallow, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRCO** – Brand's cormorant, **BRAN** – Brant, **BRBL** – Brewer's blackbird, **BRPE** – Brown pelican, **CAGU** – California Gull, **CCGO** – Canada goose, **CLSW** – Cliff swallow, **CORA** – Common raven, **GBHE** – Great blue heron, **GREG** – Great egret, **GRHE** – Green heron, **KILL** – Killdeer, **MALL** – Mallard, **NOHA** – Northern harrier, **NOMO** – Northern mockingbird, **PECO** – Pelagic cormorant, **HEEG** - Heermann's Gull, **PIGU** – Pigeon guillemot, **RNPH** – Red-necked phalarope, **RSHA** – Red-shouldered hawk, **RWBL** – Red-winged blackbird, **SAND** – Sanderling, **SAPH** – Say's phoebe, **SNEG** – Snowy Egret, **SOSP** – Song sparrow, **TUVU** – Turkey vulture, **WEGU** – Western gull, **WESA** – Western sandpiper

Appendix 4. Paid Advertisement Documentation January 1, 2023 – June 30, 2023

Figure 18. Paid advertisement that ran in the Santa Cruz Sentinel during this reporting period.

Figure 19. Paid advertisement that ran in the Good Times Weekly during this reporting period.

90.3 kazu
npr for Monterey, Salinas, & Santa Cruz
a community service of CSU Monterey Bay

100 Campus Center, Bldg. 201 Room 317
Seaside, CA 93955

INVOICE

Contract
Contract Date 03/14/23
Billing Date 03/31/23

YOUNGER LAGGON
RESERVE 100 MCALLISTER
WAY SANTA CRUZ, CA 95060

Younger Lagoon Reserve

Aired Spots 3/1/2023 thru 3/31/2023 PO #

Description	Day	Date	Time	Copy	Dura	Amount
Younger Lagoon Reserve - Wknds	Sat	03/25/23	9:58:30a	126259	15	30.00
	Sun	03/26/23	9:06:00a	126259	15	30.00
	Sun	03/26/23	4:18:45p	126259	15	30.00
Younger Lagoon Reserve - Bonus AA	Mon	03/27/23	8:59:00a	126259	15	0.00
	Thu	03/30/23	3:48:45p	126259	15	0.00
	Fri	03/31/23	6:29:45p	126259	15	0.00
Younger Lagoon Reserve - Classical HD-2	Mon	03/27/23	6:59:30p	126259	15	0.00
	Tue	03/28/23	6:18:15p	126259	15	0.00
	Wed	03/29/23	12:44:15p	126259	15	0.00
	Thu	03/30/23	9:59:30a	126259	15	0.00
	Thu	03/30/23	3:59:15p	126259	15	0.00
	Fri	03/31/23	7:18:15a	126259	15	0.00
	Fri	03/31/23	6:18:15p	126259	15	0.00

Total Number of Spots 13

Net Total Due	90.00
Amount Paid This Period	$0.00
Previous Amount Billed	$0.00
Previous Amount Paid	$0.00
Amount Due to Keep Contract Current	**$90.00**

Original Contract Amount $1,200.00 *Payments Are Monthly Per Credit*

For Billing Questions, please contact the KAZU Business Office at (831) 582-5298

Page No. 1

Figure 20. Invoice for KAZU radio announcements during this reporting period.

Appendix 6. Publications

Biological Conservation 280 (2023) 109956

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Lessons learned from an interdisciplinary evaluation of long-term restoration outcomes on 37 restored coastal grasslands in California

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ARTICLE INFO

Keywords:
Biodiversity
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Mitigation
Revegetation
Science-practice gap
Statutory management

ABSTRACT

Governmental and non-governmental organizations spend considerable funding on restoring ecosystems to counter biodiversity loss, yet outcomes are often not assessed at a regional scale. Monitoring is done ≤5 years after project-implementation, if at all, and rarely assesses the effects of management practices on project success. We combined vegetation surveys and management interviews to compare long-term restoration outcomes of 37 California coastal grassland projects (5–33 y post-implementation) that spanned a 1000-km north-south gradient. We found that coastal grassland restoration is largely successful at reaching project goals (95 %) and a standard performance metric (80 %) to restore native cover, but land managers preferentially use a small number of well-tested, "high success" species, potentially at the expense of regional diversity. Medium and high maintenance intensity resulted in lower non-native cover and improved native cover and rarefied native richness. Managers of voluntary (non-statutory) sites were more open to assessing outcomes and spent less per hectare compared to legally mandated (statutory) projects but achieved similar plant cover and even higher rarefied richness. Statutory project managers indicated that regulatory agencies sometimes lowered compliance goals for native cover if the initial targets were not met. Additional funding for greater maintenance intensity and incorporating more locally distinctive species (*i.e.*, endemic or range-restricted) may help counteract potential unintended consequences from preferential plant selection, and inter-agency coordination of species selection could reduce biotic homogenization. We recommend delegating funds to a third-party monitoring group to ensure legally mandated compliance and consistency in assessment.

1. Introduction

Governments, conservationists and land managers make large expenditures to restore ecosystems (BenDor et al., 2015; Bernhardt et al., 2005; Menz et al., 2013) but outcomes vary greatly, and projects are seldom monitored after implementation (Bernhardt et al., 2005; Li et al., 2019). Project assessment is important to ensure goals are reached, adaptive management applied, and successful practices identified (Dickens and Suding, 2013; Mönkkönen et al., 2009). Project assessment of restoration outcomes typically only occur for legally-mandated (statutory) projects over the short-term (≤5 years), and rarely compare multiple sites (Bernhardt et al., 2005; Wyżga et al., 2021). Yet restoration project evaluation at a regional scale can help elucidate the effects of management on outcomes that cannot be observed at a single site (Bernhardt et al., 2005; Holl et al., 2022), and long-term data are required to develop strategies for adaptive management. For example, Matthews and Spyreas (2010) found initial recovery after wetland restoration but in later years found the plant community became homogenized by reinvasion.

Biotic homogenization across multiple levels of diversity after ecological restoration is a growing concern (Holl et al., 2022; Matthews and Spyreas, 2010; Zhang et al., 2022). Restoration practitioners make intentional choices during plant selection to maximize success and minimize risk (Lesage et al., 2020), however, these choices may have unintended consequences. For example, Lesage et al. (2018), found that practitioners tend to use perennial species that are more likely to persist over multiple years, resulting in loss of annual species diversity. Similarly, Talal and Santelmann (2020) found that land managers sometimes have multiple goals related to aesthetics and human safety that may exclude the use of certain native species to ensure all goals are met.

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Furthermore, biotic homogenization can be compounded by changing climatic conditions and land uses that promote biological invasions and fast-growing species (Holl et al., 2022; Matthews and Spyreas, 2010).

Restoration management decisions affect ecological outcomes (Burnett et al., 2019; Guiden et al., 2021; Lesage et al., 2018) but are often not considered (Cabin et al., 2010; Dickens and Suding, 2013) simultaneously with ecological data (Bernhardt et al., 2005; Wyżga et al., 2021). These management decisions are influenced by individual management ideologies, project-based goals, local habitat conditions, and legal requirements (Cabin, 2007; Hagger et al., 2017; Kull et al., 2015). For example, risk averse land managers may avoid species that grow slowly or have low survival due to a desire for achieving timebound project goals (Lesage et al., 2018). In addition, propagation methods often are not documented for the vast diversity of species that could be used for restoration (Bartholomew et al., 2022; Ladouceur et al., 2018). Integrating management perspectives and local ecological knowledge can improve understanding of restoration outcomes by providing context and justification for the use of certain species and management choices (Bernhardt et al., 2005; Cabin, 2007; Wagner and Davis, 2003).

We assessed restoration outcomes against project goals and a standard performance metric for 37 coastal grassland restoration projects across a 1000-km span in California, USA (Fig. 1; Barbour et al., 2007) to answer (1) whether restoration projects are meeting site-level targets for native cover and richness; and (2) how successful projects are in restoring plant diversity at a regional scale. We combined vegetation surveys, document analysis, and interviews with land managers to (3) determine which ecological, financial, and management factors most strongly affected (1) and (2). We hypothesized that most projects would not achieve ecological targets due to strong competition from non-native species (Matthews and Spyreas, 2010; Pearson et al., 2016) and a lack of funding for ongoing site management. At the regional scale, we anticipated that land managers would preferentially use a subset of species that have been demonstrated to establish well in many projects due to concerns about regulatory compliance (Lesage et al., 2018).

Finally, we highlight unexpected differences in results from statutory and voluntary projects. Restoration projects are motivated by a range of goals, including compliance with legislation (Holl, 2020). Some grassland restoration projects in coastal California are legally-mandated by county general plans or regional regulatory agencies ("statutory projects") and others are undertaken voluntarily ("voluntary projects") when a manager had a keen interest in restoration or discretionary funds (Hagger et al., 2017). Due to their inherent differences, statutory and voluntary projects have different project constraints, approaches, and monitoring goals. For example, past studies suggest voluntary projects tend to have limited monitoring due to budget limitations (Brancalion et al., 2019; Mönkkönen et al., 2009). However, practitioners who create voluntary restoration projects may have greater intrinsic motivation for undertaking the project compared to mandated statutory projects (Bittmann and Zorn, 2020; Mönkkönen et al., 2009) and may use innovative methods for habitat restoration due to limited funding and fewer legal requirements (Hagger et al., 2017).

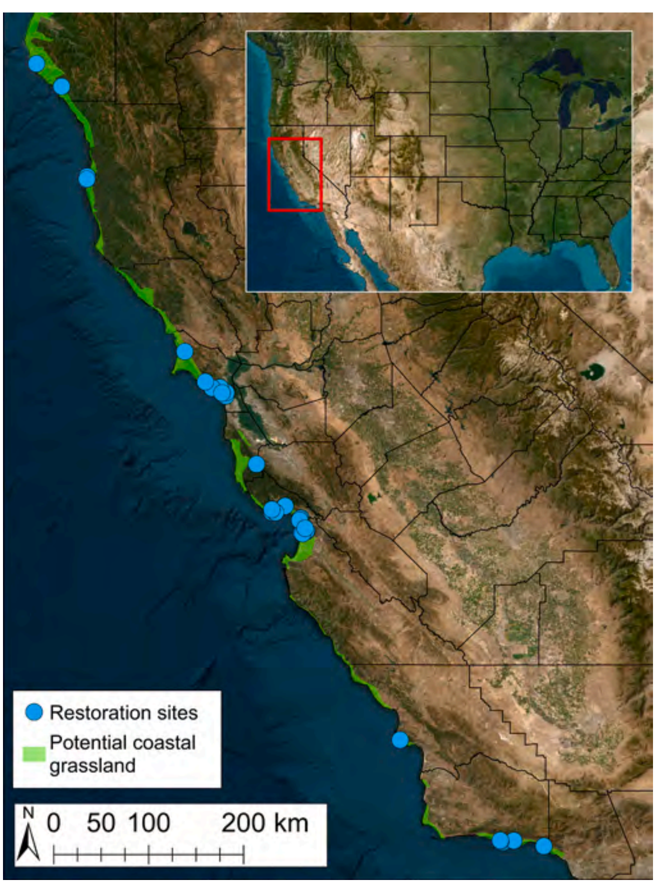

Fig. 1. Study region, restoration sites, and extent of historic coastal grassland habitat in California, USA.

2. Materials and methods

2.1. Study area

California is a biodiversity hotspot (Myers et al., 2000) and its grasslands host nearly 90 % of the state's endangered and threatened plant species (Eviner, 2016). California coastal grasslands evolved with maritime fog during otherwise hot, dry summers, and are one of the most diverse grassland types in North America with numerous forb species (Ford and Hayes, 2007). The extent of these native grasslands has been reduced by 99 % due to urban development, conversion to agricultural lands, and altered disturbance regimes, and non-native species dominate most of the remaining coastal grassland (Ford and Hayes, 2007). Hence, they are the focus of extensive restoration efforts (Stromberg et al., 2007) and often designated as environmentally sensitive habitat areas (California Coastal Act, 1976).

2.2. Ecological field surveys

Study sites (SI Table 1) spanned a 1000-km distance from Carpinteria (Santa Barbara County) to Petrolia (Humboldt County), CA, USA (Fig. 1; Barbour et al., 2007), covering approximately 90 % of the extant range for California coastal grasslands. Average annual temperature and precipitation at the southern end of the gradient is 15.0 °C and 451 mm, as compared to 11.6 °C and 1002 mm at the northern end (30-year average from 1990 to 2019; SI Table 2). Precipitation was within 25 % of the long-term average for most sites during the first (2019) and third (2021) sampling years, but the second year (2020) had much lower precipitation (SI Table 2). For this study, we selected restoration sites that were: 1) actively "reconstructed" *via* planting or seeding native plants, 2) ≥3 years post-implementation, 3) ≥0.5 ha, and 4) experience summertime coastal fog (Ford and Hayes, 2007). Regular presence of coastal summertime fog was confirmed by land managers during site selection. We chose to focus on sites that were actively "reconstructed" *sensu* Gann et al., 2019, because we wanted to assess whether the most intensive grassland restoration efforts were successful, and because grassland plants tend to be strongly dispersal limited (Kiviniemi and Eriksson, 1999; Pinto et al., 2014). California grasslands are dominated by invasive non-native species, so invasive management alone is rarely successful, particularly in sites that have been used for agriculture and have depleted native seed banks (Hayes and Holl, 2003; Stromberg et al., 2007). As such, active reintroduction through planting or seeding is often required to recover local biodiversity. Moreover, invasive control methods and intensity vary widely making comparisons challenging.

We conducted vegetation surveys at 37 restored coastal grasslands during the peak growth season for Mediterranean climates (April–June) over a three-year period: 32 sites in 2019, 19 in 2020, and 34 in 2021 (SI Table 1). We monitored for multiple years because grassland ecosystems can show strong interannual variation (Zhu et al., 2016). The projects ranged from 5 to 33 years post-implementation by 2021. Through our exhaustive search for all restored coastal grasslands in California, we contacted 213 land managers, researchers and government officials to identify all potential study sites that met our criteria. In 2020 and 2021 we resurveyed the original 32 sites where possible given COVID-19 travel and access limitations (SI Table 1). We identified 16 additional sites that fit our surveying criteria through management interviews after 2019 surveys. We could not survey eight of these newly identified statutory projects because land managers would not permit access. We surveyed four additional projects (one statutory, three voluntary) in 2021 and did not survey the other four newly identified voluntary projects because they were executed by agencies for which we already had surveyed four or more sites.

At each site, we estimated absolute plant cover at the species-level in 0.25-m^2 quadrats every 5-m along 50-m transects (11 quadrats per transect). We estimated plant cover to the nearest 1 % for cover ≤10 %, and for cover >10 % we estimated cover into 5 % bins (*e.g.*, 10–15 % … 95–100 %). We used 3–16 transects scaled for project area which ranged from 0.5 to 13 ha.

2.3. Management data

We reviewed available documents to determine project: 1) restoration goals, 2) age and area, 3) planting composition, and 4) voluntary (projects that had no legal requirement or incentive) or statutory status. Documents included any plans or permit applications that were completed prior to implementation, but only 25 % of projects had documents. We asked land managers to provide information on these four topics during semi-structured interviews if a project did not have documentation.

Management interviews can help contextualize patterns observed from vegetation surveys that are not always readily apparent (Cabin et al., 2010; Homewood et al., 2001) and help guide better allocation of resources to improve future restoration efforts. We conducted semi-structured interviews with restoration managers individually through video meetings and asked about restoration practices, financial and labor investment, plant selection, and perceived barriers to restoration goals (full interview guide in Appendix A). For interview consistency, the same person (JCL) conducted all the interviews. Semi-structured interviews have guiding topics but are flexible to allow the participant to direct the conversation (Dunn, 2000). Semi-structured interviews were conducted after the first round of vegetation surveys in 2019 because we asked managers to reflect on their specific project outcomes, as measured by our field surveys. Although there were 37 projects, we conducted 26 interviews because, in some cases, multiple sites (up to five) were managed by one agency. In such instances, we interviewed two land managers when possible. Managers of two statutory projects elected to not participate in interviews. Interviews and document analyses were approved by the University of California Institutional Review Board.

2.4. Assessing restoration outcomes

Original project targets were used to determine whether restoration efforts achieved project-based goals using plant community data. Because projects had different targets, we compared project outcomes relative to a standard performance metric of ≥25 % native cover and ≥5 native species. Although 25 % cover may appear to be a low target, California grasslands are highly susceptible to invasion, making it difficult to achieve high native cover (Ford and Hayes, 2007; Stromberg et al., 2007), so statutory requirements typically require projects to achieve between 25 and 50 % native cover. Moreover, the classification of native grasslands in California only requires >10 % native cover (Barbour et al., 2007). A global review also indicated that 20 % native cover is a typical goal for working lands (Garibaldi et al., 2021). We used a singular numeric target for species richness to be consistent with how projects are designed and monitored for statutory compliance but acknowledge that this could contribute to a bias of higher success for larger projects due to higher sampling effort and a well-established species-area relationship (MacArthur and Wilson, 1967).

To determine site-level plant cover we first averaged cover by species identity across the 11 quadrats for each transect, and then averaged cover by species across all transects for each site. To determine native and non-native cover we summed cover of all native and non-native species within each quadrat along a transect and then averaged values of native and non-native cover the same as for site-level species cover. We quantified site-level native species richness ("raw native richness") by summing the total number of native taxa at a site, as we were only interested in native taxa. We calculated native rarefied species richness using `rarefy` through the VEGAN package (Oksanen et al., 2018; R Core Team, 2020) to correct for differences in the number of transect per site and potential undersampling. Rarefied native richness was calculated for each site at the quadrat level, which consisted of 33–176 sampling points, dependent on site size. For assessing whether projects reached targets, we compared plant cover and raw native richness (number of native taxa) with both project-based goals and our standard performance metric. For statistical models we used rarefied native richness (Oksanen et al., 2018), though results using raw and rarefied native richness were similar. All values were calculated per sampling year and compared at the site-level (n = 37). Trends in plant metrics (native and non-native cover and native richness) were similar across years despite differences in annual precipitation (SI Table 2). For simplicity, we use the most current annual (2021) vegetation data when possible and 2019 data for projects with no 2021 data. We used 2019 and not 2020 data for projects with no 2021 data because 2019 and 2021 were more climatically similar (SI Table 2).

We used generalized linear models (GLMs) to examine the relationships between cost per hectare and post-implementation project with native cover, non-native cover and rarefied native richness (SI Table 3). Using one-tailed Spearman's rank correlation tests, we evaluated the relationship between the number of restoration species used against both cost per hectare and rarefied native richness (SI Table 3). We used analysis of variance with a covariate (ANCOVA) of post-implementation project age to test the effect of our independent variable, maintenance intensity (low = no or annual non-targeted biomass control; medium = targeted invasive control annually twice or more and low-cost seeding; high = periodic invasive control, permanent staff, replanting efforts; Appendix B for more details) on plant cover, rarified native richness, and cost per hectare. We compared plant metrics between statutory and voluntary projects using *t*-tests (SI Table 3). Analyses were completed in R (v4.0.3; R Core Team, 2020) and maps were created using ArcGIS (v10.8.2; ESRI).

3. Results

3.1. Project outcomes

Native species cover ranged from 2 to 74 %, raw native richness ranged from 3 to 65 and rarefied native richness ranged from 5 to 107. Non-native cover ranged from 10 to 110 % and raw non-native richness ranged from 12 to 53. Forty-three percent of surveyed projects were statutory and 57 % were voluntary. Project related costs ranged from \$371 to \$66,718/ha with an average cost of \$26,579 ± \$24,031/ha.

Project-based goals for voluntary projects all were directional, either for increasing native cover or decreasing non-native cover or erosion. Prior to 2000, statutory projects mostly had directional goals, but projects initiated after 2000 all had numeric, time-bound targets (*e.g.*, 25 %

native cover after 5 years). All but two projects reached project-based goals (35/37 = 95 %). However, managers for 25 % (4/16) of statutory projects indicated that targets were reduced by the regulatory agency when they were not reached, so that a project would reach its new, adjusted project-based goal. In all three survey years, ~80 % of surveyed projects reached the standard 25 %-cover metric (2019: 82 %; 2020: 79 %; 2021: 79 %).

Projects with high and medium maintenance intensity had higher rarefied native richness (F = 6.09, $p = 0.007$), native cover (F = 8.84, $p < 0.001$) and lower non-native cover compared to sites with low maintenance (F = 4.41, $p = 0.020$; Fig. 2). However, there was no relationship between annual cost per hectare and plant cover metrics (SI Table 3). Cost per hectare did not differ as a function of maintenance intensity (F = 1.77, $p = 0.196$). On average, high intensity projects spent $31,814 ± $21,921/ha whereas, medium intensity spent $36,242 ± $29,926 and low maintenance projects spent $16,593 ± $20,178. Statutory projects spent more per hectare compared to voluntary projects ($t = 3.00$, $p = 0.007$) but the two types of projects did not differ in native and non-native cover (SI Table 3). However, voluntary projects had higher rarefied native richness compared to statutory sites ($t = 1.99$, $p = 0.027$). Not surprisingly, 81 % of project managers indicated that funding limited management decisions such as plant selection and maintenance intensity.

Project age (years post-implementation) was not significantly correlated with native ($t = 0.67$, $p = 0.509$) or non-native cover ($t = 1.74$, $p = 0.091$; Fig. 3A). Unsurprisingly, native species cover was negatively correlated with non-native cover ($t = -4.30$, $p < 0.001$; Fig. 3B) and positively related to rarefied native richness ($t = 4.79$, $R^2 = 0.379$; $p = 0.032$). As expected, all managers (100 %) indicated that invasive species management was a barrier to achieving project goals and diverted focus from other management activities that could further increase habitat quality. Seventy-eight percent of projects indicated they would have increased maintenance intensity or increased the number of species planted if they had additional financial resources.

All statutory projects undertaken after 2000 had post-implementation monitoring. No voluntary projects had post-implementation monitoring, but 78 % indicated they would monitor if given sufficient funding. Pre-2005 only 10 % of restoration managers believed they could achieve restoration goals but post-2005, 65 % were confident in reaching project goals.

Ninety-two percent of restoration managers preferentially use one or more of the same seven species (*Achillea millefolium*, *Bromus carinatus*, *Danthonia californica*, *Elymus glaucus*, *Festuca rubra*, *Hordeum brachyantherum*, *Stipa pulchra*) for restoration because they anticipate these species will have sufficiently high survival or growth to meet project goals. Half or more of all projects specifically used *S. pulchra* (69 %), *E. glaucus* (59 %), or *B. carinatus* (50 %) for this reason. All preferentially selected species were perennial bunchgrasses (Poaceae), with the exception of

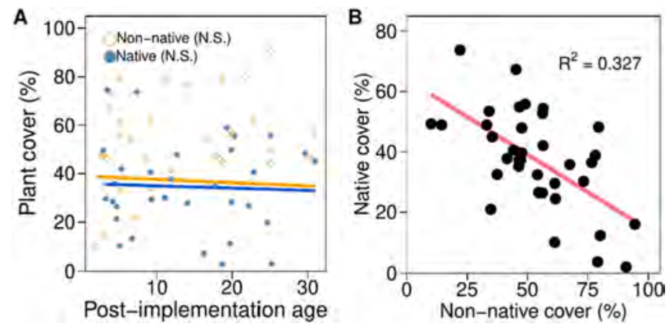

Fig. 3. Relationships (A) between post-restoration age and plant cover, and (B) native cover and non-native plant cover. Points represent restoration sites (n = 37).

A. millefolium (Asteraceae), which is a circumboreal rhizomatous perennial forb present in a range of ecosystem types. These seven species comprised 50 % or more of the native cover at most sites that met the standard performance metric. Most managers indicated they used three to six species for restoration, with a limited number of projects that used more than nine species (Fig. 4A). Notably, seven projects only utilized one species, and none used two. The total number of species used for restoration was weakly, positively correlated with restoration costs per hectare ($r = 0.366$, $p = 0.039$; Fig. 4B) and rarefied native richness ($r = 0.361$, $p = 0.041$; Fig. 4C).

4. Discussion

Contrary to our initial expectations, most coastal grassland restoration projects in California achieved their project-based goals, a standard performance metric, and statutory compliance for native plant cover. Interestingly, voluntary projects achieved similar plant cover and higher native richness compared to statutory projects despite spending less. At a regional scale, we found that managers commonly use a restricted subset of the species pool available for restoration, which can lead to habitat-wide biotic homogenization (Holl et al., 2022). Moreover, our study raised concerns about (1) the lack of openness to compliance monitoring by some statutory project managers; and (2) cases of lowering restoration targets to ensure that projects were compliant with permit requirements. We draw on the important insights and perspectives we gained from project documents, land managers interviews, and restoration in other ecosystems to suggest strategies to address these concerns and more effectively allocate limited financial resources to improve restoration efforts.

Our study uncovered some concerning issues regarding statutory restoration projects. We were given permission by land managers to survey every voluntary project but denied access to a third of identified

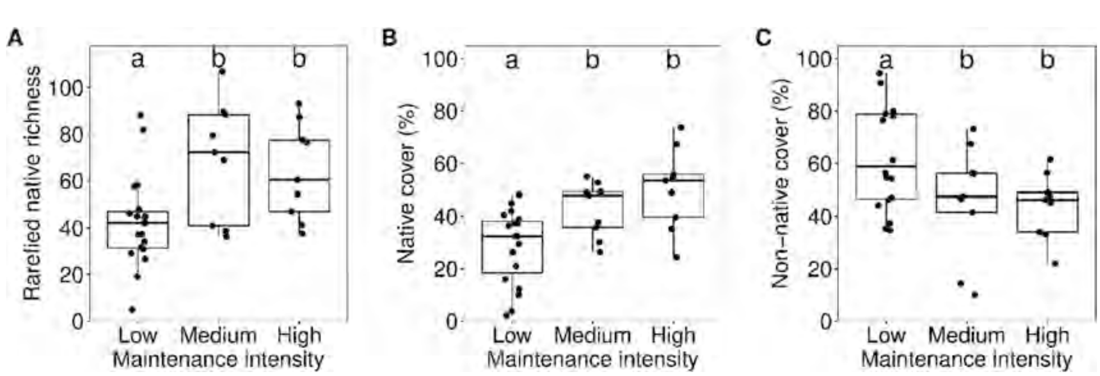

Fig. 2. Relationship of maintenance intensity with (A) rarefied native richness, (B) native cover, and (C) non-native cover across 37 sites using the most current annual data (2021) when possible or data from 2019 when not possible. Points represent restoration sites. See Appendix B for details about classification of maintenance intensity (n = 19 low, 9 medium, 9 high).

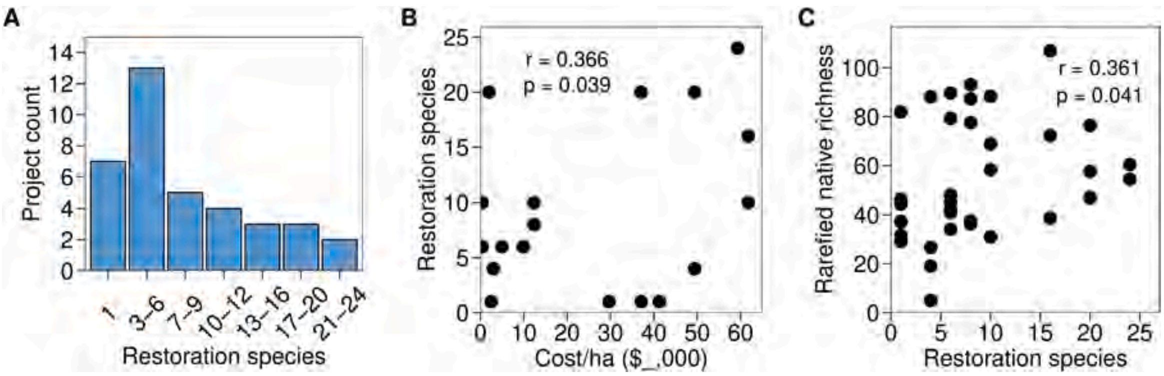

Fig. 4. (A) The binned number of native species planted or seeded ("restoration species") across surveyed restoration projects, (B) relationship between cost per hectare and the number of restoration species; and (C) relationship between the number of restoration species and rarefied native richness. Points in panels B and C represent restoration sites; r = Spearman's correlation efficient.

statutory projects. This raises serious concerns about the rigor with which biodiversity offsets are being monitored (Maron et al., 2016; Theis et al., 2020). Although we can only speculate on the outcomes of access-denied statutory projects, this result indicates that policies are needed to allow independent assessment of statutory projects in perpetuity (Skousen and Zipper, 2014). Although certain legal statutes permit this, the approval process can be time intensive and inconsistent across political boundaries. Indeed, we attempted to gain access to restricted sites, but by the time approval was granted by the responsible agencies, plant identification was not viable, as most species at potential study sites had already set seed, leaving mostly senesced or dormant standing vegetation.

To ensure consistency in statutory monitoring and to ensure ongoing compliance as mandated, we recommend delegating funds and responsibilities through legislation for independent monitoring to a regional agency. For example, under the U.S. Surface Mine Control and Reclamation Act, compliance with reclamation efforts following mining are monitored by trained inspectors who are employed by U.S. government state agencies (Skousen and Zipper, 2014). Government or non-governmental third-party professionals would follow a standard protocol for assessment, which minimizes conflicts of interest with demonstrating compliance with outcomes (Godwin et al., 2021). Ensuring these data are publicly available would further increase transparency in legal compliance when evaluating restoration success (Wallach et al., 2018), and provide information for land managers to adapt future practices.

Our interviews with land managers revealed a troubling result that regulatory agencies sometimes lower baselines for mitigatory statutory projects. The reduction of statutory plant cover targets to meet observed outcomes raises concerns about the widespread use of restoration to mitigate habitat destruction elsewhere (*i.e.* mitigation banking), as restoration efforts rarely reach similar function and diversity as remnant habitats (Bull et al., 2013; Moreno-Mateos et al., 2015; Theis et al., 2020). We have not seen the issue of adjusting targets discussed in the literature but suspect that it may occur in other ecosystem types and think that it is an important area for further investigation. If this is a common practice, then there need to be strict criteria for when these targets are adjusted, implications for offsetting environmental mitigation and a clear record documenting changed goals (Brandt-Hawley, 2021).

Insufficient funding was commonly viewed as a factor limiting restoration success across our interviews (Bayraktarov et al., 2015; Brancalion et al., 2019; Cabin et al., 2010). We, however, suggest that the relationship between the amount of money invested and outcomes is not necessarily linear (Bayraktarov et al., 2019) and funds need to be thoughtfully allocated both within and among projects. In our study, there was no relationship between direct monetary costs and plant cover or maintenance intensity, which is likely due to a few projects in which costs were inflated by other expenditures for consultants or construction (*e.g.*, removing concrete from a retired lumber mill). In contrast, we found that projects with medium and high allocation to maintenance had improved restoration outcomes, which highlights the importance of budgeting for long-term maintenance to increase restoration success (Kimball et al., 2015). Projects with high maintenance had an annual budget for management in perpetuity, which highlights the need for funding pools that focus on long-term stewardship.

Our interview results were consistent with prior research showing that practitioners often plant or seed a small subset of a highly diverse regional species pool in an effort to reduce risk and cost while maximizing success (Barak et al., 2022; Brancalion et al., 2018; Lesage et al., 2018). Heavy reliance on just seven species at the expense of countless other species is cause for concern, as California coastal grasslands are one of the most diverse grassland types in North America with over 400 native plant species (Ford and Hayes, 2007). Over long temporal scales, coastal grasslands may support less regional richness (gamma diversity) as remnant habitat is gradually degraded, and restoration projects commonly reintroduce only a handful of well-tested species (Bartholomew et al., 2022). A growing body of literature suggests that typical restoration species selection practices can lead to biotic homogenization at multiple levels of diversity across a wide variety of ecosystems (Holl et al., 2022; Matthews and Spyreas, 2010; Zhang et al., 2022).

Given that the relationship between project cost and species richness was weak, we think that several strategies besides additional funding could help to increase the number of locally distinctive species (*i.e.*, endemic or range-restricted) used for restoration. Our interviews and other research suggest that the use of fewer species may be due to insufficient information about propagation protocols for a diverse suite of species (Bartholomew et al., 2022; Brancalion et al., 2012; Ladouceur et al., 2018; White et al., 2018). This lack of knowledge, combined with practitioner demand for "high success" species, means that native seed nurseries typically produce a restricted subset of the local and regional species pool (White et al., 2018). Funding for the co-production of scientific studies between scientists and restoration managers can improve knowledge of natural history, propagation protocols and reintroduction methods to address the science-practice gap (Bartholomew et al., 2022; Cabin et al., 2010), and in turn, increase the use of less utilized species (Ladouceur et al., 2018). Regional restoration networks and seed exchange programs can be useful in developing nursery propagation of a wider variety of species (Brancalion et al., 2012). Furthermore, legislative policies could be implemented for statutory restoration to require the use of locally distinctive native species (Chaves et al., 2015), or to designate experimental zones that allow managers to test rarely utilized species and learn through "intelligent tinkering" (Cabin et al., 2010) without risking noncompliance with statutory targets (Holl et al., 2022).

Despite spending less money per area restored, voluntary projects reached similar levels of native and non-native cover, and even higher rarefied native richness. This may be due, in part, to greater intrinsic motivation for undertaking the project compared to mandated statutory projects (Bittmann and Zorn, 2020; Hagger et al., 2017; Mönkkönen et al., 2009; Wagner and Davis, 2003). It also suggests the importance of sharing results from successful projects since they may have innovative methods to achieve similar outcomes with more limited resources. Additional polices that support tax-exemptions for voluntary projects or generate other financial incentives could be a powerful tool for increasing successful restoration efforts in a region (Barrett and Livermore, 1983; Jantz et al., 2007). Our interviews indicated that both voluntary and statutory projects received funding from government and non-profit grants. This funding was in addition to budgeted support from the restoration agency or developer (for statutory projects) responsible for restoration. Such funding could be tied to regional coordination of experimentation with locally distinctive species, ensuring the use of a diverse suite of species and sharing best practices to enhance the restoration success and regional biodiversity.

CRediT authorship contribution statement

JCL, KDH conceived research ideas; JCL, KDH designed field methodology; JCL led site selection and plant surveys; JCL, DMP designed document analysis and interview methodology; JCL led analysis and writing with input from KDH and DMP; JCL, KDH acquired funds.

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Declaration of competing interest

Authors declare no conflict of interests.

Data accessibility

Data used for analyses is available on PANGAEA Data publisher for Earth and Environmental Sciences (doi.org/doi.pangaea.de/10.1594/PANGAEA.945320).

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.biocon.2023.109956.

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Extreme drought impacts have been underestimated in grasslands and shrublands globally

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Climate change is increasing the frequency and severity of short-term (~1 y) drought events—the most common duration of drought—globally. Yet the impact of this intensification of drought on ecosystem functioning remains poorly resolved. This is due in part to the widely disparate approaches ecologists have employed to study drought, variation in the severity and duration of drought studied, and differences among ecosystems in vegetation, edaphic and climatic attributes that can mediate drought impacts. To overcome these problems and better identify the factors that modulate drought responses, we used a coordinated distributed experiment to quantify the impact of short-term drought on grassland and shrubland ecosystems. With a standardized approach, we imposed ~a single year of drought at 100 sites on six continents. Here we show that loss of a foundational ecosystem function—aboveground net primary production (ANPP)—was 60% greater at sites that experienced statistically extreme drought (1-in-100-y event) vs. those sites where drought was nominal (historically more common) in magnitude (35% vs. 21%, respectively). This reduction in a key carbon cycle process with a single year of extreme drought greatly exceeds previously reported losses for grasslands and shrublands. Our global experiment also revealed high variability in drought response but that relative reductions in ANPP were greater in drier ecosystems and those with fewer plant species. Overall, our results demonstrate with unprecedented rigor that the global impacts of projected increases in drought severity have been significantly underestimated and that drier and less diverse sites are likely to be most vulnerable to extreme drought.

climate extreme | Drought-Net | International Drought Experiment | productivity

Most terrestrial ecosystems are impacted to some degree by drought, defined meteorologically as an anomalous period of low precipitation relative to normal (1). While droughts vary widely with respect to severity, duration, and spatial extent, multi-year drought events that incur catastrophic ecological, economic, and societal impacts tend to capture the lion's share of the attention by scientists and the public (e.g., the 1930's US Dust Bowl, ref. 2; the 2000 to 2003 US Southwest drought, ref. 3; the 2012 to 2016 California Drought,

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ref. 4; the 2001 to 2009 Millennium Drought in Australia, ref. 5; the 2015 to 2017 drought in Cape Town, South Africa, ref. 6). Yet, globally most droughts are *short-term*, lasting ~1 y in duration (7). Because short-term droughts are so numerous, they can cause substantial loss of ecosystem functioning at local, regional, and global scales (8, 9). As Earth's climate continues to change, short-term droughts that are statistically extreme in intensity (e.g., rare with respect to the long-term climate record, ref. 10) will become more common (11, 12), with 1-in-100-y droughts potentially happening every 2 to 5 y (7). Indeed, evidence of such drought intensification already exists for some regions (13). Unfortunately, because of the historic rarity of extreme drought, we have limited, and primarily anecdotal, estimates of the magnitude of their ecological consequences.

Knowledge of how short-term extreme drought may alter ecosystem functioning is particularly important for grasslands and shrublands. These ecosystems cover more than 40% of the ice-free terrestrial land surface (14, 15) and are found in every region of the globe (15). Grasslands and shrublands are characterized by high variability and frequent deficits in precipitation (16), and thus, are expected to be the most vulnerable to climate change (17). Moreover, grasslands and shrublands store more than 30% of the global stock of carbon (15) and contribute significantly to variability in global terrestrial carbon sinks (18) and atmospheric CO_2 concentrations (19). Thus, grassland and shrubland ecosystems can be expected to cause greater variation in global carbon cycling with intensifying droughts in the future.

Fortunately, many drought experiments have been conducted in grasslands and shrublands, relative to other ecosystems (e.g., forests, ref. 1), and a consensus has emerged based on recent meta-analyses of these studies. These meta-analyses show the expected—that drought has negative impacts on multiple aspects of ecosystem functioning, particularly those functions related to C cycling (e.g., productivity)—but also that considerable variation in terrestrial ecosystem responses is observed among studies (20, 21). Much of this variation could be caused by differences in the magnitude and duration of the droughts (or alteration in precipitation) imposed among the experiments included in these meta-analyses (20, 21). Although most droughts imposed are not statistically extreme, Wang et al. (21) showed that magnitude and duration were important factors for determining variation in ecosystem responses to experimental alterations in precipitation. They found a linear decrease in ecosystem functioning with greater reductions in precipitation; but, over time, productivity became less responsive to altered precipitation (21). One might conclude from this analysis that the effects of droughts, when imposed at statistically (i.e., historically) extreme levels, would result in even further declines in function with the greatest effects manifested in the short term. However, such extreme reductions in precipitation are uncommon in experiments (10); instead, precipitation reductions are for the most part within the range of nominal variability of a particular ecosystem. Consequently, we lack the critical understanding of how grassland and shrubland ecosystems will respond to a future where historically extreme droughts will become the norm rather than the exception.

Here we report results from the first-of-its-kind coordinated distributed experiment—the International Drought Experiment or IDE—designed to impose a statistically extreme, short-term (~1 y, *Materials and Methods*) drought across grassland and shrubland sites globally, using a common methodology (22). At the time of analysis, IDE consisted of 44 sites that experimentally imposed a historically extreme, 1-in-100-y drought treatment for at least a full growing season. The IDE network also provided an additional 56 sites imposing a less severe drought treatment, one that was not extreme by our definition but rather within the range of historic variability (hereafter referred to as nominal drought; Fig. 1 and *Materials and Methods*). These 100 sites were arrayed across six continents and spanned broad climatic (Fig. 1 and *SI Appendix*, Table S2) and edaphic gradients (23). At all sites, we measured annual aboveground net primary production (ANPP, *Materials and Methods*), a foundational component of the global carbon cycle, as a metric of drought-induced loss of ecosystem functioning in these grasslands and shrublands.

The results from this globally distributed experiment allowed us to 1) quantify the effects of short-term extreme drought on ANPP and determine if this effect differed between grassland and shrubland ecosystems globally, 2) compare the effects of extreme drought to less severe, nominal (or non-extreme) drought on ANPP, and 3) broadly assess factors potentially contributing to variation in ecosystems' responses to both extreme and nominal drought. We expected to observe a significant loss in ANPP with extreme drought, and that this loss in ANPP would be greater in grasslands vs. shrublands, consistent with past studies (24–26). Furthermore, we expected that extreme drought would suppress ANPP substantially more than nominal drought. We also expected that the extreme drought effects would differ from those derived in previous meta-analyses of

Significance

Drought has well-documented societal and economic consequences. Climate change is expected to intensify drought to even more extreme levels, but because such droughts have been historically rare, their impact on ecosystem functioning is not well known. We experimentally imposed the most frequent type of intensified drought—one that is ~1 y in duration—at 100 grassland and shrubland sites distributed across six continents. We found that loss of aboveground plant growth, a key measure of ecosystem function, was 60% greater when short-term drought was extreme (≤1-in-100-y historical occurrence). This drought-induced loss in function greatly exceeds previously reported losses for grasslands and shrublands, suggesting that the global impacts of projected increases in drought severity have been substantially underestimated.

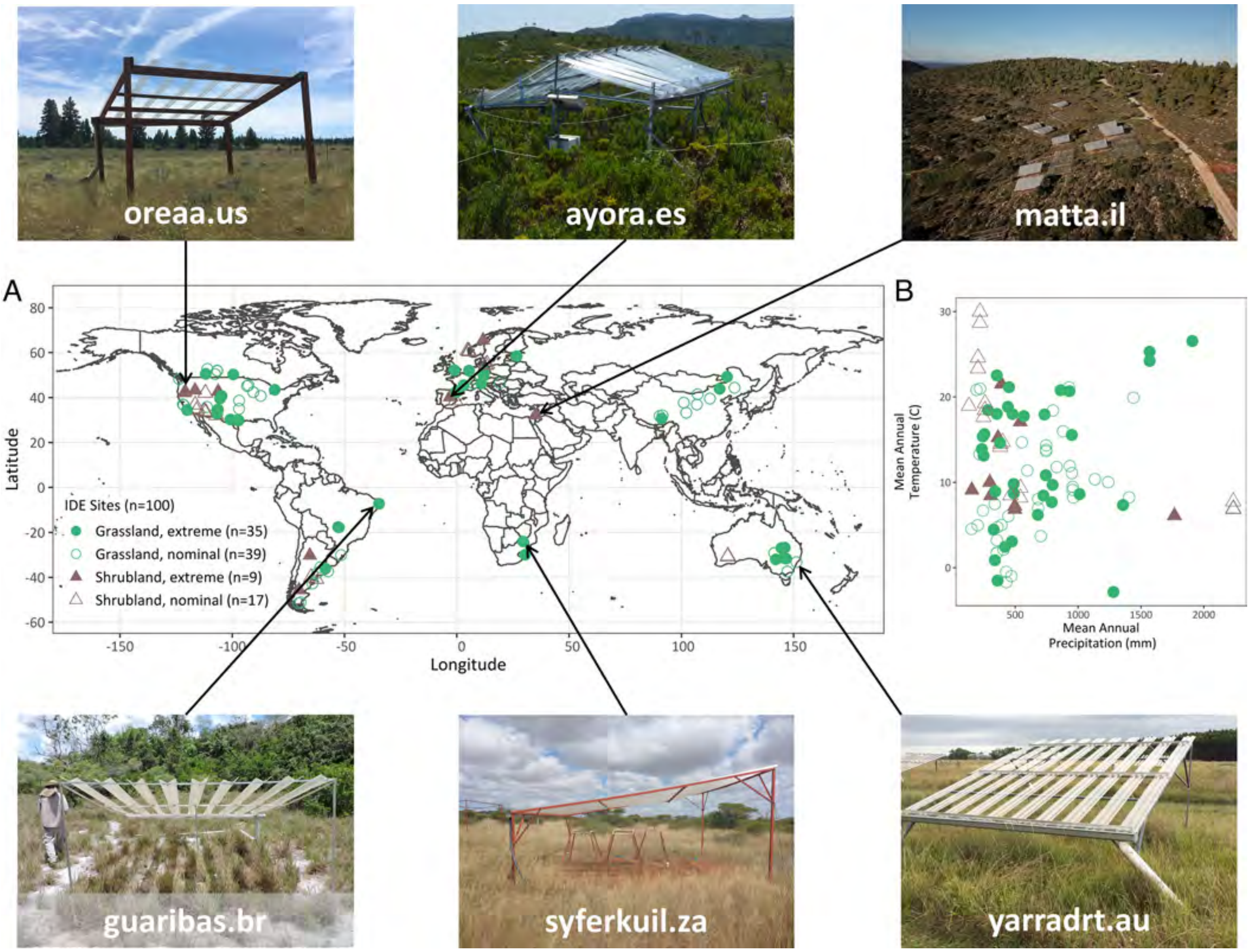

Fig. 1. Geographic extent and climate space encompassed by the IDE. The 100 grasslands (green circles) and shrublands (brown triangles) included in the analysis spanned six continents (*A*) and broad gradients of mean annual temperature and MAP (*B*). Closed symbols denote sites (n = 44) that experienced statistically extreme 1-in-100-y drought (i.e., below average annual precipitation during the experiment year). Open symbols denote IDE sites (n = 56) that experienced nominal (not statistically extreme) drought (i.e., average or above-average annual precipitation during the experiment year). Photos: Shown are drought shelters at representative sites on each continent. Drought shelters were designed to exclude a fixed proportion of each rainfall event from the plots below. The proportion excluded was selected to impose a 1-in-100-y drought for each site during years with average annual precipitation (based on long-term precipitation records, see *Materials and Methods* for details; see *SI Appendix*, Table S2 for site codes).

experimental drought results (20, 21, 27), given that past meta-analyses are subject to publication bias (28) and that their effect sizes were based on studies that varied widely in the type, duration, and magnitude of the drought imposed (29–31).

Results and Discussion

Consistent with most previous research, drought experimentally imposed over ~1 y (<2 y), whether nominal or extreme in magnitude, reduced ANPP relative to ambient conditions (Fig. 1 and *SI Appendix*, Table S3). For those sites that experienced extreme drought, ANPP was reduced on average by ~35% overall; by ~38% and 21% for grasslands and shrublands, respectively (Fig. 2*A*). Thus, across the 44 sites that experienced extreme drought, grasslands incurred greater losses in ANPP than shrublands, consistent with previous studies (24–26), though this difference was not statistically significant (*SI Appendix*, Table S4). For those sites that experienced nominal drought, ANPP was suppressed by ~21%, much less (>half) than in sites experiencing extreme drought, and there was a smaller difference between grasslands and shrublands in these nominal drought responses (Fig. 2*A*). This suggests that ANPP of grasslands and shrublands responds similarly to drought unless droughts are extreme, in which case these ecosystems are more likely to diverge in their average response to even a single year of drought.

The 95% CIs for mean reductions in ANPP due to nominal (non-extreme) droughts, and for grasslands and shrublands separately, overlapped with the range of mean effects reported in recent meta-analyses of drought experiments (Fig. 2*A*). This equivalence between the mean effects of nominal droughts in the IDE network and past meta-analyses occurred despite the wide variety of experimental protocols for imposing drought treatments included in the meta-analyses. In contrast, the effect of extreme drought on ANPP was well outside the range of these past reported effects, with the reduction in ANPP more than 1.5-fold greater. Thus, our results suggest that past studies have underestimated the ecosystem effects of statistically extreme droughts—the droughts of the future.

While it is reassuring that there is similarity among the full suite of sites in our study (n = 100), the subset of sites subjected to nominal drought (n = 56), and the mean effect sizes of meta-analyses, there are several reasons to view the IDE estimates as being more robust. First, by including results from all sites (including those

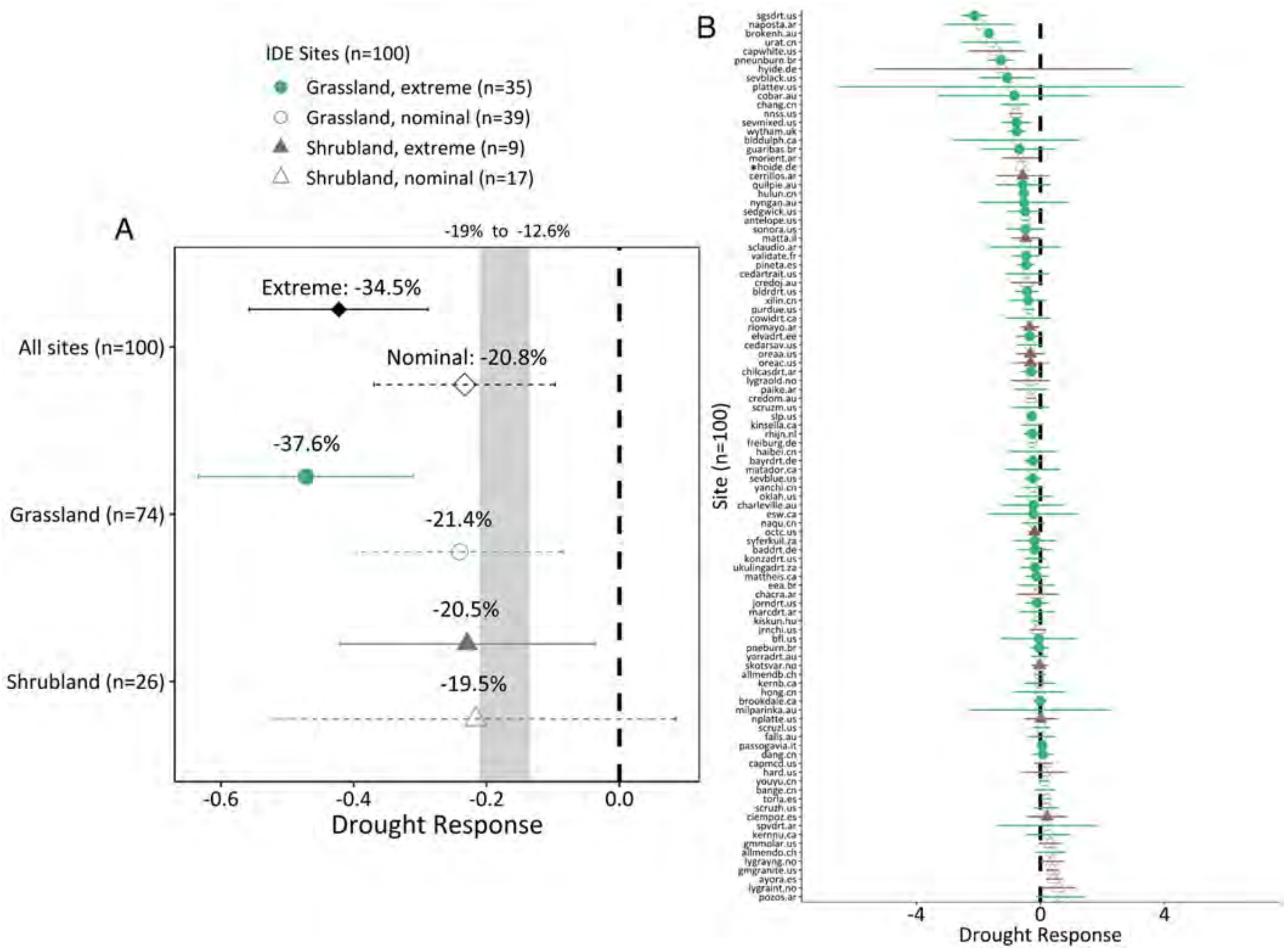

Fig. 2. Response of ANPP to a standardized 1-y drought for 100 IDE sites. (*A*) Mean drought response for sites that experienced extreme drought or nominal conditions for: all sites, grasslands, and shrublands (*SI Appendix*, Tables S3 and S4). The gray bar indicates the range of ANPP loss from −19 to −12.6% found in Song et al. and Wang et al. (20, 21), respectively. Drought response is calculated as: ln(average $ANPP_{DROUGHT}$/average $ANPP_{CONTROL}$); 0 (black dashed line) represents no effect of drought, and negative numbers indicate less ANPP in drought vs. control plots. (*B*) Mean drought response for each site ordered from negative (*Top*) to positive (*Bottom*). Site codes and corresponding site information are listed in *SI Appendix*, Table S2. Shown are 95% CIs for mean site-level drought responses. *Indicates site with CI that was omitted for clarity because it exceeds the *x* axis scale.

with no evidence of a drought effect, Fig. 2*B*), we eliminated the long-standing issue of publication bias affecting meta-analysis effect sizes (i.e., bias towards significant results, (28, 32)). In addition, although the statistical power was relatively low for detecting drought effects at individual sites—a concern of many global change experiments (32)—the large number of IDE sites, almost twice as many as included in Song et al. (20) and Wang et al. (21), provided broader and in some cases denser geographic coverage.

Furthermore, the standardized experimental design and sampling protocols we used ensured drought treatments were imposed, and responses assessed comparably, across all sites. Thus, variation in our dataset should be attributable to ecological differences among sites and not methodological differences inherent in meta-analyses. By reducing methodological differences, we anticipated that site-to-site variability would be reduced in this coordinated, distributed experiment (22, 23), at least relative to previous studies. Contrary to that expectation, a surprising amount of variation was still observed in ANPP responses to both extreme and nominal drought across sites (Fig. 2*B*). While 79 sites experienced the expected losses in ANPP, 21 sites were insensitive to the 1-y extreme drought, i.e., control and treatment ANPP means differed by <1% or were slightly higher in treatment plots, suggestive of high resistance to short-term drought (Fig. 2*B*). Variation in ecosystem responses was also observed with nominal drought, with 39 of 56 sites experiencing a loss in ANPP, but 17 sites displaying high drought resistance. Thus, individual IDE sites still differed in their responsiveness to both extreme and nominal drought despite the use of common protocols. This begs the question: What factors are contributing to the large variation in drought response among sites?

Determinants of Variation in Ecosystem Response to Drought. Although there are myriad factors that may contribute to site-level variation in the ANPP responses observed, we focused on seven key abiotic and biotic variables that were reliably available for >75% of the IDE sites. These included mean annual precipitation (MAP), previous year's precipitation (relativized by MAP), historic variability in precipitation (expressed as the interannual coefficient of variation of MAP), aridity index (AI), soil texture, plant species richness, and the dominant plant growth-form (expressed as proportion of graminoids) of the ecosystem (*Materials and Methods* and *SI Appendix*, Table S5).

Past empirical studies have indicated that the factors above may underpin variations in ANPP responses among sites to drought. For example, evidence suggests that drier and more arid sites (low MAP and AI) tend to be more sensitive to drought than wetter or less arid sites (33–36). But, in addition to MAP (or AI), historic variability in precipitation also may contribute to variation in drought responses (37, 38). In this case, sites that experience higher year-to-year variation in MAP are expected to be less sensitive to extreme drought, a product of these ecosystems being adapted to large interannual variations in precipitation. Research also suggests that legacy effects of the previous year's precipitation may play an important role in determining plant productivity, such that responses lag behind the increases or decreases in precipitation from the previous year (39–41). Finally, the inverse soil texture hypothesis (42) proposes that plants growing in coarse-textured (sandy) soils should experience less water stress than plants growing in fine-textured soils in relatively arid ecosystems, with the opposite pattern for ecosystems with higher precipitation. This interaction between soil texture and MAP is expected to be amplified with drought, but this prediction has rarely been tested (43). With IDE spanning a broad range of edaphic conditions (23), we provide one of the first tests of the inverse soil texture hypothesis on drought responses.

In addition to the abiotic factors listed above, plant species richness has been shown to influence the magnitude of ecosystem response to drought, with more species-rich communities being more resistant to drought than less species-rich communities (44). There is also abundant evidence that growth forms differ in their sensitivity to drought, with grasses and grass-like plants (i.e., graminoids) typically more sensitive to water deficits than woody plants (45, 46) or forbs (47). Given that the IDE sites represent a range of plant species richness and graminoid abundance (*SI Appendix*, Table S5), we evaluated the relationship between average plot-level species richness and abundance of graminoids and the magnitude of the drought response observed.

Three of these potential sources of variation in drought response had statistical support in the IDE dataset. We found weak evidence (P = 0.08) for MAP and moderate evidence (P = 0.02) for aridity (low values indicate lower plant water availability or more arid sites) being related to magnitude of drought responses (*SI Appendix*, Table S6). Drier sites (lower MAP or greater aridity) experienced greater losses in productivity than wetter grassland and shrublands. This finding matches studies demonstrating that production losses at more arid sites are greater in response to drought (32, 35–37) and supports the Huxman-Smith model (35) of greater sensitivity of ANPP to interannual variation in precipitation (and dry years) in more arid sites. Finally, as demonstrated previously (44), there was moderate evidence for more species-rich sites being more resistant to a loss in productivity than less rich sites (P = 0.04).

In contrast, we found no evidence that previous year's precipitation (as relativized by MAP), CV in MAP, percent sand (a key component of soil texture), or the proportion graminoids explained the variation in drought responses observed across all sites (Fig. 3 and *SI Appendix*, Table S6). We also found no evidence for an interactive effect between MAP and percent sand on drought response (*SI Appendix*, Table S7), and thus no support for the inverse soil texture hypothesis affecting differential drought sensitivity.

The Importance of Drought Severity. As indicated above, drought magnitude or severity (i.e., % reduction in precipitation relative to the control) was an important predictor of ecosystem response to drought in the recent meta-analysis by Wang and et al. (21). Because the passive approach to imposing drought employed with IDE (Fig. 1; *Materials and Methods*) relies on ambient precipitation levels, the actual amount of precipitation that was reduced with the drought treatment at each site (with respect to the long-term record, i.e., MAP) varied with the amount of annual precipitation received during the year of the experiment. We used this variation in drought severity to determine if differences in drought responses could be explained simply by the magnitude of drought imposed (calculated

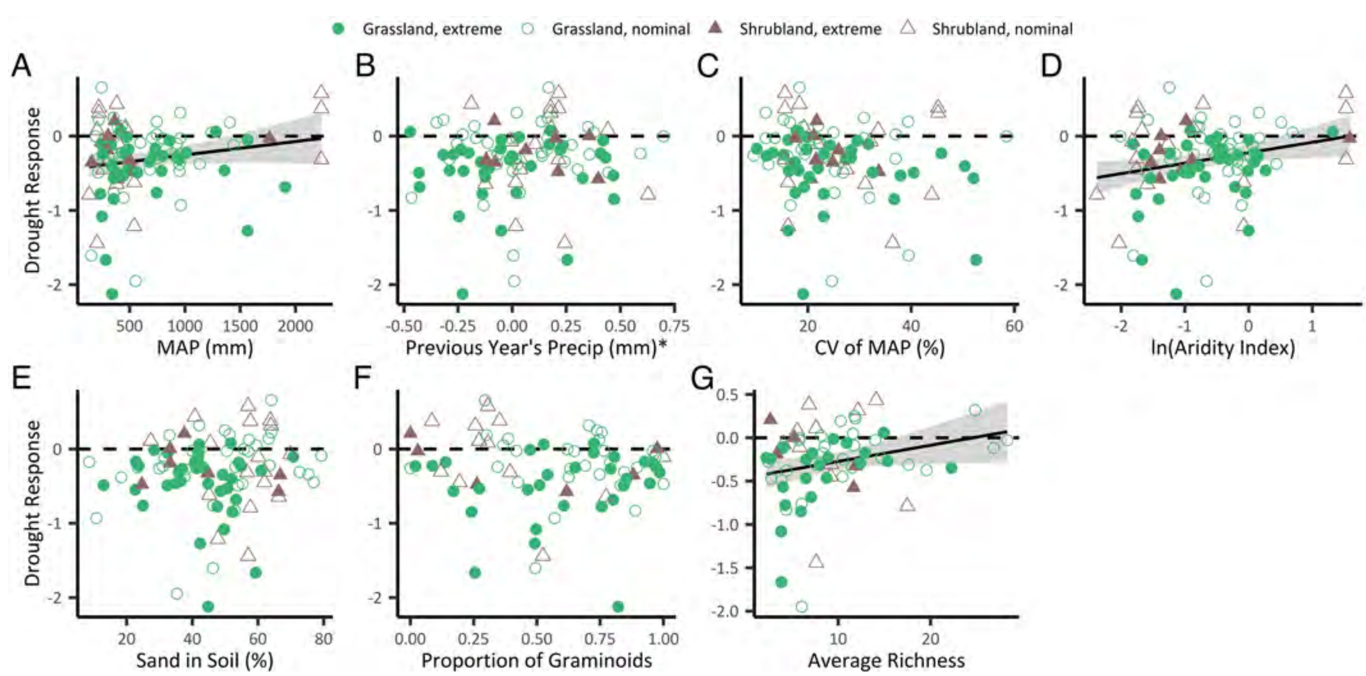

Fig. 3. Effect of abiotic and biotic factor on drought response. Relationships between 1-y drought responses across IDE sites and (*A*) MAP, (*B*) previous year's precipitation (relativized by MAP), (*C*) interannual percent coefficient of variation (CV) of MAP, (*D*) natural log of the AI, (*E*) percent sand, (*F*) average proportion of graminoids, and (*G*) average richness of plant species. Information on abiotic and biotic characteristics for each site can be found in *SI Appendix*, Table S5. Model results are summarized in *SI Appendix*, Table S6. Drought response is calculated as: ln(average $ANPP_{DROUGHT}$/average $ANPP_{CONTROL}$); 0 (black dashed line) represents no effect of drought, and negative numbers indicate less ANPP in drought vs. control plots. Lines are shown only for significant relationships. Shaded area represents the 95% CI. *Previous year's precipitation included the precipitation in the 365 to 730 d preceding the biomass collection date and was relativized by MAP.

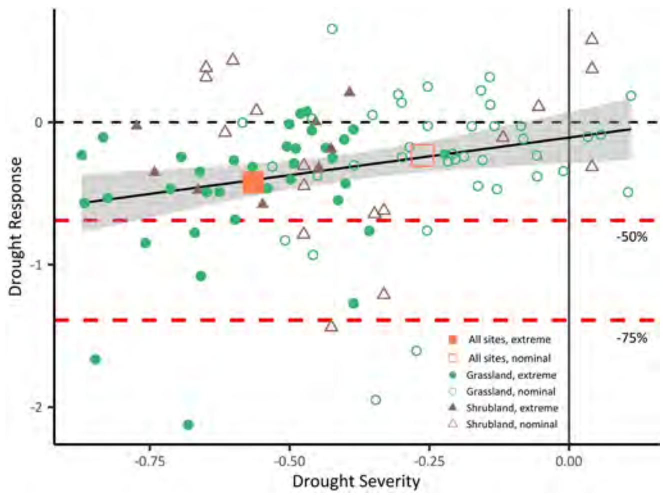

Fig. 4. Relationship between drought severity and drought response. A linear mixed effects model found strong evidence for a negative effect of increasing drought severity (becoming more negative) on drought response for 1 y of drought across all sites (intercept = −0.11; slope = 0.53; $P = 0.009$; adjusted $R^2 = 0.06$). Model results for the effects of drought severity on drought response for extreme and nominal sites are summarized in the Main Text. Shaded area represents the 95% CI. Drought response is calculated as: ln(average $ANPP_{DROUGHT}$/average $ANPP_{CONTROL}$). For drought responses, 0 represents no effect of drought, negative numbers indicate less ANPP in drought vs. control plots. Drought severity is calculated as: ($Precip_{DROUGHT}$-MAP)/MAP; MAP = mean annual precipitation. Because ambient precipitation during the experiment year determines the severity of the imposed drought, positive drought severity can occur during anomalously wet years when plots beneath drought shelters also experience above average precipitation. The open symbols denote those IDE sites (n = 56) where ambient precipitation was above average, and thus the imposed drought was not statistically extreme (1-in-100 y). Closed symbols denote those sites (n = 44) with average or below average annual precipitation during the experiment year. All of these IDE sites experienced statistically extreme drought. The filled orange square denotes the mean drought response for sites experiencing extreme drought whereas the open orange square is the mean for sites that experienced less severe drought. Note that there was no relationship between drought severity and drought response when only those sites that experienced extreme drought are considered. The red dashed lines provide visual guides for 50% and 75% reductions in ANPP.

as drought severity = ($Precipitation_{DROUGHT}$-MAP)/MAP). As expected, we found strong evidence ($P = 0.009$) that increasing (more negative) drought severity led to larger reductions in ANPP when examined across all 100 sites (Fig. 4). Further, the amount of variability explained doubled when drought severity, MAP, previous year's precipitation, CV in MAP, percent sand, and proportion of graminoids were included together in the model (*SI Appendix*, Table S8); though, drought severity remained the only significant factor in the model, underscoring the primary importance of this metric in determining the magnitude of the drought response.

One concern with passively reducing ambient precipitation is that in particularly dry years, differences in ecosystem responses between drought and control treatments tend to be minimized (48). In other words, if ambient precipitation is well below average, ANPP would be expected to be low even in control treatments and further reductions in precipitation with the drought treatment may not cause any additional appreciable reductions in ANPP. Thus, the difference between the drought and control treatments would be small, resulting in an effect size close to zero. This would give the appearance of the site being highly resistant to drought. We examined whether this was a possibility for sites with a large drought severity index (45% reduction in precipitation) and yet a drought response close to zero. We found that this phenomenon may indeed be responsible for the high resistance observed for these few sites (n = 4), but for most sites that exhibited resistance to drought (n = 17), this potential experimental phenomenon could be dismissed, suggesting that other factors are contributing to high resistance of these sites to a single year of extreme drought.

With the above analyses, we were able to evaluate how climate, soil texture, vegetation structure, and drought severity broadly influence drought response. However, given that drought severity was the primary determinant of variation in drought response, other factors that we were unable to include in our analyses are likely contributing to observed high variability in ecosystem response to extreme drought. Moving forward, a key challenge is to determine what these other factors are and identify those ecosystem attributes (e.g., soil fertility, root:shoot ratios, plant community composition, plant-microbe interactions, etc.) that may strongly influence resistance to a single year of extreme drought. Measurement of these factors at the site level and inclusion of these factors in future analyses will be crucial for predicting and mitigating the impacts of extreme drought as climate changes.

Despite the uncertainty of what may be determining variation in drought response in grasslands and shrublands globally, our analysis suggests that overall, ANPP declines as a linear function of increasing drought severity (Fig. 4). In other words, there was no evidence for catastrophic or nonlinear losses in ANPP when single-year droughts become statistically extreme. However, the results from this globally distributed drought experiment do indicate that losses in ANPP are greater than previously expected when drought is historically extreme. With climate change, droughts are not only expected to become more extreme, but also more frequent and longer in duration. It remains unknown what effects these aspects of intensified drought may have when overlaid with greater losses in ANPP with increased drought severity.

In conclusion, given that many ecosystems, particularly grasslands and shrublands, experience substantial interannual variability in precipitation (16, 49), it is not surprising that short-term precipitation reductions that are not statistically extreme would result in only "moderate" (~20%) losses in productivity. Even such moderate responses are likely to have important implications for the global carbon cycle and the wildlife, livestock, and human populations that rely on plant production. Of greater concern, however, is that grassland sites and grassland and shrubland sites combined experienced a magnified loss of function (more than 1.8- and 1.5-fold greater reduction, respectively) when drought was statistically extreme for ~1 y. Clearly, with climate change increasing drought intensity and frequency (50), and given that effects can linger long after drought ends, even more substantial impacts on the global carbon cycle can be expected. Indeed, reductions in ANPP exceeding 35% are not often observed in moderate droughts of longer duration (24, 51), and a recent study suggests that experimental droughts may underestimate the magnitude of ANPP loss by more than half when compared to naturally-occurring droughts (52). Thus, results from our distributed experimental approach reveal that extreme droughts are likely to substantially slow C sequestration in grasslands and shrublands, surpassing predictions from past meta-analyses (20, 53) and experiments (9, 52). Finally, the underlying cause of the striking range in ecosystem responses to short-term extreme drought, from highly resistant to highly vulnerable, remains unresolved. Results from our globally distributed and standardized drought experiments demonstrated little to no evidence for key factors typically thought to drive ecosystem variability in response to drought: CV of MAP, previous year's precipitation, soil texture, and proportion of graminoids. Yet, we found strong support for MAP/aridity and plant species richness being at least partially predictive of ANPP response to extreme drought. If traditionally invoked variables do not explain most of the cross-site variation in responses to intensified droughts, we must rethink our measurements and experiments to allow us to identify other underexplored factors. Understanding the determinants of differences in both short- and longer-term drought vulnerability will provide critical insight into both the mitigation potential and adaptative capacity of ecosystems in a future where today's extremes become the norm rather than the exception.

Materials and Methods

The IDE. IDE was initiated in 2013 as part of the Drought-Net Research Coordination Network, funded by the US NSF. Drought-Net is a global network of researchers committed to understanding how terrestrial ecosystems respond to extreme drought. For all network investigators, we provided and continue to provide standard experimental protocols on the DroughtNet website (droughtnet.weebly.com). Sites must follow these protocols for their data to be included in our analyses. At the time of analysis, 141 sites had joined our network, but data from only 100 of the sites (Fig. 1*A* and *SI Appendix*, Table S2) had been submitted and/or met our criteria for inclusion in this analysis (*SI Appendix*, Table S9). These 100 sites were well distributed across gradients of MAT and MAP (Fig. 1*B*) and represented two ecosystem types: grasslands and shrublands. Most (>90%) of the sites were dominated by perennials. Furthermore, like most grasslands and shrublands globally, all the sites had some history of management (*SI Appendix*, Table S10), but only 13 sites that we know of were actively mowed (n = 6), burned (n = 5), or grazed (n = 2).

The target for the IDE drought treatment was a statistically extreme, 1-in-100-y drought imposed year-round. To achieve the target level of extremeness, each site's treatment magnitude (reduction in precipitation) was based on the past 100 y of climate data from the site or 100 y of interpolated data from the Terrestrial Precipitation Analysis tool (54). Because precipitation history and variability are unique to each site, this approach allowed us to target the common level of statistical extremeness by allowing the proportional reduction in precipitation to vary across sites (55 and *SI Appendix*, Fig. S1). This contrasts with the alternative approach of imposing a fixed reduction in precipitation (e.g., 50%), which can result in very different levels of extremeness across sites (55).

The target level of extreme drought was imposed at each site using infrastructure that is commonly used in short-statured ecosystems (56). The infrastructure consisted of two or more open-sided shelters, each a minimum of 2 m × 2 m, with roofs that were partially covered with transparent strips of plastic (either V-shaped or corrugated). The percentage roof coverage was dictated by the target level of precipitation reduction (Fig. 1). This shelter design has been shown to have minimal effects on microclimate (57–59), while matching key characteristics (e.g., number of consecutive dry days, size of events, number of events) of naturally occurring extreme dry years across a range of ecosystems (55). For those sites (n = 9) with both control plots (no infrastructure) and plots with an infrastructure control (i.e., structures that mimic the shading of shelters but allow rain to pass through), there was no evidence that ANPP was affected by the shelter infrastructure (mean difference = 5.25%; 95% CI = −6.39%, 18.33%; t-value = 0.89; df = 33; $P = 0.38$). This suggests an absence of significant nontarget effects of the drought shelters, which has also been demonstrated in other experiments (57–59).

We also chose the shelter infrastructure to impose drought because it is highly cost-effective and can be consistently deployed across a range of short-statured ecosystems, making it amenable for use in a coordinated distributed experiment (22). However, because we manipulate precipitation passively, the target level of drought extremeness may or may not be achieved in any given year, depending on ambient precipitation amount (48). For example, an above-average year of precipitation will result in drought treatments that are less severe, while a below-average precipitation year will result in an even more extreme drought than the target level. In total, 44 of the 100 IDE sites received average or below-average precipitation in the first year of the treatment, and thus imposed the target statistically extreme, 1-in-100-y drought (*SI Appendix*, Fig. S2). The remaining 56 sites received above-average precipitation, and thus imposed a non-extreme ("nominal") drought, which was within the range of historic variability.

To be included in this analysis, sites needed to collect peak live aboveground biomass as an estimate of annual ANPP (60). While we recognize that there are numerous other ecosystem processes that can be impacted by drought, ANPP was selected because it can be comparably estimated and readily standardized across sites. Moreover, ANPP is a low-cost measurement that requires much less investment of time than other measures of ecosystem functioning–a crucial feature of response variables in CDEs and other successful experimental networks, such as the Nutrient Network (22, 61). ANPP was estimated either destructively and/or non-destructively using methods appropriate for the particular ecosystem as cited in Fahey and Knapp (62), with herbaceous-dominated sites encouraged to follow the Nutrient Network's protocols (https://nutnet.org/). We relied on investigators to use their expertise in determining the most appropriate methods–either destructive or non-destructive–to estimate ANPP for their study system. Sites then separated ANPP estimates into live and dead before further classifying live biomass by growth form (graminoid, grass, forb, woody, etc.) and submitting all estimates in grams of dry biomass per m^2. Standing dead biomass could be separated into current and previous year's growth where appropriate.

Drought Response Metric. For each site, we calculated relative drought response as the ratio of average ANPP in the drought plots compared to average ANPP in the control plots, as a metric of ecosystem response to imposed drought. Specifically, we adapted equations from Smith et al. (63) and Kreyling et al. (64) to define relative drought response as: $\ln(ANPP_{DROUGHT}/ANPP_{CONTROL})$.

Drought Severity Metric. We calculated the actual severity of the drought that was imposed during the year of precipitation manipulation using meteorological data that was either collected 1) on-site (site-submitted) or 2) from a nearby weather station (mean distance = 10.2 km). The nearby weather station data was obtained either from the Global Historical Climatology Network (GHCN, 65) or the Climate Hazards Group InfraRed Precipitation with Stations (CHIRPS, 66). When data from GHCN, CHIRPS, or local weather stations were not available, we used site-submitted annual precipitation estimates. We first calculated the amount of precipitation each site received in the 365 d preceding collection of ANPP. We then used this precipitation calculation, the site-reported percent reduction in precipitation imposed with the drought treatment, and days the drought shelters were in place prior to the collection of ANPP to estimate the total amount of precipitation reduced at each site. To qualify as 1 y of drought, a site's shelters needed to be in place for at least one full growing season (within 1 wk of 120 treatment days prior to harvest), but less than 2 y (within 1 wk of 650 d). For the drought severity metric, we compared the estimated precipitation received in drought plots to MAP (mm) as reported by each site, and calculated the deviation from this number: $(Precip_{drought} - MAP)/MAP$.

Abiotic and Biotic Factors. We included in our analysis seven abiotic and biotic factors that have been hypothesized to be important in influencing variability in drought response among sites (*SI Appendix*, Table S5). These factors included: MAP (mm), previous year's precipitation (mm), historical variability in MAP (interannual CV), AI, soil texture, proportion of graminoids, and site richness. As indicated above, we used MAP as reported by each site. We used either site-submitted, GHCN, or CHIRPS data to calculate how much precipitation each site received in the 365 to 730 d preceding the ANPP harvest and then relativized this value by site MAP. We refer to this as previous year's precipitation in our analyses. Historical variability of precipitation was estimated using the average coefficient of variation for the 30 y of precipitation from each site using GHCN station data. The AI (an estimate of plant moisture availability), was calculated as the MAP divided by potential evapotranspiration (67); Trabucco et al. (67) uses estimates from World Clim v2 (68) to calculate these values. Lower AI values indicate lower plant water availability. For the interannual coefficient of variation in MAP, we pulled data from the Multi-Source Weighted-Ensemble Precipitation tool (69).

As a proxy for soil texture, we used a weighted mean for percent sand in the top 100 cm of soil for each site (n = 96) available in the ISRIC World Soil Information (70), which yielded information for 96 sites. We used this global dataset because site-level data was only available for 27 of the sites. However, for those 27 sites we conducted a Pearson correlation test between site-derived values and the global dataset to confirm whether the global dataset measures were accurate, which we found to be the case ($r = 0.67$, $P < 0.001$). To calculate the proportion of graminoids, we used 77 sites that submitted ANPP data for each functional group. For each plot at a site, we divided the ANPP of graminoids by the total ANPP (all functional groups added together). We then averaged these proportions across plots for each site. For richness, we used plant species composition data submitted by 68 of the 100 sites at the time of analysis. We only used data from control plots and averaged richness at the plot level for each site.

Statistical Analyses. For all statistical analyses, we used the language of evidence (71) to describe our results as an alternative to typical statistical significance testing (i.e., using a significance cut-off of P-value ≤ 0.05). With this approach, we ascribe P-values as following Muff et al. (71): >0.1 = little or no evidence, between 0.05 and 0.10 = weak evidence, between 0.01 and 0.05 = moderate evidence, and ≤0.01 = strong evidence.

To test whether ANPP in drought plots differed from that in control plots, we used six one-sided t tests in R (version 4.0.2, 72), identifying whether responses were significantly less than 0. We chose to use one-sided t tests given that out a priori hypothesis was for drought to result in a reduction in ANPP (rather than either a decrease or increase, which would be relevant for an expectation of increased ANPP with drought). However, to examine whether results differed based on one-sided vs. two-sided t tests, we conducted two-sided t tests for the six comparisons and found that this did not affect the results, except in the case of the shrubland nominal drought test (one-sided P-value = 0.07, two-sided P-value = 0.15). We tested sites with nominal and extreme droughts separately, and tested ecosystem types together and separately (*SI Appendix*, Table S3). To test for differences in grassland and shrubland responses to drought across all sites, we used linear regression (*SI Appendix*, Table S4).

To examine whether the seven abiotic and biotic factors described above explained any variation in the drought response observed, we used linear mixed effects models for all 100 sites, or separately for sites that experienced extreme or nominal drought. We built separate models that tested the following explanatory variables: ecosystem type (grassland or shrubland), MAP (mm), previous-year's precipitation (mm, relativized by MAP), average coefficient of variation (%) for MAP, AI (scaled using the natural log), average percent sand, average proportion of graminoids, and average plot-level richness. We also explored the inverse soil texture hypothesis using a linear mixed effects model (site set as a random effect) to test how the interaction of average percent sand and MAP affected drought response.

We used a Pearson correlation to test collinearity among drought severity (proportion), length of drought (days), and a categorical variable for whether sites had ambient precipitation equal to or above (group 1) or below (group 2) MAP. We set drought severity as our fixed effect as it integrates the length of drought ($r = -0.59$, $P < 0.001$), deviation in ambient precipitation from MAP ($r = 0.60$, $P < 0.001$), and a site's drought shelter design into a single variable. To test the nature of the relationship between drought response and various factors (drought severity, MAP, previous year's precipitation, aridity, coefficient of variation, and plant community richness) we compared both linear and non-linear models (asymptotic regression and general additive model with a spline function set to 3) using AIC. We did not find evidence for a non-linear response (*SI Appendix*, Table S11) and proceeded with building linear models using the lmer function (package stats) in R. We also built a multiple linear regression to see whether drought severity combined with MAP, previous year's precipitation, proportion graminoids, CV, and average percent sand could further explain variation in drought response.

Data, Materials, and Software Availability. Derived data are provided in *SI Appendix*, Table S5. All code and derived data have been deposited in Dryad (73). All other data are included in the manuscript and/or *SI Appendix*.

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