UNIVERSITY OF CALIFORNIA, SANTA CRUZ

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July 13, 2022

Executive Director Ainsworth
California Coastal Commission
45 Fremont Street, Suite 2000
San Francisco, CA 94105-2219

Re: UC Santa Cruz Marine Science Campus Coastal Long Range Development Plan (CLRDP) 2021 Annual Report

Dear Mr. Ainsworth

Section 8.8 of the CLRDP requires submission of an annual report that includes the status of implementation of the CLRDP.

A printed copy of the 2021 CLRDP Annual Report has been hand delivered to the California Coastal Commission Office in Santa Cruz.

Please let me know if you have any questions regarding the report.

Respectfully,

DocuSigned by:
Jolie Kerns
C2472DC7A82647D...

Jolie Kerns
Director of Campus Planning

cc: CA Coastal Commission Santa Cruz Office
Ryan Moroney, Coastal Planner

UNIVERSITY OF CALIFORNIA SANTA CRUZ

COASTAL (MARINE) SCIENCE CAMPUS

COASTAL LONG RANGE DEVELOPMENT PLAN

2021 ANNUAL REPORT

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*Bold text highlights stand-alone/individual documents that make up the Annual Report

2021 CLRDP Annual Report

UNIVERSITY OF CALIFORNIA SANTA CRUZ,
COASTAL (MARINE[1]) SCIENCE CAMPUS
COASTAL LONG RANGE DEVELOPMENT PLAN
2021 ANNUAL REPORT

1 Introduction

Pursuant to Section 8.8 of the Coastal Long Range Development Plan (CLRDP), this annual CLRDP report includes a cumulative and calendar-year summary of the compliance of development projects authorized under the CLRDP with the terms and conditions of their authorizations; a description of development excluded from the development review procedures in Sections 8.1.4, 8.2 and 8.4 of the CLRDP by virtue of Section 8.3; authorizations for emergency development pursuant to Section 8.10; enforcement of the provisions of the CLRDP pursuant to Section 8.9; annual monitoring reports required under the CLRDP; the status of CLRDP-required improvements and other University commitments; and any comments received on CLRDP implementation.

A record of the CLRDP annual report is maintained in the offices of UCSC Physical Planning Development and Operations and is available for public review by appointment. A copy of the annual report will be submitted to the Executive Director of the California Coastal Commission.

2 Project Compliance

This section summarizes the compliance of development projects that were authorized under the CLRDP in 2021 with the terms and conditions of their authorization, and of continuing obligations from authorizations in previous years.

Development projects authorized in 2021.

CDP Waiver 3-21-0407-W, Upper Terrace Wetland Enhancement. Enhancing an existing wetland (W2) in the Upper Terrace at the Younger Lagoon Reserve at the Coastal Science Campus of the University of California Santa Cruz in order to provide aquatic breeding habitat for the California red-legged frog (CRLF). The project would be designed and constructed by the Resource Conservation District of Santa Cruz County (RCD) in accordance with a license agreement that would be issued by the University to the RCD. Authorized on July 8, 2021 with ongoing vegetation monitoring obligations and no special conditions. Construction completed in September 2021.

In 2021, the Campus continued to comply with continuing obligations from two projects that were authorized in previous years:

NOID 12 (20-1) [SCZ-NOID-0004-20], Younger Lagoon Reserve Beach Access Management Plan. Five-year beach access management plan, covering 2020-2025.

[1] The Coastal Science Campus was formerly known as the Marine Science Campus.

Authorized on October 8, 2020 with special conditions to expand daily tours from 14 to 18 participants and offer a virtual tour instead of in-person tours during the COVID-19 pandemic. Ongoing obligation includes implementation reports every 6-months. Refer to Younger Lagoon Reserve Annual Report in Appendix B.

NOID 6 (13-1), Coastal Biology Building and Associated Development; Sign Program; Parking Program; and Specific Resource Plan Phase 1B. Authorized on October 10, 2013. The Coastal Commission determined that the proposed development is consistent with the CLRDP, with the following conditions: 1) modifications to the design of fencing proposed for the utility and storage yards, for McAllister Way, and for Overlook E; 2) limitation of parking fees to no more than $1.50 per hour on non-State holiday weekdays between 8:00 AM and 5:00 PM; and 3) revisions to the proposed design of parking signs. During 2013, the Campus completed the design of the proposed development and began the bidding process. The Campus submitted revised fencing plans to the Commission on July 10, 2014. Commission staff approved the revised fencing design on August 28, 2014. Construction began in May 2015 and was completed in 2017 with the exception of the landscaping, which will be completed in 2019. The project includes a mitigation monitoring and reporting program that was adopted by the University in conjunction with project approval in January 2012. SRP Phase 1B was completed in 2017. A copy of the mitigation monitoring checklist for the Coastal Biology Building and Associated Development is included in Appendix C.

3 Development Excluded from Development Review Procedures

This section describes development undertaken in 2018 that is excluded from the development review procedures in CLRDP sections 8.1.4, 8.2., and 8.4 by virtue of Section 8.3.

In 2021, the University carried out a variety of small repair and maintenance activities.

4 Emergency Authorizations

This section describes development undertaken in 2021 pursuant to emergency authorizations by the UCSC Chancellor or the California Coastal Commission pursuant to CLRDP Section 8.10. No emergency authorizations were approved in 2021.

5 Enforcement

This section describes actions taken to enforce the provisions of the CLRDP and the Coastal Act which are enforceable pursuant to Chapter 9 of California Public Resources Code Division 20. No enforcement actions were taken in 2021.

6 CLRDP-Required Annual Monitoring Reports

The CLRDP requires the following annual monitoring reports:

- **Water Quality Report.** The annual water quality report is to be prepared following each storm season (typically post-April 15th) and the report completed by mid-summer. The annual water quality report for 2021 storm season is presented in Appendix A of this document.
- **Resource Management Plan Reporting.** The Resource Management Plan (CLRDP Appendix

A) requires the submission of annual reports of the results of monitoring activities provided for in the Specific Resource Plan (SRP) that will be prepared for each phase of habitat restoration. The current annual report, which covers monitoring activities carried out for SRP Phase 2 in FY2020-21, is presented in Appendix B of this document.

7 Status of University Commitments

This section summarizes the status of the capital improvements identified in CLRDP Chapter 9 and in other sections of the CLRDP, including measures to protect and enhance habitat, public access policies and procedures, and transportation demand management.

7.1 Capital Improvement Program

Table 1 summarizes the status of the capital improvements identified in CLRDP Chapter 9.

Table 1

Status of Capital Improvements Required by the CLRDP

Category	Improvement	Status
Public access improvements	Trails Figure 9.1	
	Group 1 Improvement of the De Anza Trail, the Bluff Trail, the Discovery Trail, Middle Terrace Walk and Ocean Shore Railroad Trail shall be undertaken and completed concurrent with the development of any new building in the Lower or Middle Terrace development zones.	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017
	Group 2 Construction of additional east-west trails between the Middle Terrace Walk and McAllister Way shall be undertaken and completed concurrent with the development of adjacent new buildings on the Middle Terrace.	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed
	Group 3 Construction of the Upper Terrace trail shall be undertaken and completed concurrent with any new development in the Upper Terrace development zone, or when the first 10% of the new building floor area (square footage) contained in the Campus building program set forth in subsection 5.2.1 is completed.	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
	Overlooks	
	Overlook A	COMPLETE Construction completed in 2013, under NOID 5 (12-2).

	Overlook B	COMPLETE Completed in 2010, under NOID 09-1. Additional enhancements to Overlook B (Terrace Point) were completed in 2020 as part of NOID 12, including permeable resurfacing, ADA paths, new picnic tables and bench.
	Overlook C	COMPLETE Construction completed in 2013, under NOID 5 (12-2).
	Overlook D	COMPLETE Construction completed in 2013, under NOID 5 (12-2).
Category	**Improvement**	**Status**
	Overlook E	COMPLETE Construction completed in 2013, under NOID 5 (12-2).
	Overlook F	COMPLETE Construction completed in 2013, under NOID 5 (12-2).
	Parking	

	Lower terrace public coastal access At least 10 dedicated public coastal access parking spaces shall be identified in the Lower Terrace development zone in a location that provides the easiest and most direct access to public coastal access amenities (e.g., in the parking bay along the east side of McAllister Way opposite the Ocean Health building).	COMPLETE Campus submitted a NOID to the Commission in March 2012. Based on subsequent discussions with Commission staff, this project is now included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
	Lower terrace dual use At least 40 dual use parking spaces (i.e., reserved exclusively for public coastal access parking and for parking by visitors to the Seymour Marine Discovery Center) shall be identified in the Lower Terrace development zone in a location that provides the easiest and most direct access to public coastal access amenities and the Marine Discovery Center.	COMPLETE Campus submitted a NOID to the Commission in March 2012. Based on subsequent discussions with Commission staff, this project is now included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
	Middle terrace public coastal access At least 5 dedicated public coastal access parking spaces shall be developed in the Middle Terrace development zone.	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.

Category	Improvement	Status
	Campus Entrance At least 15 dedicated public coastal access parking spaces shall be developed in the Campus Entrance development zone	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
	Updated signs and information-public access Parking New and/or updated signs and information regarding CLRDP public coastal access parking availability consistent with Policy 5.3 and its implementation measures shall be installed/provided throughout the Campus at appropriate locations.	COMPLETE New signs were installed in 2011 as part of the Outdoor Research Yard Expansion and Public Access Improvements Project (NOID-09-1). Additional signs were installed in 2017 in conjunction with the designation of lower terrace public coastal access parking spaces as part of the Parking Program included as part of NOID 6 (13-1), which was approved in October 2013.
	Parking program A parking management program, including any associated physical development (e.g., signs, kiosks, etc.), that is consistent with all CLRDP parking requirements shall be implemented to ensure that public coastal access parking areas are used for public coastal access use only.	ONGOING Campus submitted a NOID to the Commission in March 2012. Based on subsequent discussions with Commission staff, this project is now included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.

	Identification of Access Facilities	COMPLETE (CLRDP section 9.1.4) Informational signs are scattered throughout the site at public visitor destinations, showing public access trail map. Brochures about research activities, educational opportunities, planned events, and participation opportunities are available at the Seymour Center entry area, the Seymour Center administrative office, and at the Long Marine Lab main administrative office.
Habitat enhancements	Natural areas restoration	See Section 7.2, below.
	Remove/restore parking area west of McAllister Way	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
Circulation Improvements	Shaffer Rd. Improvements	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
	Realigned Main Campus Street	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015. The new Campus street was completed in 2016.

	Shaffer/Delaware Intersection	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
Drainage System Improvements *Figure 9.5*	De Anza Mobile Home Park drainage pipe	NOT APPLICABLE The Campus has determined that the drainage pipe from wetland W4 functions adequately with appropriate maintenance and that this pipe does not need to be replaced.
	Outfall west of NOAA	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.
	Middle terrace percolation trench and berm	COMPLETE Included in NOID 6 (13-1), which was approved in October 2013. Construction began in May 2015 and was completed in 2017.

7.2 Habitat Enhancement and Protection

On July 24, 2008 the University of California Natural Reserve System (UCNRS) and UCSC Campus Administration signed an agreement incorporating the approximately 47 ac (19 ha) of natural areas outside of the development zones on the Coastal Science Campus into the University of California Natural Reserve System (UCNRS) as part of the Younger Lagoon Reserve (YLR). The agreement outlines the commitment by the NRS and campus to comply with restoration, management, and research on all YLR lands. The Chancellor of UCSC appointed a Scientific Advisory Committee (SAC) to guide the creation of a Specific Resource Plan (SRP) on January 30, 2009. During 2009, Reserve staff drafted an SRP for Phase 1 of the restoration and management of the Terrace Lands, in consultation with the SAC and other technical professionals. The Campus submitted a NOID for the SRP Phase 1A, which was authorized by the Coastal Commission in

September 2010. The Campus submitted a NOID for the SRP Phase 1B, which was authorized by the Coastal Commission in September 2013. Both SRP Phase 1A and SRP Phase 1B are complete. During 2018, Reserve staff drafted an SRP for Phase 2 of the restoration and management of the Terrace Lands, in consultation with the SAC and other technical professionals. SRP for Phase 2 was submitted to the Coastal Commission as part of the 2019 annual report.

Restoration activities that were initiated on the Younger Lagoon Reserve Terrace Lands in 2009 continued in 2021. The work was performed largely by undergraduate students and community volunteers. Reserve staff conducted weed patrols of the entire terrace, continued removing ice plant from the coastal bluffs, removed all Jubata grass and French Broom re-sprouts from the terrace, and removed all Cape Ivy re-sprouts from the west arm of the lagoon. Reserve staff collected seeds to propagate plants for restoration in the summer and fall of 2019. These seeds were propagated at the UCSC Teaching Greenhouse in the fall and winter of 2019/2020. With the assistance of hundreds of volunteers and student interns, Reserve staff planted native seedlings in coastal prairie habitats. Vegetation surveys for restoration compliance monitoring of planted areas on the Terrace Lands were conducted in the spring of 2018. The YLR annual report for FY2020-21 is included in this report as Appendix B.

7.3 Public Access Policies and Procedures

Due to the unprecedented COVID-19 global pandemic, in April 2020, the University received a Coastal Development Permit Waiver (Coastal Act Section 30611) to temporary close and/or restricted access to the Coastal Science Campus, and tour programs at Younger Lagoon and Big Creek reserves, due to County of Santa Cruz's Supplemental Public Health Order to Shelter in Place (dated April 29, 2020) related to the COVID-19 pandemic. Some of these changes remained in effect throughout 2021 due to the ongoing pandemic.

Prior to the COVID-19 pandemic and consistent with the provisions of the CLRDP, the Coastal Science Campus is open to the public during daylight hours. Access to the Coastal Science Campus is free except that a fee is charged for admission to the Seymour Marine Discovery Center. In 2017, the Campus began charging for parking, consistent with the Parking Program approved under NOID 6. Visitors to the Seymour Marine Discovery Center receive up to three hours of free parking as part of their admission and free three-hour public parking for coastal visitors is provided at Lot #207, at the entrance to the campus. This parking policy continued during 2021.

Prior to the COVID-19 pandemic, the Seymour Marine Discovery Center holds several community free days each year. Organized tours offer controlled access to some research areas, research buildings, and parts of the lagoon portion of the Younger Lagoon Reserve; these areas are otherwise not open to the public. The Seymour Center is open seven days a week during July and August and six days a week during the rest of the year.

Prior to the COVID-19 pandemic, supervised site tours of parts of Long Marine Lab, as well as the Seymour Center exhibit halls and outdoor areas are offered four times a day when the Seymour

Center is open. Tours of marine mammal research areas are generally offered twice a month. The Seymour Center also offers a variety of field trips for K-12 school classes and community college groups, including hands-on lab activities.

From 2010-2017, the Reserve offered 90-minute tours of the original Younger Lagoon Reserve twice a month. Beginning in January 2018 and continuing through March 2020 when tours were temporarily suspended due to the COVID-19 pandemic, the total number of tours offered was increased from 24 to 38. Access to other parts of the Younger Lagoon Reserve, on the terrace lands, is not controlled at this time.

7.4 Transportation Demand Management

Santa Cruz Metropolitan Transit District (SCMTD) began operating a new Route 22 bus between CSC and the main campus during Fall Quarter 2017 and this service continued through 2021. Route 22 service operates hourly Monday through Friday. The Route 3 bus, which operates between the Metro Center and CSC, arrives at CSC seven times each weekday. SCMTD UC Westside Route 20 bus provides hourly service to Delaware Avenue and Natural Bridges Drive weekdays from 7:20 a.m. until 6:20 p.m., and weekends from 11:30 a.m. until 3:30 p.m. Supplemental bus service is provided on weekdays during the UCSC school term to handle overload on this route. SMTD

Through an agreement between the University and the SCMTD, students who display a valid UCSC ID card do not have to pay a fare to ride SCMTD buses. SCMTD service for students is funded through the Student Transit Fee. Faculty and staff may obtain a SCMTD bus pass for $14 per month, or $168 annually, which provides UCSC's Transportation and Parking Services (TAPS) with funding for payments to the SCMTD to accommodate faculty and staff transit ridership.

The Campus' Long Marine Lab Shuttle was discontinued in Fall 2009, as ridership levels continued to decline for the third year in a row. With a total ridership for 2008-09 of only 741 passengers, the cost of the shuttle was more than $56 per ride, and the shuttle was determined not to be a cost effective means of reducing trips to the campus.

TAPS coordinates a vanpool program that is open to faculty, staff and students. Zimride, a Facebook-based application, provides ride matching (on a regular or occasional basis) to members of the UCSC community. Zipcars are also available on campus for hourly or daily car rentals. TAPS also has several programs to support the use of bicycles as a means of transportation: classes on bicycle safety, free bicycle licensing, a no-interest bike loan program, an emergency-ride-home program, and bicycle maintenance and repair clinics on the main campus.

TAPS' website provides detailed information about all of the Campus' alternative transportation programs and links to the SCMTD website.

7.5 Removal of Existing Non-Conforming Facilities

The was no removal of existing non-conforming facilities in 2021.

7.6 CLRDP EIR Mitigation Monitoring Program

The CLRDP EIR Annual Mitigation Monitoring Reports are presented in Appendix C.

8 Comments Received on CLRDP Implementation

A public comment was received in January 2021 from a De Anza Mobile Home Park neighbor regarding a perceived decline in terrace wildlife, specifically birds. A public comment/inquiry was received in July 2021 from a Santa Cruz resident regarding the design of the Upper Terrace Wetland Enhancement project.

9 Appendices

Appendix A: Annual Water Quality Report

Appendix B: Younger Lagoon Reserve Annual Report

Appendix C: Annual Mitigation Monitoring Report

Appendix A

Annual Water Quality Report

UC SANTA CRUZ, COASTAL LONG RANGE DEVELOPMENT PLAN

APPENDIX A

2021 ANNUAL WATER QUALITY REPORT

1 Introduction

As specified in Section B.6.3 of the UC Santa Cruz Coastal Long Range Development Plan (CLRDP), this annual water quality report includes:

1) the results of the Drainage Monitoring and Maintenance Program described in Fig. B.22 of the CLRDP;

2) the results of any water quality monitoring requirements emanating from individual development projects;

3) any monitoring or other related information applicable to other Campus discharges (such as NPDES requirements associated with seawater discharges);

4) recommendations for any modifications to Campus drainage system components that are necessary to achieve CLRDP water quality performance standards.

The annual water quality report is prepared following each storm season (typically post-April 15th) and the report completed by mid-summer to allow any necessary changes to be implemented prior to the next storm season (i.e., by October 15th). Annual water quality reports are maintained in the offices of UC Santa Cruz Physical Planning and Construction, and are available for public review and shall be made readily available to researchers investigating the performance of water quality “best management practices” (BMPs).

2 Drainage Monitoring and Maintenance Program

This section summarizes the results of the Drainage Monitoring and Maintenance Program, including the assessment of source control BMP efficacy and the required monitoring and maintenance for treatment BMPs. The Drainage Monitoring and Maintenance Program includes monitoring and maintenance requirements for source control BMPs and treatment BMPs.

2.1.1 Source Control BMPs

Table 1 summarizes the results of the Campus’ annual assessment of source control BMPs, as specified in Section B.6.1 of the CLRDP.

Table 1

Annual Assessment of Source Control BMPs

Minimum Performance Standard	Status
That the Campus is providing adequate and convenient means for the recycling/disposal of commercial and household hazardous wastes. The performance standard to be achieved is	Currently, the caretaker’s residence is the only residence on the Coastal Science Campus. All campus employees who handle hazardous waste are required to receive hazardous waste training and to follow the hazardous waste

Minimum Performance Standard	Status
that all commercial and household hazardous wastes that can be recycled are being recycled, and that all such wastes that cannot be recycled are being properly disposed of.	handling procedures established by UCSC Environmental Health and Safety (EH&S). EH&S collects all hazardous wastes generated on the campus for proper disposal. EH&S maintains online recycling and disposal guidelines that help members of the campus community identify which materials can be recycled and which must be disposed of as hazardous waste. A recycling bin for used batteries is kept in the Center for Ocean Health mail room.
That less toxic alternatives to commercial and household hazardous chemicals (such as lubricants, pesticides, solvents, acids, alkalis and paints) are being used where possible, and that all such chemicals are appropriately stored and sparingly used. The performance standard to be achieved is that all commercial and household hazardous chemicals are stored in a manner designed to contain all spills, that information on less-toxic alternatives has been provided to potential Campus users, and that chemicals are used sparingly, per their intended application, and in a manner designed to minimize the potential for such chemicals to be applied outside target application areas.	The Campus' in-person hazardous waste training has been converted to a web based training accessed through the campus Learning Management System. Training topics include the UCSC Waste Management website, where training participants learn how to navigate the site, find and use the fact sheets and the waste minimization webpage, hazardous waste determination and classification guidelines, the online hazardous waste tracking system, a new recycling and disposal guide, and a link to the Green Alternatives Wizard, a database that provides information on alternatives to hazardous chemicals or processes.
That all roads, parking lots, and other paved surfaces are being vacuum swept with a regenerative-air sweeper designed to control litter, dust, dirt, and other potential pollutants to the maximum extent feasible. The performance standard to be achieved is that all paved surfaces are vacuum swept at least one time per month and that all regenerative-air sweepers used are maintained in good working order per the manufacture's recommendations.	The Campus began using a regenerative air sweeper in February 2014. Before February 2014, a broom sweeper was used. In 2020, the roads were swept monthly.
That all landscaping uses native plants with low nutrient, water, and pesticide/rodenticide requirements. The performance standard to be achieved is that all Campus landscaping meets this criterion.	Landscaping consistent with this requirement was installed in conjunction with the improvements to Overlook B, which were implemented in 2010 under NOID 09-1. Areas disturbed for construction of the improvements to overlooks A, C, D, and E (NOID 5 [12-2]) were planted with native, low-water-use plants. The landscaping installed under NOID 6 (13-3) is also consistent with this requirement.

Minimum Performance Standard	Status
That the University is providing Marine Science Campus users with convenient recycling and yard waste programs, and that Campus users are fully utilizing the University's recycling and yard waste programs. The performance standard to be achieved is that 100 percent of recyclable materials are recycled and that 100 percent of yard wastes are mulched/reused.	Mixed recycling containers are staged at the Center for Ocean Health, Seymour Marine Discovery Center, the Boat Yard, the green house area and at the California Fish & Game Facility, and CBB. All of these facilities also have centralized indoor office-paper recycling centers, generally in the copy rooms. Two cardboard dumpsters service the same group of facilities. CBB has trash, cardboard, and mixed recycling dumpsters. Additionally, yard waste is put into cubic yard carts that are emptied into a large debris box that is green-wasted at the City Recycle Center. Finally, Physical Plant provides a separate debris box as requested for all Natural Reserve and Site Stewardship 'yard waste'.

2.1.2 Treatment BMPs

Treatment BMPs have been installed in conjunction with the development approved under NOID 6 and planting was completed in 2019. A summary of Treatment BMP post-construction monitoring and maintenance for 2021 is included in Appendix A.

3 Project Water Quality Monitoring

This section describes the results of any individual water quality monitoring requirements emanating from individual development projects.

4 Monitoring Applicable to Other Campus Discharges

This section describes monitoring or other related information applicable to other Campus discharges (such as NPDES requirements associated with seawater discharges). Discharges of seawater from the Campus are subject to the monitoring requirements of the General Permit for Discharges from Aquaculture and Aquariums (NPDES Permit No. CAG993003). For monitoring periods in 2021 the Long Marine Lab discharge was in full compliance in all aspects of the permit.

5 Recommendations

This section presents recommendations for any modifications to Campus drainage system components that are necessary to achieve CLRDP water quality performance standards. No drainage system components were complete in 2021.

Attachment: Treatment BMPs Monitoring and Maintenance Report 2021

Long Marine Laboratory Annual Report 2021, NPDES General Permit No.CAG993003, and Monitoring and Reporting Program No. R3-2013-041.

Public and Private Structural BMPs Program

Structural BMPs are designed to improve urban runoff water quality by capturing and treating stormwater through infiltration or filtration before it reaches the receiving water. The **UC Santa Cruz** has 57 structural stormwater BMPs built within its regulated boundary that treat **23 acres of impervious area.** The collective volume treated by these investments is approximately **5 million gallons** of urban stormwater. 96% of the structural BMPs classify as green infrastructure, directly contributing to the **UC Santa Cruz's** urban greening goals.

The MS4 structural BMP inspection program requires all public assets are inspected annually and all private structural BMPs are inspected once per permit term (effectively 20% per year). The condition of the remaining (unassessed) private structural BMPs is based on modeled BMP condition decline since the time of the last assessment. The MS4 records indicate 0 of the 57 were assessed this reporting year.

Based on the required field observations and modeled BMP condition decline scores, **89% of all structural BMP assets within the UC Santa Cruz are functional** and provide at or near the intended water quality benefit. This equates to effective treatment of urban stormwater that is generated from a total of 23 impervious acres throughout the UC Santa Cruz. The MS4 uses this structural BMP performance data to prioritize available resources to repair non-functional assets.

DIVISION OF PHYSICAL & BIOLOGICAL SCIENCES
OFFICE OF THE DEAN

February 16, 2022

Peter von Langen, Ph.D., P.G.
Engineering Geologist
Central Coast Water Board
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401

Re: Long Marine Laboratory Annual Report 2020
National Pollutant Discharge Elimination System (NPDES) Permit
General Permit No. CAG993003
Order No. R3-2013-0041

Dear Mr. Peter von Langen,

Please accept this letter and attachment in satisfaction of our Annual Report requirement for 2021, in accordance with the requirements of the above referenced General Permit and Order. In addition to this letter is a summary of our quarterly observations and sample analysis results performed by Soil Control, actual quarterly chemical analysis reports and Chain of Custody sample sheets.

The following statements are intended to satisfy specific requirements of our permit for annual reporting:

Chemical Analysis
For 2021, the chemical analyses of the sampled ocean discharge from Long Marine Lab indicated full compliance with the permit, and no corrective actions are indicated.

Discharge Flow
Discharge flow from Long Marine Laboratory remained consistent with prior years except for an increase of 42 gpm over last year, as activity is about half way back to 2019 levels.

Chemical Usage
In 2020, hypochlorite solution in the form of household bleach was used for routine pool and tank cleaning on a weekly basis. In addition, at our marine mammal holding pools hypochlorite solution generated by electrolysis from seawater is added to re-circulating seawater to maintain a maximum residual of 0.5 ppm on a continuous basis. In both cases, the chlorinated water added to the discharge stream is significantly diluted with non-chlorinated seawater effluent, and when necessary is de-chlorinated with a liquid sodium bisulfite solution to meet regulatory concentration standards at the point of discharge to the ocean.

Exotic Species
There are currently no exotic species maintained in our flow through seawater system, other than captive marine mammals. The marine mammals are contained within individual fenced pens within a fenced yard, with significant overland travel required to reach the bay, so no threat of accidental introduction exists.

Best Management Practices Plan
Each of the three agencies that oversee seawater operations related to this discharge permit (UCSC Long Marine Lab, NOAA Fisheries Laboratory, and CDFW Marine Wildlife Center) have reviewed and/or updated their individual Best Management Practices Plans for 2021. These BMPs include operational protocols with regards to any substance that may enter the discharge stream

In accordance with the Standard Provisions and Reporting Requirements, I certify under penalty of law that this document and all attachments were prepared under my direction or supervision following a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my knowledge of the person(s) who manage the system, or those directly responsible for data gathering, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

This report is being transmitted via email. If you have any questions regarding this report or about the Long Marine Laboratory seawater system/ocean discharge operations, please contact Ashley Vizurraga, Director of LML, at (831) 459-2886 or ashviz@ucsc.edu.

Respectfully submitted,

Paul Koch, Dean
Physical and Biological Sciences

Cc:
Ashley Vizurraga, Director
UCSC Long Marine Laboratory

Steve Lindley, Director
NOAA Southwest Fisheries Science Center

Laird Henkel, Director
Calif. Dept. Fish and Wildlife, Marine Wildlife Center

Deirdre Whalen, Government and Community Relations Coordinator
NOAA Monterey Bay National Marine Sanctuary

Karen Grimmer, Resource Protection Coordinator
NOAA Monterey Bay National Marine Sanctuary

Sophie De Beukelaer, Permit Coordinator

LONG MARINE LABORATORY ANNUAL REPORT SUMMARY 2021
General Permit No. CAG993003 Order No. R3-2013-0041

		1st Quarter	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
Sample Collection/Observation Dates	**Discharge Limits***	24-Feb-2021	21-April-2021	8-July-2021	12-Oct-2021
Influent Analysis	**Monthly Max Conct.**				
Temperature (degrees C)	**N/A**	12.9	11.4	17.3	13.8
pH Value (units)	**6.0 - 9.0**	8.1	7.8	8.1	7.9
Turbidity (NTU)	**75 NTU**	1.7	3.1	1.5	4.3
Total Suspended Solids (mg/L)	**60.0 mg/L**	4.1	8.5	4.1	13
Effluent Analysis	**Monthly Max Conct.**				
Temperature (degrees C)	**N/A**	13.0	13.4	17.3	14.3
pH Value (units)	**6.0 - 9.0**	7.9	7.9	7.9	7.8
Turbidity (NTU)	**75 NTU**	4.3	0.35	0.35	0.30
Total Suspended Solids (mg/L)	**60.0 mg/L**	5.3	5.1	ND	ND
Settleable Solids (mg/L)	**1.0 mg/L**	ND	ND	ND	ND
Grease & Oil (mg/L)	**25.0 mg/L**	ND	ND	ND	ND
Estimated Flow (MGD)	**2.1**	0.73	0.98	0.81	0.83
Receiving Water Observations (for the area 100' upcoast and downcoast of the discharge point)					
Floating or suspended matter	**absent**	absent	absent	absent	absent
Discoloration	**absent**	absent	absent	absent	absent
Visible films, sheens, coatings	**absent**	absent	absent	absent	absent
Objectionable growths	**absent**	absent	absent	absent	absent
Potential nuisance conditions	**absent**	absent	absent	absent	absent

*California Ocean Plan 2015 - General Management Requirements of Waste Discharge to the Ocean			

Coastal Science Campus Seawater Discharge Best Management Practices Plan

January 2021

The following document is required reading for all seawater system users and supervisors on UC Santa Cruz's Coastal Science Campus.

Best Management Practices plan statement

The University of California Santa Cruz (UCSC) Coastal Science Campus (CSC) Best Management Practices (BMP) plan is a joint management effort, controlled and monitored by CSC seawater system users who share a common ocean discharge point. All seawater system users follow BMP regulations to ensure compliance with ocean discharge permit requirements.

Seawater system users at the CSC include UCSC's Long Marine Laboratory (LML) and Coastal Biology Building (CBB), NOAA's Southwest Fisheries Science Center, and the California Department of Fish and Wildlife's (CDFW) Marine Wildlife Veterinary Care and Research Center.
The guidelines noted in this action plan are specific to seawater users at the Coastal Science campus.

Drains at the Coastal Science campus that discharge toward the ocean include:

- Seawater return system, draining into sea water scepter, then to ocean outfall.
- Bioswales slow storm water flow and allow infiltration, overflow and storm drains distributed throughout the Coastal Science campus drain to Younger lagoon or through the sea water scepter and then to ocean outfall.

BMP Policy

Water discharged from our seawater system must be free of pollutants attributed to: (1) uneaten feeds and feces, (2) residual drugs used for animal health, and (3) residual chemicals for cleaning pools, aquaria, equipment or for maintaining or enhancing water quality conditions.

The guidelines and procedures herein help ensure compliance with ocean discharge permit requirements set forth by the State of California Regional Water Quality Control Board (General Permit No.
CAG993003, Order No. R3-2013-0041).

Animal feeding procedures

To minimize uneaten feed and fecal discharge to the ocean, procedures shall limit animal feed input to the minimum amount necessary to achieve targeted growth rates. Guidelines to help achieve this goal include:

- Animal feed shall be limited to quantities that are expected to be consumed over a short period of time.
- Animal care staff must actively monitor pools and/or aquaria during and after feedings to ensure excess feed material does not remain for extended periods of time.
- Animal care staff must regularly remove un-eaten feed materials and feces from pools and/or aquaria to minimize solid waste discharge.

Cleaning and maintenance

Residual chemical compounds, solid waste, animal mortalities and other contaminants can enter discharge waters due to facilities cleaning and operations. The Coastal Science Campus requires that such operations minimize pollutant discharge during cleaning, maintenance, laboratory work or other activities.

- Cleaning agents are allowed only if protocols for use have been approved by management.
- Cleaning processes must prevent the release of measurable chlorine in accordance with objectives of the California Ocean Plan.
- Animal mortalities must be disposed of on a regular basis.
- The discharge of animal feces, blood, viscera or carcasses must be minimized.
- No contaminants or refuse shall be allowed to enter storm or seawater drains.

Schedule of activities

Feeding and cleaning activities shall occur as necessary unless management notifies system users otherwise.

Materials Storage

- Drugs, chemicals, and feed must be stored so as to prevent spills that could enter the ocean discharge stream.
- Emergency spill response procedures must be posted in materials storage areas.

Structural Maintenance

- Routine inspection and maintenance of the discharge system is provided by Physical Plant Services.
- It is the responsibility of system users to immediately report any malfunctions to management and Physical Plant Services.

Prohibited Practices

- Discharge of any hazardous materials or toxic drugs.
- Discharge of any non-native or invasive species.
- Discharge of fish pathogens identified by the CDFW, title 14 of the California Code of Regulations, section 245.
- Discharge of prohibited materials indicated in the Transmittal of Adopted Waste Discharge Requirements Order No. R3-20012-0041.
- Activities in violation of the BMP.

Treatment methods

For any project or experiment that requires drug treatment or chemical additives to the seawater in pools or aquaria that have the potential to discharge into the ocean, the investigator must first consult with management to establish ocean pollution avoidance protocols.

Non-native Species

One lab researcher is culturing tropical coral in a recirculating aquarium, separate from the flow through seawater system. The risk of introducing these species into Monterey Bay's ecosystems is avoided through the following steps:

1) These organisms do not reproduce in the system.
2) Coral fragments are never disposed of into the drainage system.
3) The cultured species have not evolved to survive at temperatures below 25 degrees Celsius (Local waters range from 10 – 20 C).
4) Any water removed from the aquarium during cleaning is discharged to sanitary sewer, not the seawater outflow.

Employee training

All seawater system users must be familiar with the BMP and receive documented training in the following areas, as applicable (training shall be provided by the appropriate lab supervisor or management staff):

- Feeding procedures
- Cleaning procedures
- Chemical cleaning reagent use
- Chemical spill prevention and response

Record keeping

- Training records must be maintained by lab supervisors, and must include trainee names, dates and descriptions of completed training.

- Groups that use more than 10 kg/week of animal feed must maintain records that document feed amounts, along with animal numbers and weights.
- Records of inspection, maintenance and repair of the seawater discharge system are maintained by the Physical Plant Services.
- Any spill or other National Pollutant Discharge Elimination System (NPDES) permit violation must be immediately reported to the facility manager, who will communicate with the Regional Water Quality Control Board and the Monterey Bay National Marine Sanctuary.

Seawater receiving and discharge monitoring

- All flow measurement devices must be inspected and calibrated at least once per year and are maintained by Physical Plant Services.
- Water sampling and monitoring is performed by the facilities manager on a quarterly basis. Grab samples from the designated discharge point are collected during peak loading conditions downstream of the discharge point and upstream of any mixing with receiving waters.
- Receiving water conditions at point(s) of discharge and throughout the reach must be visually inspected on a quarterly basis. Presence of any of the following must be recorded:
    - Floating or suspended matter
    - Discoloration
    - Bottom deposits
    - Visible films, sheens, or coatings
    - Fungi, slimes, or biological growth
    - Any other unusual observations
- Water quality analyses must be performed by a laboratory certified by the State Department of Public Health (DPH).
- Monitoring results must meet permitted effluent limitations and must be submitted annually to the Central Coast Regional Water Quality Control Board.

Effluent Limitations

Pollutant	Units	Monthly Average	Weekly Average	Instantaneous Maximum
Oil & Grease	mg/L	25	40	75
Total Suspended Solids (TSS)	mg/L	---	---	60
Settleable Solids	mL/L/hr	1.0	1.5	3.0
Turbidity	NTUs	75	100	225
pH	s.u.	6.0 – 9.0 at all times		

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
Fisheries Ecology Division
110 Shaffer Road
Santa Cruz, California 95060

February 27, 2021

Revision date January 25, 2018

BEST MANAGEMENT PRACTICES PLAN
For
OCEAN DISCHARGE AT FISHERIES ECOLOGY DIVISION

REQUIRED READING FOR SEAWATER SYSTEM USERS

Statement of BMP Policy

For the purposes of this Best Management Practices Plan for the operation of the FED Laboratory ocean discharge, it is our policy to limit the amount of food or feces from animals and to keep our ocean discharge free of pollutants attributed to residuals of drugs used for animal health and residuals of chemicals used in cleaning our pools, aquaria, and equipment or for maintaining or enhancing water quality.

All personnel at the FED lab who use the seawater system and its discharge to the ocean must read and be familiar with this plan.

This Plan, which addresses seawater users at the FED Laboratory facilities, is intended as the facility BMP Plan, which serves to satisfy our general ocean discharge permit requirements, overseen by the State of California Regional Water Quality Control Board.

Animal Feeding Procedures

- Animal feed shall be limited to quantities expected to be consumed over a short period of time to prevent uneaten food from accumulating on the bottom of tanks.
- Animal care staff must monitor their pools and/or aquaria during and after feedings to ensure that excess feed material does not remain for excessive periods of time.
- Animal care staff must regularly remove un-eaten feed materials from their pools and/or aquaria to minimize solids discharge events to the ocean outfall.

Pool and Aquaria Maintenance Procedures Involving Ocean Discharge

1. Cleaning agents are allowed only if a protocol for their use has been approved by the Aquarium Room Manager at FED.
2. Chlorine bleach disinfectant and Iodine are approved for use at FED Lab when the following use protocol is followed.
3. When disinfecting with bleach, the process must preclude the release of

4. When bleach is used in the cleaning or disinfection process, the waste water must be directed to the isolation sump. When the isolation sump is full it must be de-chlorinated prior to the waste water being discharged.
5. Use of bleach as a disinfectant must be supervised by staff who have been trained in the procedure, including the proper techniques to de-chlorinate the water.
6. Iodine is to be used at a concentration of 25 ppm. After the tanks are cleaned the water is to be left on to fill the tanks and slowly clear the tank of the iodine.

Schedules of Activities

1. Feeding and cleaning activities may occur as necessary unless the FED Facilities Manager or Aquarium Room Manager notifies system users otherwise due to maintenance or repair activities that may conflict.

Materials Storage

1. Drugs, chemicals, and feed must be stored so as to prevent spills that could enter the ocean discharge stream.
2. Simplified emergency spill response procedures must be posted in areas where these materials are stored.

Structural Maintenance

1. Routine inspection and maintenance of the FED discharge and dechlorination system is provided by the FED Facilities Manager.
2. It is the responsibility of users of the systems to immediately report any mal function to FED Facilities Manager.

Prohibited Practices

1. Discharge to the ocean of any hazardous material or drug.
2. Activities in violation of these Best Management Practices.

Treatment Methods

1. For any project or experiment that requires drug treatment of or chemical additives to the seawater in a pool or aquaria and has the potential to discharge to the ocean, the investigator must first consult with the FED Aquarium Room manager and UCSC Campus Veterinarian to establish proper protocols that avoid pollution of the ocean discharge stream.

Training

1. All FED laboratory seawater system users (whose use includes the ocean discharge stream) must be familiar with this BMP Plan and receive documented training in the following areas, as applicable. Training shall be provided by the appropriate lab/work group supervisor or management staff of the FED Laboratory:

Record Keeping

- Feeding procedures.
- Cleaning procedures where chemical cleaning or disinfection agents are used.
- Operation of the de-chlorination system.
- Chemical spill prevention and response.

1. The supervisors of each lab/work group, or FED Laboratory management staff as appropriate, must maintain training records, to include: Description of the training; who was trained and dates that individuals were trained.
2. Any lab/work groups that feed more than 10 kilograms of food each week must maintain records that document feed amounts, along with the numbers and weight of their animals.
3. Records of inspection, maintenance and repair of the discharge system are kept by the FED Facility Manager.

Erick Sturm
Research Fisheries Biologist
FED Aquarium Systems
Manager

Coastal Biology Building seawater discharge Best Management Practices plan

January 2021

The following document is required reading for all seawater system users and supervisors in the Coastal Biology Building on UC Santa Cruz's Coastal Science Campus.

Best Management Practices plan statement

The University of California Santa Cruz (UCSC) Coastal Science Campus (CSC) Best Management Practices (BMP) plan is a joint management effort, controlled and monitored by CSC seawater system users who share a common ocean discharge point. All seawater system users follow BMP regulations to ensure compliance with ocean discharge permit requirements.

Seawater system users at the CSC include UCSC's Long Marine Laboratory (LML) and Coastal Biology Building (CBB), NOAA's Southwest Fisheries Science Center, and the California Department of Fish and Wildlife's (CDFW) Marine Wildlife Veterinary Care and Research Center.

The guidelines noted in this action plan are specific to seawater users at CBB. Drains at CBB

that discharge toward the ocean include:

- Tank farm seawater drain joins sea water return system, draining into sea water scepter, then to ocean outfall.
- Bioswales slow storm water flow and allow infiltration, overflow and storm drains distributed throughout the Coastal Science campus drain to Younger lagoon or through the sea water scepter and then to ocean outfall.

CBB BMP Policy

Water discharged from our seawater system must be free of pollutants attributed to: (1) uneaten feeds and feces, (2) residual drugs used for animal health, and (3) residual chemicals for cleaning pools, aquaria, equipment or for maintaining or enhancing water quality conditions.

The guidelines and procedures herein help ensure compliance with ocean discharge permit requirements set forth by the State of California Regional Water Quality Control Board (General Permit No.
CAG993003, Order No. R3-2013-0041).

Animal feeding procedures

To minimize uneaten feed and fecal discharge to the ocean, procedures shall limit animal feed input to the minimum amount necessary to achieve targeted growth rates. Guidelines to help achieve this goal include:

Animal feed shall be limited to quantities that are expected to be consumed over a short period of time.

Animal care staff must actively monitor pools and/or aquaria during and after feedings to ensure excess feed material does not remain for extended periods of time.

Animal care staff must regularly remove un-eaten feed materials and feces from pools and/or aquaria to minimize solid waste discharge.

Cleaning and maintenance

Residual chemical compounds, solid waste, animal mortalities and other contaminants can enter discharge waters due to facilities cleaning and operations. CBB requires that such operations minimize pollutant discharge during cleaning, maintenance, laboratory work or other activities.

Cleaning agents are allowed only if protocols for use have been approved by CBB management.

Cleaning processes must prevent the release of measurable chlorine in accordance with objectives of the California Ocean Plan.

Animal mortalities must be disposed of on a regular basis.

The discharge of animal feces, blood, viscera or carcasses must be minimized.

No contaminants or refuse shall be allowed to enter storm or seawater drains at CBB.

Schedule of activities

Feeding and cleaning activities shall occur as necessary unless CBB management notifies system users otherwise.

Materials Storage

Drugs, chemicals, and feed must be stored so as to prevent spills that could enter the ocean discharge stream. Emergency spill response procedures must be posted in materials storage areas.

Structural Maintenance

- Routine inspection and maintenance of the CBB discharge system is provided by Physical Plant Services.
- It is the responsibility system users to immediately report any malfunctions to CBB management and Physical Plant Services.

Prohibited Practices

- Discharge of any hazardous materials or toxic drugs.
- Discharge of any non-native or invasive species.
- Discharge of fish pathogens identified by the CDFW, title 14 of the California Code of Regulations, section 245.
- Discharge of prohibited materials indicated in the Transmittal of Adopted Waste Discharge Requirements Order No. R3- 20012-0041.
- Activities in violation of the CBB BMP.

Treatment methods

For any project or experiment that requires drug treatment or chemical additives to the seawater in pools or aquaria that have the potential to discharge into the ocean, the investigator must first consult with CBB management to establish ocean pollution avoidance protocols.

Employee training

All CBB seawater system users must be familiar with the CBB BMP and receive documented training in the following areas, as applicable (training shall be provided by the appropriate CBB lab supervisor or management staff):

- Feeding procedures
- Cleaning procedures
- Chemical cleaning reagent use
- Chemical spill prevention and response

Record keeping

- Training records must be maintained by CBB lab supervisors, and must include trainee names, dates and descriptions of completed training.
- Groups that use more than 10 kg/week of animal feed must maintain records that document feed amounts, along with animal numbers and weights.
- Records of inspection, maintenance and repair of the seawater discharge system are maintained by the Physical Plant Services.
- Any spill or other National Pollutant Discharge Elimination System (NPDES) permit violation must be immediately reported to the facility manager and CBB management, who will communicate with the Regional Water Quality Control Board and the Monterey Bay National Marine Sanctuary.

Seawater receiving and discharge monitoring

- All flow measurement devices must be inspected and calibrated at least once per year and are maintained by Physical Plant Services.

- Water sampling and monitoring is performed by the CBB facilities manager on a quarterly basis. Grab samples from the designated discharge point are collected during peak loading conditions downstream of the discharge point and upstream of any mixing with receiving waters.

- Receiving water conditions at point(s) of discharge and throughout the reach must be visually inspected on a quarterly basis. Presence of any of the following must be recorded:
    - Floating or suspended matter
    - Discoloration
    - Bottom deposits
    - Visible films, sheens, or coatings
    - Fungi, slimes, or biological growth
    - Any other unusual observations

- Water quality analyses must be performed by a laboratory certified by the State Department of Public Health (DPH).
- Monitoring results must meet permitted effluent limitations and must be submitted annually to the Central Coast Regional Water Quality Control Board.

Effluent Limitations

Pollutant	Units	Monthly Average	Weekly Average	Instantaneous Maximum
Oil & Grease	mg/L	25	40	75
Total Suspended Solids (TSS)	mg/L	---	---	60
Settleable Solids	mL/L/hr	1.0	1.5	3.0
Turbidity	NTUs	75	100	225
pH	s.u.	6.0 – 9.0 at all times		

State of California -The Natural Resources Agency
DEPARTMENT OF FISH AND WILDLIFE
Office of Spill Prevention and Response
Marine Wildlife Veterinary Care & Research Center
151 McAllister Way
Santa Cruz, CA 95060
www.wildlife.ca.gov/OSPR

EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

January 25, 2021

Randolph Skrovan
Facilities Manager
Long Marine
Laboratory
University of California, Santa Cruz
115 McAllister Way
Santa Cruz, CA 95060

Dear Randolph:

Attached, please find our Best Management Practices Plan for Ocean Discharge at the California Department of Fish and Wildlife Marine Wildlife Veterinary Care & Research Center, updated for 2021. There are no significant changes to this plan, and we will continue to train any new personnel using the seawater system.

Please let me know if you have any questions.

Sincerely,

Laird Henkel

Facility Director
Marine Wildlife Veterinary Care & Research Center
Ph: 831-469-1726
Email: laird.henkel@wildlife.ca.gov

BEST MANAGEMENT PRACTICES (BMP) PLAN
For
OCEAN DISCHARGE AT THE CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
MARINE WILDLIFE VETERINARY CARE & RESEARCH CENTER

January 2021

Background

Ocean discharges from the U.C. Santa Cruz Coastal Campus seawater system, including from the NOAA Fisheries Santa Cruz Laboratory and the CDFW Marine Wildlife Veterinary Care & Research Center (MWVCRC), are permitted under NPDES general permit No. CAG993003 (for discharges from aquaculture facilities and aquariums). The UC Santa Cruz Institute for Marine Sciences is listed as an authorized discharger under this permit, and provides quarterly reports to the Central Coast Regional Quality Control Board regarding discharge volumes and any potential permit violations.

The NPDES permit requires dischargers to maintain written Best Management Practices (BMP) Plans to prevent pollutants from being discharged to the ocean. This BMP Plan for the MWVCRC is intended to prevent pollution from entering the U.C. Santa Cruz seawater system discharge. Because the MWVCRC is used in part by U.C. Santa Cruz personnel (particularly for marine mammal husbandry), this BMP Plan largely mirrors the BMP Plan for the U.C. Santa Cruz Long Marine Lab. Specifically, this BMP Plan aims to keep the MWVCRC ocean discharge free of pollutants attributed to the feeding of or feces from animals; residuals of drugs used for animal health; residuals of chemicals used in cleaning pools and/or equipment, or for maintaining or enhancing water quality; and pollution from storm water runoff or accidental spills.

Drains at the MWVCRC that allow water to enter the U.C. Santa Cruz seawater system ocean discharge include:

1. Animal husbandry pool seawater return drains (unless switched to drain into a holding tank)
2. Trenches and storm drains in the animal pool yard
3. The driveway storm drain east of the necropsy lab near the south edge of the property
4. Storm drains on the concrete pad outside/behind the necropsy lab (except the smaller drains under the roof overhang in front of the building).
5. The storm drains along the front of the main building, south of the breezeway entrance

Policy

All supervisors of personnel at the MWVCRC or U.C. Santa Cruz who use the seawater system (and its discharge to the ocean) at the MWVCRC must read and be familiar with this plan, and that their personnel comply with these BMPs.

Storm Drains

1. No contaminants or refuse shall be allowed to enter the storm drains at the MWVCRC.

Animal Feeding Procedures

1. Animal feed shall be limited to quantities expected to be consumed over a short period of time.
2. Animal care staff must monitor pools they are using during and after feedings to ensure that excess feed material does not remain for excessive periods of time.
3. Animal care staff must regularly remove un-eaten feed materials from pools they are using to minimize such solids discharge to the ocean outfall.

Pool Maintenance Procedures Involving Ocean Discharge

1. Cleaning agents are allowed only if a protocol for their use has been approved by the Director of the MWVCRC.
2. Chlorine bleach disinfectant and the following use protocol, is approved for the MWVCRC.
    a. When disinfecting with bleach, the process must preclude the release of measurable chlorine residuals to the ocean.
    b. When bleach is used in the cleaning or disinfection process, the de-chlorination system in the discharge stream (at Long Marine Lab) must be turned on before any chlorine residual is allowed to enter the discharge stream.
    c. Use of bleach as a disinfectant must be supervised by staff who have been trained in the procedure, including the proper use of the de-chlorination system.

Schedules of Activities

1. Feeding and cleaning activities may occur as necessary unless the MWVCRC Facilities Manager or Director notifies system users otherwise due to maintenance or repair activities that may conflict.

Materials Storage and Spill Response

1. Drugs, chemicals, and feed must be stored so as to prevent spills that could enter the ocean discharge stream.
2. Simplified emergency spill response procedures (for spills of any pollutant that could enter the ocean discharge stream) must be posted in areas where these materials are stored.
3. In the event that the MWVCRC is used to care for oiled wildlife, water contaminated with petroleum products and/or cleaning agents will be directed to a wastewater holding tank, and not allowed to enter the seawater discharge.

Structural Maintenance

1. Routine inspection and maintenance of the MWVCRC discharge system is provided by the MWVCRC Facilities Manager.
2. It is the responsibility of users of the systems to immediately report any malfunction to MWVCRC management.

Prohibited Practices

1. Discharge to the ocean of any hazardous material or drug.
2. Discharge to the ocean of any non-native invasive species.
3. Activities in violation of these Best Management Practices.

Treatment Methods

1. For any project or experiment that requires drug treatment of or chemical additives to the seawater in a pool that has the potential to discharge to the ocean, the investigator must first consult with the MWVCRC Director to establish proper protocols which must include procedures that avoid pollution of the ocean discharge stream.

Training

1. All MWVCRC seawater system users (whose use includes the ocean discharge stream) must be familiar with this BMP Plan and receive documented training in the following areas, as applicable. Training shall be provided by the appropriate staff of the MWVCRC or Long Marine Lab:
    - Feeding procedures.
    - Cleaning procedures where chemical cleaning or disinfection agents are used.
    - Chemical spill prevention and response.

Record Keeping

1. The MWVCRC Director and appropriate Long Marine Lab management staff must maintain training records, to include: description of the training; who was trained; and dates that individuals were trained.
2. Any pool users that feed more than 10 kilograms of material each week must maintain records that document feed amounts, along with the numbers and weight of their animals.
3. Records of inspection, maintenance and repair of the discharge system on MWVCRC grounds are kept by the MWVCRC Facilities Manager.
4. Any spill or other NPDES permit violation must be reported without delay to the Long Marine Lab Facilities Manager, who will report pertinent information to the RWQCB and the MBNMS.

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1020662
Reporting Date: March 5, 2021

Date Received:	February 24, 2021
Project # / Name:	None / None
Sample Identification:	influent - grab, sampled 2/24/2021 2:05:00PM
Sampler Name / Co.:	Randolph Skrovan / UCSC Long Marine Lab
Matrix:	Aqueous
Laboratory #:	1020662-01

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	8.1	pH Units	0.1	SM4500-H+ B	02/24/21	
Turbidity	1.7	NTU	0.10	SM 2130B	02/24/21	
Total Suspended Solids	4.1	mg/L	1.0	SM 2540D	02/25/21	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1020662
Reporting Date: March 5, 2021

Date Received:	February 24, 2021
Project # / Name:	None / None
Sample Identification:	effluent - grab, sampled 2/24/2021 2:15:00PM
Sampler Name / Co.:	Randolph Skrovan / UCSC Long Marine Lab
Matrix:	Aqueous
Laboratory #:	1020662-02

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	7.9	pH Units	0.1	SM4500-H+ B	02/24/21	
Oil & Grease (total)	ND	mg/L	5.0	EPA 1664B	03/01/21	
Turbidity	4.3	NTU	0.10	SM 2130B	02/24/21	
Total Settleable Solids	ND	mL/L	0.10	SM2540F	02/25/21	
Total Suspended Solids	5.3	mg/L	1.1	SM 2540D	02/25/21	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

TEL: 831-724-5422
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UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1020662
Reporting Date: March 5, 2021

*** DEFAULT GENERAL METHOD *** - Quality Control

Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PC10004 - Default Prep GenChem											
Blank (PC10004-BLK1)					Prepared & Analyzed: 01-Mar-21						
Oil & Grease (total)	ND		5.0	mg/L							
Reference (PC10004-SRM1)					Prepared & Analyzed: 01-Mar-21						
Oil & Grease (total)	36.60		5.0	mg/L	39.8		92.0	80-120			

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1020662
Reporting Date: March 5, 2021

Classical Chemistry Parameters - Quality Control
Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PB10377 - Default Prep GenChem											
Duplicate (PB10377-Dup1)		**Source: 1020594-01**			Prepared & Analyzed: 24-Feb-21						
pH	5.67		0.1	pH Units		5.75			1.40	20	
Reference (PB10377-SRM1)					Prepared & Analyzed: 24-Feb-21						
pH	6.73		0.1	pH Units	6.70		100	80-120			
Batch PB10383 - Default Prep GenChem											
Blank (PB10383-BLK1)					Prepared & Analyzed: 24-Feb-21						
Turbidity	ND		0.10	NTU							
Duplicate (PB10383-Dup1)		**Source: 1020662-02**			Prepared & Analyzed: 24-Feb-21						
Turbidity	4.400		0.10	NTU		4.300			2.30	20	
Reference (PB10383-SRM1)					Prepared & Analyzed: 24-Feb-21						
Turbidity	14.00		0.10	NTU	14.5		96.6	80-120			
Batch PB10400 - Default Prep GenChem											
Blank (PB10400-BLK1)					Prepared & Analyzed: 25-Feb-21						
Total Suspended Solids	ND		1.0	mg/L							
Duplicate (PB10400-Dup1)		**Source: 1020564-01**			Prepared & Analyzed: 25-Feb-21						
Total Suspended Solids	45.21		5.3	mg/L		45.86			1.43	20	

Soil Control Lab

42 Hangar Way : Watsonville, CA 95076
Phone: (831) 724-5422
Fax: (831) 724-3188

CHAIN-OF-CUSTODY

1020662

Client/Company Name:	**UCSC Long Marine Lab**	Comments/Special Instructions:	Seawater
Attn:	**Randolph Skrovan**		
Address:	115 McAllister Way		
	Santa Cruz, CA 95060		
Phone:	831-459-4735		
Fax:	831-459-3383		
E-mail:	rskrovan@ucsc.edu		
Project Name:	LML Ocean Discharge Monitoring	Send Invoice To:	Jody Bruner
Project Number:		P.O. / Contract No:	PO718153

Lab Use Only: Storage Location: / Freezer #: / Refrigerator #: / Shelf #:

Lab Use Only: ID Number	Client Sample Identification	Sampling Date	Sampling Time	Matrix	Sample Preservative	Bottle Type	Bottle Size	No. of Bottles	TSS / Turbidity	pH	Settleable Solids	Oil and Grease		Sample Condition
01	influent / grab	2/24/21	1405	Seawater	none	HDPE ✓	250 ml	1		X				
01	influent / grab		"	Seawater	none	HDPE ✓	1 L	1	X					
02	effluent / grab		1415	Seawater	none	HDPE ✓	1 L	1			X			
02	effluent / grab			Seawater	none	HDPE ✓	1 L	1	X					
02	effluent / grab			Seawater	none	HDPE ✓	150 ml	1		X				
02	effluent / grab			Seawater	H_2SO_4	AG ✓	1 L	1				X		

Sampler's Signature and Printed Name:

Relinquished By (Signature and Printed Name):	Date	Time	Transported By:	Received By (Signature and Printed Name):	Date	Time:
Randolph Skrovan	2/24/21	1600	AB	Adam Wachtel	2/24/21	1615
				Susan Ussler/ Lynne Nagata		

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1040571
Reporting Date: July 6, 2021

Date Received:	April 21, 2021
Project # / Name:	None / LML Ocean Discharge Monitoring
Sample Identification:	Influent/ Grab, sampled 4/21/2021 12:05:00PM
Sampler Name / Co.:	Randolph Skrovan / UCSC Long Marine Lab
Matrix:	Aqueous
Laboratory #:	1040571-01

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	7.8	pH Units	0.1	SM4500-H+ B	04/21/21	
Turbidity	3.1	NTU	0.10	SM 2130B	04/21/21	
Total Suspended Solids	8.5	mg/L	1.2	SM 2540D	04/26/21	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1040571
Reporting Date: July 6, 2021

Date Received:	April 21, 2021
Project # / Name:	None / LML Ocean Discharge Monitoring
Sample Identification:	Effluent/ Grab, sampled 4/21/2021 12:05:00PM
Sampler Name / Co.:	Randolph Skrovan / UCSC Long Marine Lab
Matrix:	Aqueous
Laboratory #:	1040571-02

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	7.9	pH Units	0.1	SM4500-H+ B	04/21/21	
Oil & Grease (total)	ND	mg/L	4.8	EPA 1664B	05/13/21	
Turbidity	0.35	NTU	0.10	SM 2130B	04/21/21	
Total Settleable Solids	ND	mL/L	0.10	SM2540F	04/22/21	
Total Suspended Solids	5.1	mg/L	1.1	SM 2540D	04/26/21	

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ANALYTICAL CHEMISTS
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TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1040571
Reporting Date: July 6, 2021

*** DEFAULT GENERAL METHOD *** - Quality Control

Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PE10010 - Default Prep GenChem											
Blank (PE10010-BLK1)					Prepared & Analyzed: 13-May-21						
Oil & Grease (total)	ND		5.0	mg/L							
Reference (PE10010-SRM1)					Prepared & Analyzed: 13-May-21						
Oil & Grease (total)	37.80		5.0	mg/L	39.8		95.0	78-114			

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1040571
Reporting Date: July 6, 2021

Classical Chemistry Parameters - Quality Control
Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PD10329 - Default Prep GenChem											
Duplicate (PD10329-Dup1)		**Source: 1040571-02**			Prepared & Analyzed: 21-Apr-21						
pH	7.87		0.1	pH Units		7.86			0.127	20	
Reference (PD10329-SRM1)					Prepared & Analyzed: 21-Apr-21						
pH	6.70		0.1	pH Units	6.70		100	80-120			
Batch PD10335 - Default Prep GenChem											
Blank (PD10335-BLK1)					Prepared & Analyzed: 21-Apr-21						
Turbidity	ND		0.10	NTU							
Duplicate (PD10335-Dup1)					Prepared & Analyzed: 21-Apr-21						
Turbidity	0.3500		0.10	NTU						20	
Reference (PD10335-SRM1)					Prepared & Analyzed: 21-Apr-21						
Turbidity	14.00		0.10	NTU	14.5		96.6	80-120			
Batch PD10398 - Default Prep GenChem											
Blank (PD10398-BLK1)					Prepared & Analyzed: 26-Apr-21						
Total Suspended Solids	ND		1.0	mg/L							
Duplicate (PD10398-Dup1)		**Source: 1040622-02**			Prepared & Analyzed: 26-Apr-21						
Total Suspended Solids	191.7		14	mg/L		189.5			1.15	20	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Soil Control Lab

42 Hangar Way : Watsonville, CA 95076
Phone: (831) 724-5422
rev. Feb 21

**** All BOLDED Sections MUST Be Completed ****

Chain-of-Custody

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Soil Control Lab Use Only

Account #   Laboratory #: 1040571

Client/Company Name: UCSC Long Marine Lab
Attn: Randolph Skrovan
Address: 115 McAllister Way
City, State & Zipcode: Santa Cruz, CA 95060
Billing Address if different:
Phone: 831-459-4735
E-mail (1): rskrovan@ucsc.edu
E-mail (2):
Project #:
Project Name: LML Ocean Discharge Monitoring
Water System # is assigned by the State or County if applicable
Water System Name/ #:

Contact information for Bacteria Samples:
If sample(s) is positive for coliform bacteria contact:
Name: ______________ **Phone #:** ________
Name: ______________ Phone #: ________
(if we are unable to notify, by law the regulator may be contacted)
Sampling Period: ☐ Monthy ☐ Quarterly ☐ N/A or Other ________
Δ* Note: if bacteriological sample is for regulatory purposes, per §64423.1, a Δ*Sample Designation (Below) is Required.

Regulator **Regulatory Sample: Yes☐ No☐** (If no, leave this section blank)
Copies To: ☐EHS Santa Cruz County Health ☐EHB Monterey County Health Dept
☐DOHS/ SWRCB - (CA WaterBoard*) ________ *(ex.Dist 05 Monterey, Dist 17 Richmond)
☐ Electronic Data Transfer to State (PS Code must be provided in Sample ID)
☐Other Regulator ________

Sampler's Name (Print): Randolph Skrovan
Sampler's Company: UCSC
Sampler's Signature: [signature]

Comments/ Special Instructions:
Sea water

Analyses Requested - [Tests Needed]
(Examples: Nitrate, General Mineral, Inorganics, etc.)

	Sample Name/ Identification/ Location/Site (inc lude PS code if this is a regulatory sample)	**Sampled: Date and Time**		*Matrix Code	Cl2 Residual	Field Notes or reading (Optional):	**Δ* Sample Designation (Type): Routine, Repeat, or Other:**	Bacteria: Total Coliforms / E.Coli Sampler must specify: P/A ☐ or MPN ☐	TSS/Turbidity	pH	Settleable Solids	Oil & Grease
01	Influent / grab / 250ml/1L	~~4/19/21~~ 4/21/21	11:57				Routine		X	X		
02	Effluent / grab 1L	↓	12:05								X	
02	Effluent / grab 1L								X			
02	Effluent / grab 250ml									X		
02	Effluent / grab 1L											X

*Matrix code examples: DW= Drinking Water , AqW=WasteWater, AqIR=Irrigation or Reclaimed, or [Solids]

Relinquished By (Signature and Print Name):	**Date/Time:**		Received By:	*Date/Time:*
[signature] Randolph Skrovan	4/21/21	16:15	[signature] Susan Ussler / Mike Galloway / Adam Wachtel	4.21.21 1630

For Lab Use Only: Receiving Temp: 10.1 °C Thermometer: #1 ☑ #2 ☐ Cooling Method: Wet Blue None Other: ________
Sample Notes: Chilling Process Begun by client? Y / N Container Received: Bacteria ☐ 8oz Poly ☑ ~~8oz Poly w/ HNO₃~~ ☐
8oz Poly w/ H2SO4 ☐ 1L Poly ☑ 1L 8oz AG w/ H2SO4 ☑ Other ☐ ________

Bottle(s) Marked / Chain of Custody Filled Out Properly By Client? Yes ☐ No ☐

ANALYTICAL CHEMISTS
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BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1070223
Reporting Date: July 30, 2021

Date Received: July 8, 2021
Project # / Name: None / LML Ocean Discharge Monitoring
Sample Identification: Influent Grab, sampled 7/8/2021 2:45:00PM
Sampler Name / Co.: Randolph Skrovan / UCSC Long Marine Lab
Matrix: Aqueous
Laboratory #: 1070223-01

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	8.1	pH Units	0.1	SM4500-H+ B	07/08/21	
Turbidity	1.5	NTU	0.10	SM 2130B	07/08/21	
Total Suspended Solids	4.1	mg/L	1.4	SM 2540D	07/09/21	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1070223
Reporting Date: July 30, 2021

Date Received:	July 8, 2021
Project # / Name:	None / LML Ocean Discharge Monitoring
Sample Identification:	Effluent Grab, sampled 7/8/2021 2:50:00PM
Sampler Name / Co.:	Randolph Skrovan / UCSC Long Marine Lab
Matrix:	Aqueous
Laboratory #:	1070223-02

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	7.9	pH Units	0.1	SM4500-H+ B	07/08/21	
Oil & Grease (total)	ND	mg/L	5.0	EPA 1664B	07/28/21	
Turbidity	0.35	NTU	0.10	SM 2130B	07/08/21	
Total Settleable Solids	ND	mL/L	0.10	SM2540F	07/09/21	
Total Suspended Solids	ND	mg/L	1.4	SM 2540D	07/09/21	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1070223
Reporting Date: July 30, 2021

*** DEFAULT GENERAL METHOD *** - Quality Control

Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PG10413 - Default Prep GenChem											
Blank (PG10413-BLK1)					Prepared & Analyzed: 28-Jul-21						
Oil & Grease (total)	ND		5.0	mg/L							
Reference (PG10413-SRM1)					Prepared & Analyzed: 28-Jul-21						
Oil & Grease (total)	36.70		5.0	mg/L	39.8		92.2	78-114			

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

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UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1070223
Reporting Date: July 30, 2021

Classical Chemistry Parameters - Quality Control
Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PG10115 - Default Prep GenChem											
Blank (PG10115-BLK1)					Prepared & Analyzed: 08-Jul-21						
Turbidity	ND		0.10	NTU							
Duplicate (PG10115-Dup1)		**Source: 1070223-01**			Prepared & Analyzed: 08-Jul-21						
Turbidity	1.500		0.10	NTU		1.500			0.00	20	
Reference (PG10115-SRM1)					Prepared & Analyzed: 08-Jul-21						
Turbidity	14.00		0.10	NTU	14.5		96.6	80-120			
Batch PG10124 - Default Prep GenChem											
Blank (PG10124-BLK1)					Prepared & Analyzed: 09-Jul-21						
Total Suspended Solids	ND		1.0	mg/L							
Blank (PG10124-BLK2)					Prepared & Analyzed: 09-Jul-21						
Total Suspended Solids	ND		1.0	mg/L							
Duplicate (PG10124-Dup1)		**Source: 1070148-01**			Prepared & Analyzed: 09-Jul-21						
Total Suspended Solids	96.30		15	mg/L		111.5			14.7	20	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Soil Control Lab
42 Hangar Way : Watsonville, CA 95076
Phone: (831) 724-5422
rev. March 21

**** All BOLDED sections MUST Be Completed ****

Chain-of-Custody

Page ___ of ___

Soil Control Lab Use Only
Account # Laboratory #: 1070223

Client/Company Name: UCSC Long Marine Lab
Attn: Randolph Skrovan
Address: 115 McAllister Way
City, State & Zipcode: Santa Cruz, CA 95060
Billing Address if different:
Phone numbers(s): 831-459-4735
E-mail (1): rskrovan@ucsc.edu
E-mail (2):
Project #:
Project Name: LML Ocean Discharge Monitoring
Water System # is assigned by the State or County if applicable
Water System Name and #:

Sampler's Name (Print): Randolph Skrovan
Sampler's Company: UCSC
Sampler's Signature: [signature]

Comments/ Special Instructions:
Seawater

Contact information for Bacteria Samples:
If sample(s) is positive for coliform bacteria contact:
Name: ______ **Phone #:** ______
Name: ______ Phone #: ______
(if we are unable to notify, by law the regulator may be contacted)
Sampling Period: ☐ Monthly ☐ Quarterly ☐ N/A or Other

Δ* Note: if bacteriological sample is for regulatory purposes, per §64423.1, a Δ*Sample Designation (Below) is Required.

Regulator Copies To:
Regulatory Sample: Yes☐ **No**☐ (If no, leave this section blank)
☐ EHS Santa Cruz County Health ☐EHB Monterey County Health Dept
☐ SWRCB-DDW-CA WaterBoards-District ________ (Monterey=D5, Santa Clara=D17
☐ Electronic Data Transfer to State (PS Code must be provided in Sample ID)
☐ Other Regulator:

Analyses Requested - [Tests Needed]
(Examples: Nitrate, General Mineral, Inorganics, etc.)

Sample Name/ Identification/ Location/Site (include PS code if this is a regulatory sample)		**Sampled: Date and Time**	*Matrix Code	Field Notes or reading (Optional): Field Cl_2 Residual	**Δ* Sample Designation (Type): Routine, Repeat, or Other:**	Bacteria: Total Coliforms / E.Coli [Sampler must specify: (P/A or MPN)]	TSS/Turbidity	pH	Settleable Solids	Oil & Grease	
Influent/grab/250ml/	1L	7/8/21 14:45			Routine		X	X			01
Effluent/grab	1L	14:50							X		02
Effluent/grab	1C						X				
Effluent/grab	250ml							X			
Effluent/grab	1C									X	

*Matrix code examples: DW= Drinking Water , AqW=WasteWater, [illegible]igation or Reclaimed, or [Solids]

Relinquished (delivered to lab) by (Signature and Print Name): [signature] **Date/Time:** 7/8/21 16:09
Randolph Skrovan

For lab use only: - Received By: [signature] Date/Time: 7-8-21 1625
Susan Ussler / Mike Galloway / Adam Wachtel

For Lab Use Only: Receiving Temp: 16.0 Thermometer: #1 ☑ #2 ☐
Sampler Cooling Method: Wet Blue None Other: ______
Sample Notes: Chilling Process Begun by client? Y / N
Container Received: Bacteria ☐ 8oz Poly ☐ 8oz Poly w/ HNO_3 ☐ 8oz Poly w/ H_2SO_4 ☐ 1L Poly ☐ 1L/ 8oz AG w/ H_2SO_4 ☐ Other ☐ ______

Bottle(s) Marked / Chain of Custody Filled Out Properly By Client? Yes ☐ No ☐

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1100294
Reporting Date: November 10, 2021

Date Received:	October 12, 2021
Project # / Name:	None / LML Ocean Discharge Monitoring
Sample Identification:	Influent/ Grab, sampled 10/12/2021 2:35:00PM
Sampler Name / Co.:	Randolph Skrovan / UCSC Long Marine Lab
Matrix:	Aqueous
Laboratory #:	1100294-01

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	7.9	pH Units	0.1	SM4500-H+ B	10/12/21	
Turbidity	4.3	NTU	0.10	SM 2130B	10/12/21	
Total Suspended Solids	13	mg/L	1.1	SM 2540D	10/19/21	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1100294
Reporting Date: November 10, 2021

Date Received:	October 12, 2021
Project # / Name:	None / LML Ocean Discharge Monitoring
Sample Identification:	Effluent/ Grab, sampled 10/12/2021 2:40:00PM
Sampler Name / Co.:	Randolph Skrovan / UCSC Long Marine Lab
Matrix:	Aqueous
Laboratory #:	1100294-02

	Results	Units	RL	Analysis Method	Date Analyzed	Flags
pH	7.8	pH Units	0.1	SM4500-H+ B	10/12/21	
Oil & Grease (total)	ND	mg/L	5.0	EPA 1664B	10/27/21	
Turbidity	0.30	NTU	0.10	SM 2130B	10/12/21	
Total Settleable Solids	ND	mL/L	0.10	SM2540F	10/13/21	
Total Suspended Solids	ND	mg/L	1.0	SM 2540D	10/19/21	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1100294
Reporting Date: November 10, 2021

*** DEFAULT GENERAL METHOD *** - Quality Control

Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PJ10362 - Default Prep GenChem											
Blank (PJ10362-BLK1)					Prepared & Analyzed: 27-Oct-21						
Oil & Grease (total)	ND		110	mg/L							
Reference (PJ10362-SRM1)					Prepared & Analyzed: 27-Oct-21						
Oil & Grease (total)	791.9		110	mg/L	873		90.7	80-120			

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

ANALYTICAL CHEMISTS
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SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188

UCSC Long Marine Lab
115 McAllister Way
Santa Cruz, CA 95060
Attn: Randolph Skrovan

Work Order #: 1100294
Reporting Date: November 10, 2021

Classical Chemistry Parameters - Quality Control
Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PJ10165 - Default Prep GenChem											
Duplicate (PJ10165-Dup1)		**Source: 1100294-02**			Prepared & Analyzed: 12-Oct-21						
pH	7.82		0.1	pH Units		7.82			0.00	20	
Reference (PJ10165-SRM1)					Prepared & Analyzed: 12-Oct-21						
pH	7.21		0.1	pH Units	7.23		99.7	80-120			
Batch PJ10171 - Default Prep GenChem											
Blank (PJ10171-BLK1)					Prepared & Analyzed: 12-Oct-21						
Turbidity	ND		0.10	NTU							
Duplicate (PJ10171-Dup1)					Prepared & Analyzed: 12-Oct-21						
Turbidity	0.3500		0.10	NTU						20	
Reference (PJ10171-SRM1)					Prepared & Analyzed: 12-Oct-21						
Turbidity	1.600		0.10	NTU	14.5		11.0	80-120			
Batch PJ10238 - Default Prep GenChem											
Blank (PJ10238-BLK1)					Prepared & Analyzed: 19-Oct-21						
Total Suspended Solids	ND		1.0	mg/L							

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Soil Control Lab
42 Hangar Way : Watsonville, CA 95076
Phone: (831) 724-5422
rev. March 21

**** All BOLDED sections MUST Be Completed ****

Chain-of-Custody

Page 1 of 1

Soil Control Lab Use Only
Account #   Laboratory #: 1100244

Client/Company Name: UCSC Long Marine Lab
Attn: Randolph Skrovan
Address: 115 McAllister Way
City, State & Zipcode: Santa Cruz, CA 95060
Billing Address if different:
Phone numbers(s): 831-818-2071
E-mail (1): rskrovan@ucsc.edu
E-mail (2):
Project #:
Project Name: LML Ocean Discharge Monitoring
Water System # is assigned by the State or County if applicable
Water System Name and #:

Sampler's Name (Print): Randolph Skrovan
Sampler's Company: UCSC
Sampler's Signature: [signature]

Comments/ Special Instructions:
Seawater

Contact information for Bacteria Samples:
If sample(s) is positive for coliform bacteria contact:
Name: **Phone #:**
Name: **Phone #:**
(if we are unable to notify, by law the regulator may be contacted)
Sampling Period: ☐ Monthy ☐ Quarterly ☐ N/A or Other
Δ* Note: if bacteriological sample is for regulatory purposes, per §64423.1, a Δ*Sample Designation (Below) is Required.

Regulator Copies To: **Regulatory Sample: Yes**☐ **No**☐ (If no, leave this section blank)
☐ EHS Santa Cruz County Health ☐EHB Monterey County Health Dept
☐ SWRCB-DDW-CA WaterBoards-District ________(Monterey=D5, Santa Clara=D17
☐ Electronic Data Transfer to State (PS Code must be provided in Sample ID)
☐ Other Regulator:

Field Notes or reading (Optional):

Analyses Requested - [Tests Needed] (Examples: Nitrate, General Mineral, Inorganics, etc.)

Sample Name/ Identification/ Location/Site (include PS code if this is a regulatory sample)	Sampled: Date and Time	*Matrix Code	Field Cl_2 Residual	Δ* Sample Designation (Type): Routine, Repeat, or Other:	Bacteria: Total Coliforms / E.Coli [Sampler must specify: (P/A or MPN)]	TSS/ Turbidity	pH	Settleable Solids	Oil & Grease
Influent/grab 250ml/1L	10/12/21 14:35			Routine		X	X		
Effluent/grab 1L	14:40							X	
Effluent/grab 1L						X			
Effluent/grab 250ml							X		
Effluent/grab 1L									X

*Matrix code examples: DW= Drinking Water , AqW=WasteWater, AqIR=Irrigation or Reclaimed, or [Solids]

Relinquished (delivered to lab) by (Signature and Print Name): [signature] Randolph Skrovan **Date/Time:** 10/12/21 16:20

For lab use only: - Received By: Susan Ussler / Mike Galloway / Adam Wachtel *Date/Time:* 10/12/21 16:30

For Lab Use Only: Receiving Temp: 15.1°C Thermometer: #1 ☑ #2 ☐ Sampler Cooling Method: Wet Blue None Other: ________
Sample Notes: Chilling Process Begun by client? Y / N Container Received: Bacteria ☐ 8oz Poly ☑ 8oz Poly w/ HNO_3 ☐ 8oz Poly w/ H2SO4☐ 1L Poly ☑ 1L 8oz AG w/ H2SO4 ☑ Other ☐

Bottle(s) Marked / Chain of Custody Filled Out Properly By Client? Yes ☐ No ☐

Appendix B

Younger Lagoon Reserve Annual Report

(bound separately)

University California, Santa Cruz

Younger Lagoon Reserve

Annual Report 2020-2021

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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 60 undergraduate students who were involved with research, education, and stewardship. Prior to the COVID-19 pandemic, the majority of interns were involved in hands-on restoration and monitoring activities on the Terrace Lands engaging in a wide range of projects. When the COVID-19 pandemic began, the reserve internship program pivoted to virtual activities including readings, videos, and online discussion sections with reserve staff and local restoration experts. Although initially planned to be in place for only a short period of time (spring 2020), Younger Lagoon Reserve's virtual internship was offered for the entire FY 2020-2021 as the pandemic wore on. Despite the ongoing pandemic, Younger Lagoon Reserve continued to support use by other groups such as Cabrillo College, San Jose State University, the Santa Cruz Bird Club, local K-12 programs, and other community groups.

Restoration activities in FY 2020-2021 included weed control, planting of approximately 1.5 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 10th year of CLRDP compliance monitoring. Habitats monitored in 2021 included coastal scrub, coastal prairie, and wetland areas. YLR is meeting or exceeding restoration targets for all monitored sites and is meeting the restoration goals for Phase 2. FY 2020-2021 represented the 11th 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. With the approval of the CCC, some public access programming was temporarily suspended due to the ongoing COVID-19 pandemic. These programs will resume when public health orders allow. YLR is fulfilling all required public access requirements for the Younger Lagoon Reserve beach.

In Summary, despite the ongoing COVID-19 global health pandemic, 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 2020-2021 fiscal year (July 1, 2020 - June 30, 2021). Prior to the COVID-19 pandemic, Younger Lagoon continued to see increases in use and activity in general. As the COVID-19 pandemic continued, reserve staff found creative ways to maintain engagement with the reserve such as virtual class visits, virtual tours, and virtual internships. 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 tenth 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. The ongoing COVID-19 pandemic has highlighted the importance of high-quality open space for human health (i.e. green workouts, opportunities for mask-less conversations, a sense of connection with something larger than the present crisis, etc.) and public use of the reserve and CSC exploded during the pandemic. Due to the COVID-19 pandemic, and in response to UCSC's request for a COVID-19 emergency waiver, on July 10, 2020 the Commission issued a permit waiver to UCSC 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 entrance gate was closed to unauthorized vehicles for several months during FY 2020-2021 (), and as a result, the CSC took on something of an Open Streets atmosphere with members of the public rollerblading in the streets and families walking the trails. 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 12th 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 11th 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. Implementation of the NOID 9 special conditions by the Seymour Center cost approximately $15,000/year.

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. Implementation costs for the NOID 12 special conditions will need to be determined by the new Seymour Center Director in consultation with campus administration.

Due to COVID-19 precautions and fiscal impacts of the pandemic, and in response to UCSC's request for a COVID-19 emergency waiver, on July 10, 2020 the Commission issued a permit waiver to UCSC 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 was temporarily suspended in early March 2020 and the beach tour program remained suspended for the entire 2020-2021 fiscal year. The University will restart the free beach tour program when the Seymour Center reopens (target date, spring 2022).

A detailed report on activities under the Beach Access Management Plan is included as Appendix 1. The NOID 12 Special Conditions Implementation Report 2 is 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, and 2019-2020 Annual Reports). Compliance monitoring for restored coastal scrub, coastal prairie, and wetland areas was conducted in FY 2020-2021. All sites monitored in 2020-2021 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 2020-2021. Activities included weed control, planting, and seed collection.

<u>Restoration Monitoring efforts in 2021-2022</u>
During the 2021-2022 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.

<u>SRP Phase 1B</u>

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

To reconnect hydrology between W1 and W2, five brush packs (ditch plugs) were installed within W1 in the summer of 2016 and 2017 (See 2016-2017 Annual Report and SRP Phase 1 Summary Report). 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.

<u>Domesticated Animals</u>

In 1999, when the University purchased the land for the expanded CSC, a special exception was made in the campus code to allow leashed dogs on the bluff top trail that rings the YLR Terrace Lands. Since that time, the site had become popular with dog owners, many of whom do not obey the leash law. The CLRDP requires that all domesticated animals be eliminated from the campus. Parallel to the start of construction, implementation of the campus "no dog" policy began in May 2015 in conjunction with activities under NOID 6 (13-1), and continued in FY 2020-2021. 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 2020-2021. Discussion topics included current and future projects under the CLRDP, restoration, research, and teaching activities at YLR.

Monitoring Recommendations:
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 this year.

Research Recommendations:
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 at the direction of the SAC are below.

Increasing Success of Native Annual Forbs Through Timed Planting
Native annual forbs in California can often be competitively excluded by non-natives and competitive native species like perennial bunch grasses. Recent restoration work suggests that manipulating the temporal priority of community assembly can alter these competitive relationships. A common method to do so involves altering species' sequential arrival by prioritizing early arrival for weaker competitors. This intentional ordering of species introduction results can cause 'priority effects.' Priority effects allows early arrivers to establish access to resources before highly competitive species arrive.

Under the direction of SAC Chair, Dr. Karen Holl, graduate student Justin Luong, and undergraduate student Ernesto Chavez-Velasco tested whether planting annual forbs two weeks prior to planting perennial grasses increases annual forb survival and reproductive success, or if planting perennial grasses two years earlier than forbs might provide nurse plant and facilitation. After one-growing season, they found that giving temporal priority to planting of native annual forbs increased forb survivorship and seed production and did not decrease native perennial grass survivorship. They did not find strong evidence of perennial bunch grasses acting as nurse plants for annual forbs. Instead, they found that forb survival and reproduction often decreased when planted with *D. cespitosa*. They also found that total seed and fruit production were strongly correlated for native forbs.

Although forb priority benefited native annual forbs, it did also increase the biomass of unplanted forbs compared to grass priority. This may indicate that greater invasive control may need to be undertaken for non-native forbs in native forb priority planting areas.

Holl et al. found facilitation of native annual forb establishment using perennial native bunchgrasses as nurse plants was not supported by their results. Rather, they found that forbs often had lower survival when growing with *D. cespitosa*. This likely is because *D. cespitosa* has low biotic resistance to invasion, evidenced by greater unplanted biomass, leading to stronger negative effects of invasive competition.

Based on the results of the first year of their study, Holl et al. make the following management recommendations:

1. When planting native annual forbs and perennial grasses, annual forbs should have 2-week temporal priority before planting perennial grasses. This can increase survival and seed output of annual forbs. Giving forbs priority does not affect grass survival.
2. Areas with *D. cespitosa* may need more invasive control compared to areas planted with *E. glaucus* or *S. pulchra*. Forb priority promotes greater unplanted forb biomass compared to in grass priority, also indicating a need for invasive control in these areas.
3. Because seed counts are extremely labor and time intensive and total seed and fruit are strongly correlated, Holl et al. recommend that future work focuses on counting total fruit as a measure of reproductive success.

<u>Scientific Advisory Committee Management Recommendations:</u>

In FY 2020-2021 the SAC continued to discuss 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 need 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 continued throughout FY 2020-2021. If the permits and approvals can be obtained, the University plans to move forward with plans to build a pond to improve breeding habitat for CRLF in the upper terrace in the fall of 2021.

The SAC is generally supportive of the idea of CRLF pond(s) 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 have 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 provided feedback on draft designs for the pond in FY 2020-2021 and will continue to provide guidance as plans develop for building a CRLP breeding pond in the upper terrace.

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, and 2019-2020 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 in the middle terrace. (See 2017-2018, 2018-2019, and 2019-2020 Annual Reports).

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 6, 2021. At each photo point we collected the following information:

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

Photos are included in Appendix 4.

Restoration Activities

Restoration activities continued on the Terrace Lands of YLR and throughout the lagoon portion of the Reserve. Prior to the COVID-19 pandemic, 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. During the pandemic, implementation was conducted largely by undergraduate student employees and staff rather than undergraduate student interns and volunteers due to restrictions on in-person instruction and campus visitors (Figure 1). Here we summarize some of the restoration activities that occurred on YLR during the past year.

Figure 1. Reserve staff and undergraduate student employees transplant native seedlings in preparation for native planting following COVID precautions.

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 2020-2021, 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 2021-2022, reserve staff will continue weed control projects and patrols. Due to the long-lived seed bank of French Broom, proximity of mature Jubata grass and Panic veldgrass on adjacent properties, and known ability of Cape Ivy fragments to re-sprout, regular patrols and maintenance of these sites will be critical. Removal of new recruit Monterey Pine and Cypress will continue as will targeted removal of current individuals.

Seed Collection and Plant Propagation

In the summer and fall of 2020, 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 2020/2021.

Restoration Planting

In FY 2020-2021, approximately 1.5 acres of coastal prairie areas were planted with native seedlings (Figure 2). Coastal prairie habitat is notoriously difficult to restore. This area had been planted in 2012 but had fallen below restoration targets for three years. At the recommendation of the SAC, the 2012 restoration was scrapped, and the entire site was replanted this year.

Figure 2. 2021 Restoration Site.

Education

Instructional use at Younger Lagoon Reserve continued to be strong this year; however, due to the COVID-19 pandemic, some field courses were canceled while others transitioned to remote or hybrid instruction. Several courses participated in virtual visits of 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 – despite the pandemic. 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 proximity to the UCSC Campus and Long Marine Laboratory make it an ideal setting for undergraduate teaching and research (Figure 3). In FY 2020-2021 the reserve hosted classes in Coastal Field Studies, Ecology, Molecular Ecology, and Natural History Practicum (Table 1). Due to COVID-19 precautions, many field courses were offered online or not offered at all during the 2021 spring quarter. Reserve staff hosted virtual class visits and virtual tours of the reserve; however, the number of spring class visits (usually the busiest time of the year) was lower than in previous years due to the COVID-19 pandemic.

Figure 3. Students practice small mammal live-trapping techniques at Younger Lagoon Reserve.

Internships

In FY2020-2021, YLR staff sponsored over 30 undergraduate interns through the UCSC Environmental Studies Internship Office. This is about half the average number of student interns the reserve sponsored pre pandemic. 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. Prior to the COVID-19 pandemic, interns participated in hands-on projects including invasive species removal, re-vegetation with native species, seed collection, and propagation. During the COVID-19 pandemic, students participated in a virtual internship that included 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 (Figure 4).

Figure 4. Undergraduate student interns remove invasive Jubata grass from the upper terrace.

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
BIOE 137 – Molecular Ecology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Beth Shapiro
BIOE 112 – Ornithology	University of California, Santa Cruz (Dept. of Ecology and Evolutionary Biology)	Bruce Lyon
KRSG 3 – Natural History Practicum	University of California, Santa Cruz (Kresge College)	Sean Riley
ENVS 84 / 184 - Younger Lagoon Reserve Stewardship Interns	University of California, Santa Cruz (Dept. of Environmental Studies)	Vaughan Williams

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 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.

Luong JC, Holl KD, Loik ME. 2021. Leaf traits and phylogeny explain plant survival and community dynamics in response to extreme drought in a restored coastal grassland. Journal of Applied Ecology 58(8): 1670-1680. https://doi.org/10.1111/1365-2664.13909

Luong JC, Loik, ME. 2021. Selecting coastal California prairie species for climate-smart grassland restoration. Grasslands 31(1): 4-9.

In FY 2020-2021 we approved seven research applications. Examples and summaries of new and ongoing research are included below.

Graduate Student Research Highlight: Landscape-level mapping of plant microbiomes

Recent interest and research into microbiomes across taxa has made it abundantly clear that there is a real need for large scale natural history studies of microbial diversity and distribution. In plants, microbial partners play key roles in everything from maintaining normal function and phenology, to potentially mediating adverse effects of climate change or disturbance, to being the source of (as yet) unknown pathogens as climate change alters the dynamics in these intricate and complex relationships. One direction this need has taken is in the search for a core microbiota, but these efforts are somewhat conflated by the split arguments for a taxonomically-defined core microbiota vs. a functionally-defined core microbiota, and both often lack distinct distribution data. This project, conducted by UC Berkeley graduate student investigator Anna Scharnagel seeks to combine recent efforts at mapping the phylodiversity of California with a survey of the microbial diversity in a community of plants found in coastal prairie, which by definition of its habitat is confined to a narrow band along the coast (thus providing comparable points along a gradient). Coastal prairie is susceptible to climate change as altered precipitation regimes and lower instance and duration of coastal fogs may enhance salt stress and drought, as well as increase vulnerability to pathogens. Much of this habitat also faces various levels of disturbance from invasive species to coastal development. It also contains sites of high endemism, making it a target for conservation. The aim of this study is to contribute to our understanding of the distribution patterns of plant microbiomes and their relatedness to other distributions as part of a larger co-occurrence dataset.

Faculty Research Highlight: International Drought Experiment

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

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

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

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

During 2020-20121, the drought experiment activities at Younger Lagoon Reserve (YLR) were somewhat reduced due to COVID-19. All drought experiment and research activities at Younger

Lagoon Reserve (YLR) were undertaken with proper COVID-19 safety protocols. Work focused on: 1. Monitoring of plots in accordance with the International Drought Experiment protocol; 2. Continued collection of micrometeorological data from a sensor system set up in a prior year; 3. Publication of YLR IDE Restoration research; 4. Community composition assessment in all IDE plots (restored and not) related to Baccharis pilularis invasion; 5. Senior thesis related to soil collection from restored and unrestored IDE plots; 6. Preparation of glasshouse experiment about interactive effect of drought and competition on native species for publication; 7. Senior thesis related to a glasshouse experiment to determine the effect of fog and drought on Stipa pulchra and Sidalcea malviflora; 8. A new YLR experiment testing priority effects for establishing native annual forbs; 9. Chlorophyll fluorescence and stomatal conductance measurements of Baccharis pilularis in all IDE plots and; 10. Soil decomposition, litter and nematode responses to drought at unplanted IDE plots. A full report on the International Drought Experiment is included in Appendix 3.

To provide different modes of communicating science, graduate student researcher, Justin Luong works with artists that create graphical illustrations of completed research to help reach new audiences. In FY 2020-2021, Luong worked with artist Lesley Goren to create artwork depicting his work on how leaf traits and phylogeny explain plant survival and community dynamics in response to extreme drought in a restored coastal grassland. This work was published in the journal *Grasslands* by the California Native Grassland Association

Figure 5. Art by Lesley Goren depicting graduate student researcher Justin Luong's work on how leaf traits and phylogeny explain plant survival and community dynamics in response to

extreme drought in a restored coastal grassland, conducted at the experimental *DroughtNet* shelters.

Public Service

Public service use at Younger Lagoon Reserve was lower this year due to ongoing COVID-19 pandemic impacts to public programming; however, several new public groups did use the reserve in FY 2020-2021. Public service users encompassed a wide variety of groups. The continuation of public service use despite the pandemic is a direct result of having fulltime staff on site that are able to actively engage public groups through outreach efforts as well as providing on-the-ground assistance in public service activities. The proximity of Younger Lagoon to the town of Santa Cruz enables members of the public to easily use the Reserve for a wide variety of approved endeavors ranging from birding to K-12 teaching (Table 2, Table 3).

Seymour Marine Discovery Center Ocean Explorers Summer Camp

Every summer, the Seymour Marine Discovery Center offers a summer camp for youth ages 7-14. Prior to the COVID -18 pandemic, campers traveled as a group in vans to coastal sites around the Monterey Bay. In the summer of 2021, van travel was prohibited due to concerns of shared indoor air and all activities were offered within walking distance of the Seymour Center. Campers participated in multiple inquiry and observational activities in the lagoon area and Terrace Lands during each of the camp sessions.


Figure 6. Seymour Marine Discovery Center Ocean Explorers Summer Camp program participants explore invertebrates in the lagoon.

Reserve Use

Despite the ongoing COVID-19 pandemic, the greatest educational user group for YLR in FY 2020-2021 was once again undergraduate education. A breakdown of all user groups is included in Table 2. YLR was used by UC Santa Cruz, UC Berkeley, UC Davis, UC Los Angeles, CSU San Jose, Cabrillo College, Audubon Society, Black Oystercatcher Monitoring Project, Seymour Marine Discovery Center, and the Santa Cruz Bird Club (Table 3).

Table 2. Younger Lagoon Total Use

RESERVE USE DATA Fiscal year: 2020-2021

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	3	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	27
Research Scientist/Post Doc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	4	4
Research Assistant (non-student/faculty/postdoc)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
Graduate Student	2	34	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	44
Undergraduate Student	8	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	57
K-12 Instructor	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
Professional	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	2	2
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1
Volunteer	0	0	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2	10
SUBTOTAL	18	123	3	17	0	0	0	0	0	0	0	0	0	0	6	6	0	0	2	2	0	0	1	3	30	151
UNIVERSITY - LEVEL INSTRUCTION (CLASS)																												
Faculty	1	2	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5
Research Scientist/Post Doc	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Graduate Student	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Undergraduate Student	86	401	0	0	19	19	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	109	424
Professional	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10
SUBTOTAL	88	413	1	1	21	21	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	115	441
OTHER																												
Staff	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
Faculty	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Research Scientist/Post Doc	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
Undergraduate Student	2	154	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	155
K-12 Instructor	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	0	0	9	9	0	0	12	26
K-12 Student	30	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	83	0	0	93	193
Professional	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
Other	1	1	0	0	0	0	0	0	0	0	0	0	0	0	17	17	3	3	0	0	1	2	0	0	22	23
Volunteer	4	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	52	0	0	2	6	28	1456	35	1534
SUBTOTAL	44	301	0	0	0	0	0	0	0	0	1	1	0	0	17	17	5	66	0	0	75	100	28	1456	170	1941
HOUSING																												
TOTALS	**150**	**837**	**4**	**18**	**21**	**21**	**5**	**6**	**0**	**0**	**1**	**1**	**0**	**0**	**23**	**23**	**5**	**66**	**2**	**2**	**75**	**100**	**29**	**1459**	**315**	**2533**

Table 3. Younger Lagoon Group Affiliations

University of California Campus	**Non-governmental organizations**
University of California, Berkeley	Kids in Nature
University of California, Davis	Audubon Society
University of California, Los Angeles	Black Oystercatcher Monitoring Project
University of California, Santa Cruz	Santa Cruz Bird Club
	Seymour Marine Discovery Center
California State Universities	
California State University, San Jose	**Governmental Agencies**
	US Geological Survey
California Community College	
Cabrillo Community College	
	Business Entities
	Geophysical Survey Systems, Inc.

Summary

Despite the ongoing COVID-19 pandemic, FY 2020-2021 was a successful year for YLR. The reserve continued to move forward with restoration, initiated new projects, strengthened collaborations, and developed new online internships and virtual tours to meet user needs during the 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 2021-2022.

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.

<u>DURATION OF APPOINTMENTS</u>

Faculty Director: 5 years

Faculty Advisors: 3 years

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

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

Hours/Quarter: Chair/NRS Representative-20, Members-10
Reports to: Division of Physical & Biological Sciences Dean

MEMBERSHIPS

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

Año Nuevo Reserve Faculty Advisor	Daniel Costa Professor, Ecology & Evolutionary Biology Long Marine Lab, Center for Ocean Health (831) 459-2786 – costa@biology.ucsc.edu
UCSC Campus Reserve Faculty Advisor	Greg Gilbert Professor, Environmental Studies Environmental Studies Department (831) 459-5002 – ggilbert@ucsc.edu
Fort Ord Reserve Faculty Advisor	Laurel Fox Professor, Ecology & Evolutionary Biology Coastal Biology Building (831) 459-2533 – fox@biology.ucsc.edu
Landels-Hill Big Creek Reserve Faculty Advisor	Peter Raimondi Professor, Ecology & Evolutionary Biology Long Marine Lab, Center for Ocean Health (831) 459-5674 – raimondi@biology.ucsc.edu
Faculty Advisor at Large	Erika Zavaleta Professor, Ecology & Evolutionary Biology Coastal Biology Building (831) 459-5011 – zavaleta@ucsc.edu
Ad hoc Faculty Member	Chris Wilmers Professor, Environmental Studies Environmental Studies Department (831) 459-2634—cwilmers@ucsc.edu
1 Non-Senate Academic	Chris Lay Lecturer and Museum Curator, Environmental Studies Environmental Studies Department (831) 459-4763 – cml@ucsc.edu
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	Gage H. Dayton, Advisory Committee Convenor Administrative Director, UCSC Natural Reserves c/o Environmental Studies Department (831) 459-4867 - ghdayton@ucsc.edu
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	Patrick Robinson, Ph.D. – Director Año Nuevo Reserve Long Marine Lab, Conservation Annex
	Elizabeth Howard – Director Younger Lagoon Reserve Long Marine Lab, Conservation Annex (831) 459-2455 – eahoward@ucsc.edu
	Alex Jones, MS – Manager

Campus Natural Reserve
Natural Sciences II, Rm 465

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

Younger Lagoon Reserve Scientific Advisory Committee (SAC)

Charge

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

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

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

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

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

Dr. Karen Holl has been on the faculty in the Environmental Studies Department at the University of California, Santa Cruz for 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

2021

Younger Lagoon Reserve staff conduct a COVID-safe fish seine.

Elizabeth Howard and Gage Dayton
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.

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 2020 and a summary report for the entire 11-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 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). 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) 2020-2021 (July 1, 2020 – June 30, 2021) 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 2020-2021.

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

Due to COVID-19 precautions, the Seymour Center was temporarily closed and the free beach tour program temporarily suspended in March 2020. The University will restart the free beach tour program when the Seymour Center reopens and Orders of the State Public Health Officer and County of Santa Cruz Health Officer currently in effect are rescinded or amended (see UC Santa Cruz's Pub. Res. Code section 30611 notification letter to the Commission).

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.

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 the 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 has 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 visit the Seymour Center, and nearly 15,000 visitors take 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.

Prior to the COVID-19 pandemic, 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 will be offered 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, Twitter, Instagram, Pinterest, Flickr, 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/education/teen-programs/watsonville-area-teens-conserving-habitats-watch.

Community Bioblitz
Due to the COVID-19 pandemic, the annual Younger Lagoon Reserve Bioblitz / California Academy of Sciences was again canceled this year. 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
Prior to the COPVID-19 pandemic, 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

Despite the ongoing COVID-19 pandemic, a wide variety of public and non-profit research and educational groups used Younger Lagoon in FY20-21 (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. The free Seymour Center docent led Younger Lagoon beach tours were temporarily suspended in March 2020 and remained so through the entire fiscal year. It is our hope that these tours can be safely resumed during the 2021-2022 fiscal year. Since the start of the Seymour Center docent led beach access tours, 203 tours have gone out and more than 1,260 visitors have participated. The beach access tours are part of a broad offering of public outreach and education programming on the Coastal Science Campus managed by the Seymour Center, including K-12 school visits to the Seymour Center, the Ocean Explorers Summer Camp, Bay Area Libraries Discover and Go Program, as well as print, web, social media, and radio campaigns.

Despite ongoing staff efforts towards public outreach and education, some unauthorized uses of Younger Lagoon Reserve, including trespass and vandalism occurred in FY 2020-2021. Thus far, no significant damage to ecologically sensitive habitat areas, research sites, research equipment, or facilities has occurred. Perhaps due to the decrease in human use of the beach due to the COVID-19 pandemic, bobcats were once again detected during track plate monitoring – after a year of no bobcat detections in FY 2019-2020, while no human footprints were observed during FY 2020-2021 sampling efforts (Table 7). 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	Kids in Nature
University of California, Davis	Audubon Society
University of California, Los Angeles	Black Oystercatcher Monitoring Project
University of California, Santa Cruz	Santa Cruz Bird Club
	Seymour Marine Discovery Center
California State Universities	
California State University, San Jose	**Governmental Agencies**
	US Geological Survey
California Community College	
Cabrillo Community College	
	Business Entities
	Geophysical Survey Systems, Inc.

Table 2. Younger Lagoon Total Use.

RESERVE USE DATA Fiscal year: 2020-2021

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	3	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	27
Research Scientist/Post Doc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0	4	4
Research Assistant (non-student/faculty/postdoc)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1
Graduate Student	2	34	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	44
Undergraduate Student	8	57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	57
K-12 Instructor	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5
Professional	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	2	2
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1
Volunteer	0	0	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	2	10
SUBTOTAL	18	123	3	17	0	0	0	0	0	0	0	0	0	0	6	6	0	0	2	2	0	0	1	3	30	151
UNIVERSITY - LEVEL INSTRUCTION (CLASS)																												
Faculty	1	2	0	0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5
Research Scientist/Post Doc	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Graduate Student	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Undergraduate Student	86	401	0	0	19	19	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	109	424
Professional	1	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10
SUBTOTAL	88	413	1	1	21	21	5	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	115	441
OTHER																												
Staff	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	6
Faculty	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Research Scientist/Post Doc	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
Undergraduate Student	2	154	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	155
K-12 Instructor	2	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	11	0	0	9	9	0	0	12	26
K-12 Student	30	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	83	0	0	93	193
Professional	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
Other	1	1	0	0	0	0	0	0	0	0	0	0	0	0	17	17	3	3	0	0	1	2	0	0	22	23
Volunteer	4	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	52	0	0	2	6	28	1456	35	1534
SUBTOTAL	44	301	0	0	0	0	0	0	0	0	1	1	0	0	17	17	5	66	0	0	75	100	28	1456	170	1941
HOUSING																												
TOTALS	**150**	**837**	**4**	**18**	**21**	**21**	**5**	**6**	**0**	**0**	**1**	**1**	**0**	**0**	**23**	**23**	**5**	**66**	**2**	**2**	**75**	**100**	**29**	**1459**	**315**	**2533**

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

[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	
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				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, 201 Younger Lagoon	X	X					
May 4, 2021 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 (69%) and least at either Sand Plant Beach (28%) or Younger Lagoon (32%) (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
Younger Lagoon	28.3	23	24	25

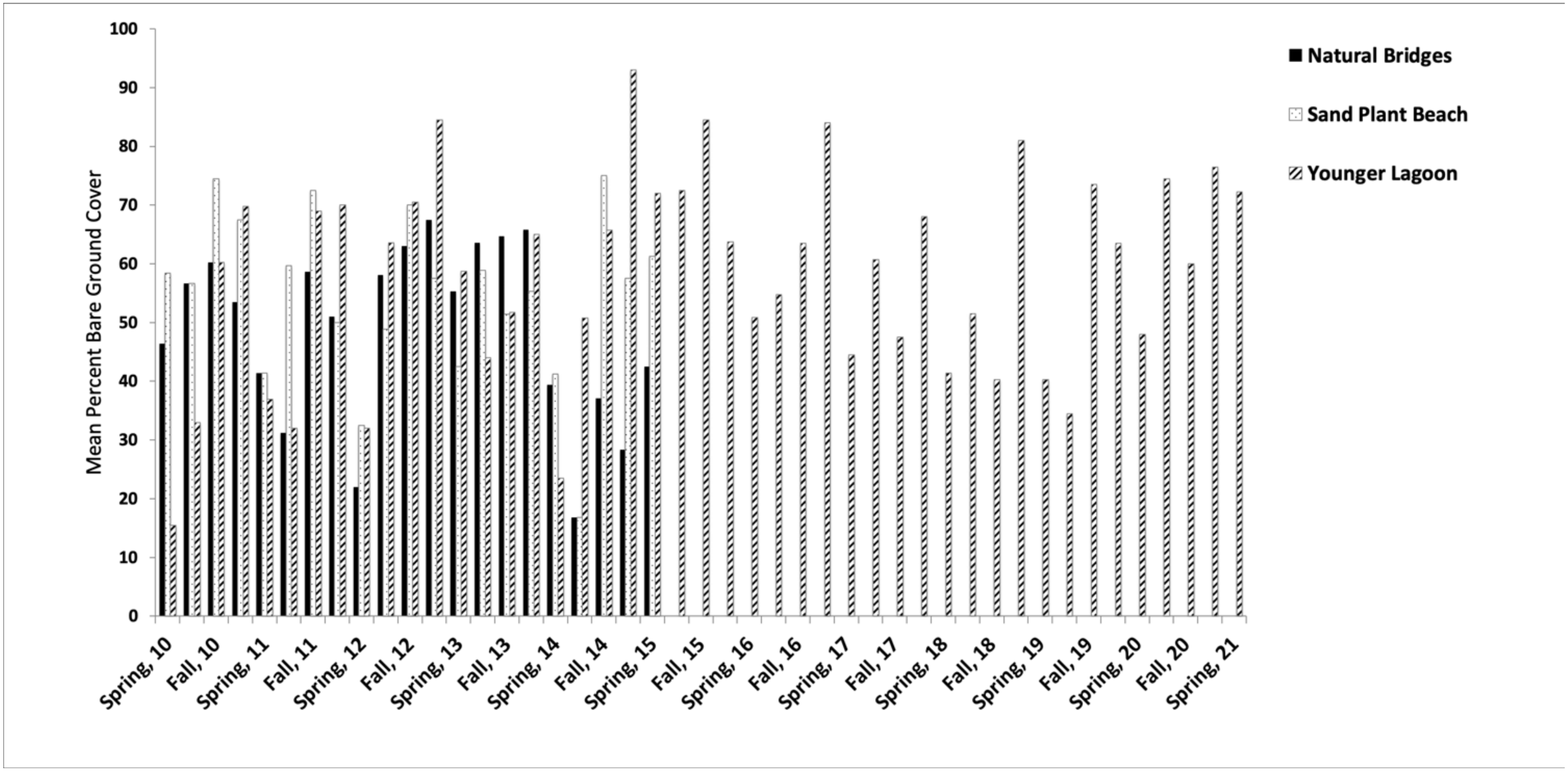

Figure 5. Mean percent bare ground encountered at each site.

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
Younger Lagoon				
Native	6 (67%)	8 (73%)	7 (58%)	7 (58%)

Non-native	3 (33%)	3 (27%)	5 (42%)	5 (42%)
Total	9	11	12	12

Site	**Proportion of native and non-native species across all sample periods**
Natural Bridges	
Native	**47%**
Non-native	**53%**
Total	
Younger Lagoon	
Native	**68%**
Non-native	**32%**
Total	
Sand Plant Beach	
Native	**72%**
Non-native	**28%**
Total	

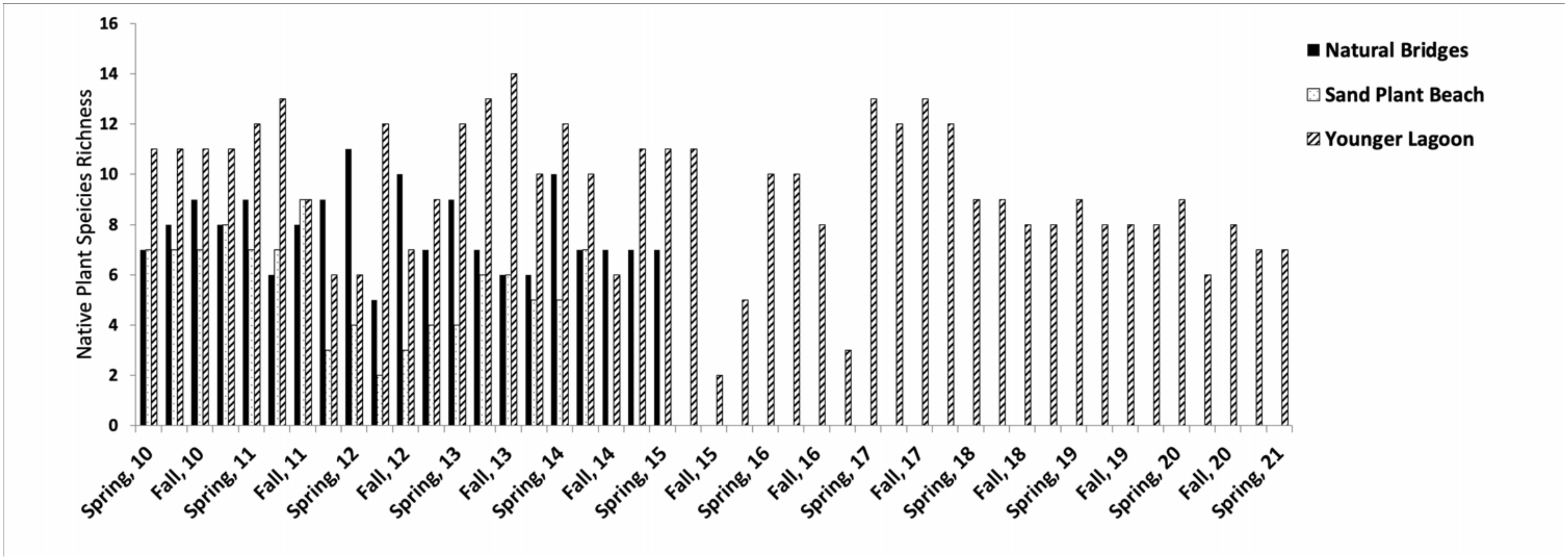

Figure 6. Number of native plant species encountered at each site.

Track Plate Monitoring

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. Native species richness of mammals detected in raked sand plots was across all three sites (n = 8). Ground squirrel were not detected at Natural Bridges and opossum have not been detected in our track surveys at Sand Plant Beach or Younger Lagoon Reserve (Table 7). It is likely that ground squirrels occur at Natural Bridges and opossum are likely using upland habitat at Sand Plant Beach and Younger Lagoon Reserve; however, they were not detected in our survey efforts. Dogs and bicycles were detected at Natural Bridges and Sand Plant Beach and vehicles were detected at Natural Bridges (Table 7). For the first time since sampling began in 2010, no bobcats were detected at Younger Lagoon Reserve in FY2019-2020, while humans were detected during every sampling event. Perhaps due to the decrease in human use due to the pandemic, in FY2020-2021, bobcats were once again detected and no humans were detected during sampling events. 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

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
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													

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
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

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
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

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

	Rodent[1]	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human
February 22-23, 2021													
Younger Lagoon				X			X		X				
May 4-5, 2021													
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 2021 track plate sampling efforts. Actual detections are included parenthetically.

Site	Rodent	Raccoon	Cottontail	Bobcat	Skunk	Squirrel	Deer	Opossum	Coyote	Bicycle	Vehicle	Dog	Human	[1]Native sp. Richness
Little Wilder	(15) 71%	(10) 48%	(4) 19%	(15) 71%	(6) 29%	(1) 6%	(2) 10%	0%	(15) 71%	(2) 10%	(0) 0%	(3) 14%	(19) 91%	8
Younger Lagoon	(21) 48%	(26) 60%	(2) 5%	(28) 65%	(9) 21%	(2) 5%	(7) 16%	0%	(29) 67%	(1) 2%	(0) 0%	(0) 0%	(19) 44%	8
Natural Bridges	(9) 43%	(15) 71%	(4) 19%	(9) 43%	(13) 62%	0%	(8) 38%	(1) 5%	(9) 43%	(1) 5%	(14) 67%	(16) 76%	(21) 100%	8

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

Small Mammal Trapping

Although we are no longer monitoring Natural Bridges and Sand Plant beaches, we continue include results in order to have standalone reports that include all data going forward. A total of 347 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**

October 29-30, 2015				
Younger Lagoon	2	6		**8**
February 2-3, 2016				
Younger Lagoon		6		**6**
May 3-4, 2016				
Younger Lagoon		3	1	**4**
July 12-13, 2016				
Younger Lagoon		4		**4**
November 9-10, 2016				
Younger Lagoon	2	1		**3**
March 1-2, 2017				
Younger Lagoon	2	1		**3**
April 25-26, 2017				
Younger Lagoon		1		**1**
August 2-3, 2017				
Younger Lagoon				**0**
October 25-26, 2017				

Younger Lagoon	1	1	2		**4**
February 8-9, 2018					
Younger Lagoon	2				**2**
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		**8**
February 20-21, 2019					
Younger Lagoon	5		2	1	**8**
May 14-15, 2019					
Younger Lagoon	4				**4**
July 15-16, 2019					
Younger Lagoon	4				**4**
October 30-31, 2019					
Younger Lagoon	1		1		**2**

Site	Pema[1]	Mica[1]	Reme[1]	Rara[1,2]	**TOTAL**
February 11-12, 2020					
Younger Lagoon	2		1		**3**
May 20-21, 2020					
Younger Lagoon	1		2		**3**
August 18-19, 2020					
Younger Lagoon	6				
November 16-17, 2020					
Younger Lagoon	6		2		
February 23-24, 2021					
Younger Lagoon	6		2		
May 4-5, 2021					
Younger Lagoon	5				
TOTAL	**195**	**56**	**92**	**4**	**347**

[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

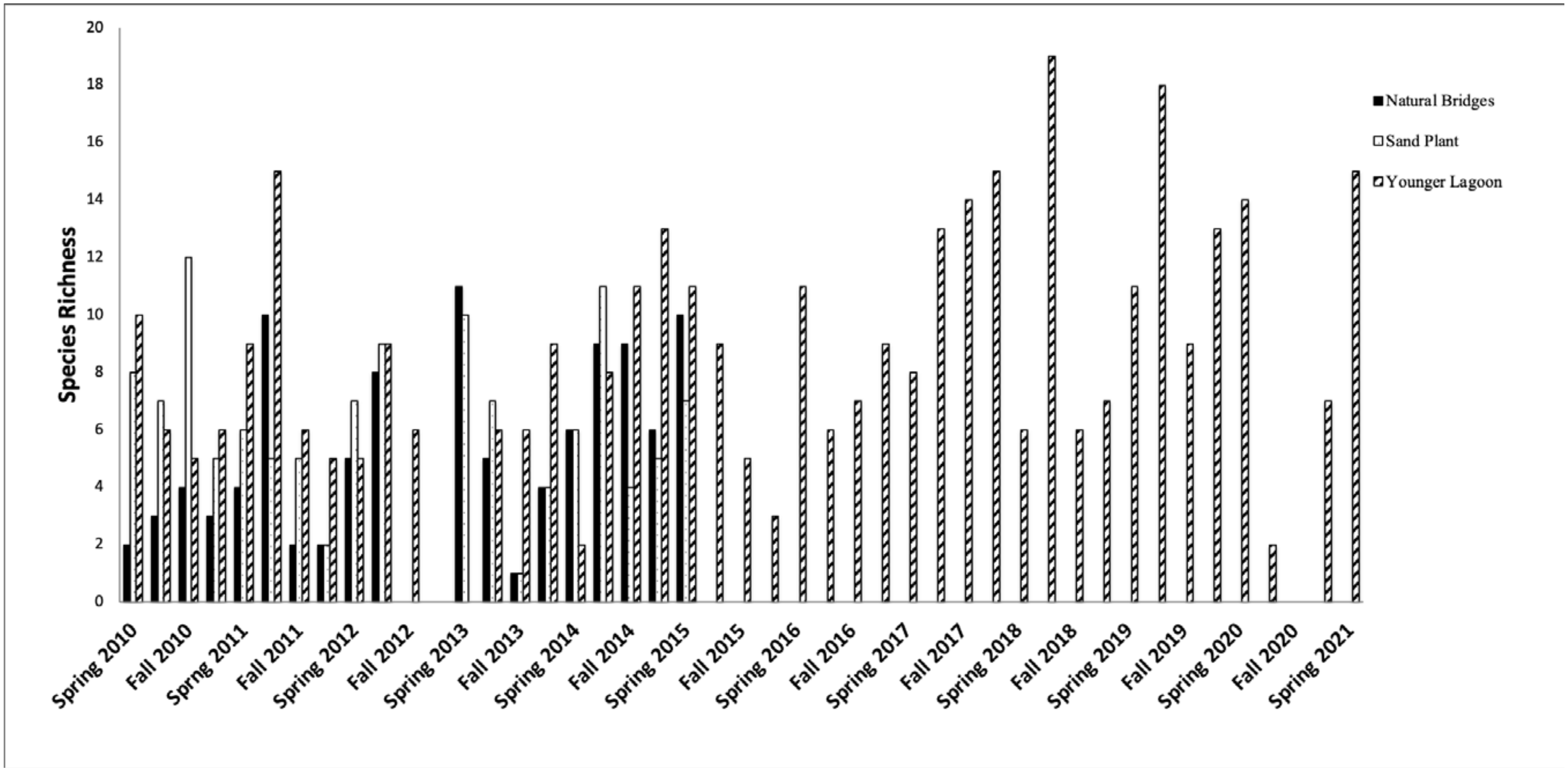

Figure 8. Total abundance of invertebrates at Natural Bridges, Sand Plant Beach, and Younger Lagoon beaches.

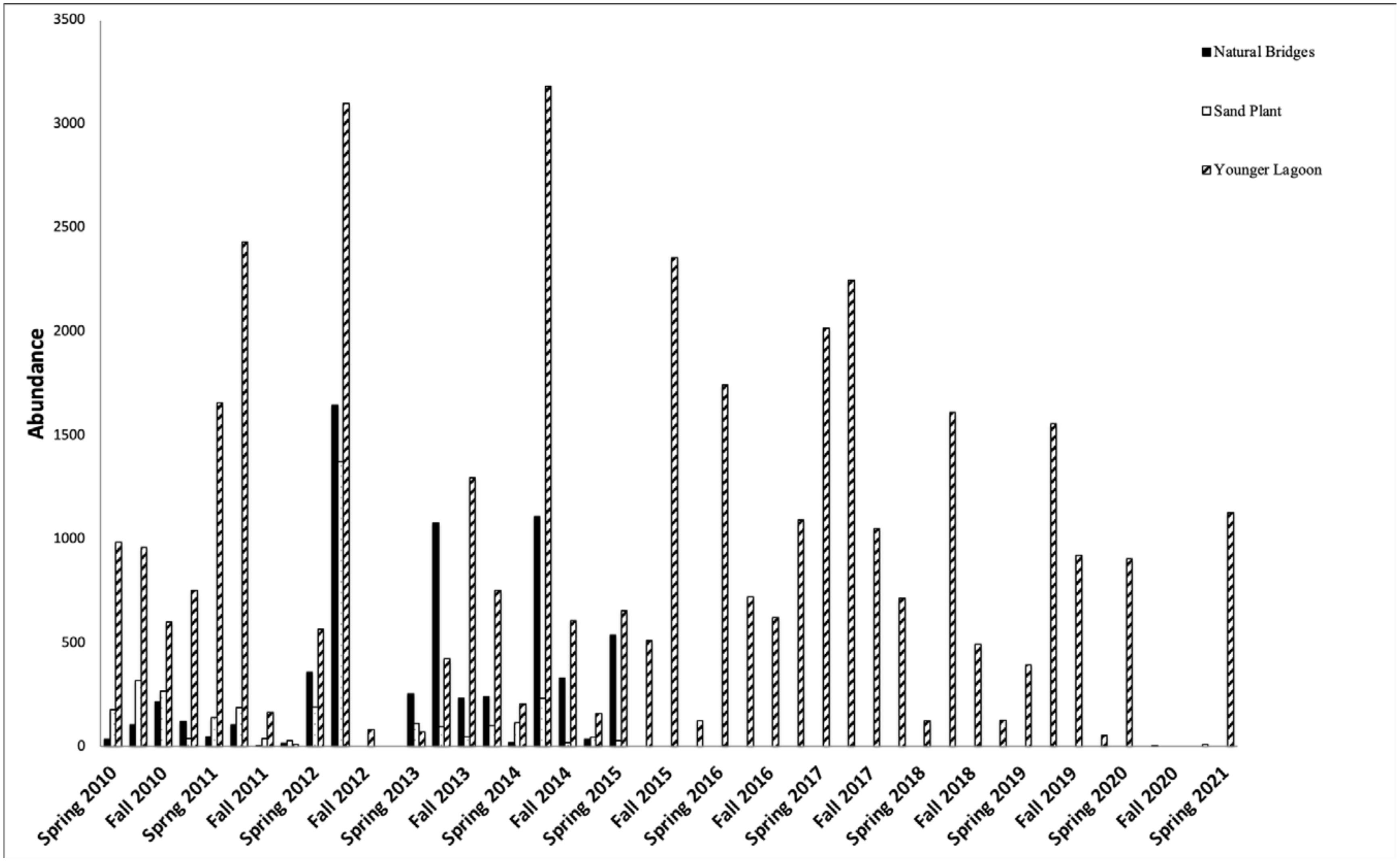

Table 10. Summary of bird surveys at Sand Plant Beach, Younger Lagoon, and Natural Bridges beaches.

Site	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Younger Lagoon										1																2						
May 1-2, 2016																																
Younger Lagoon								4		2							2															1
July 12, 2016																																
Younger Lagoon								5		1			12					2												1		
November 9-10, 2016																																
Younger Lagoon										2				1																1		
March 1-2, 2017																																
Younger Lagoon										1								4												1		
April 25-26, 2017																																
Younger Lagoon		1																	1							2						
August 2-3, 2017																																
Younger Lagoon								3	2	2		8																		1		2
October 25-26, 2017																																
Younger Lagoon										1		6		2																		
February 7-8, 2018																																
Younger Lagoon										1		2		2														1				1
May 2-3, 2018																																
Younger Lagoon								5	2	2		5	1																			
August 13-14, 2018																																
Younger Lagoon								6					1					1												3		
November 7-8, 2018																																
Younger Lagoon						1				11		26		44		1												1				
February 20-21, 2019																																
Younger Lagoon	4									5						11	4						1									
May 13-15, 2019																																
Younger Lagoon								4					1					2	12							1						
July 16-17, 2019																																
Younger Lagoon								4		2								6	17		1									1		
October 30-31, 2019																																
Younger Lagoon																																
February 10-11, 2020																																
Younger Lagoon	3									4					1	1		1									1					
May 20-21, 2020																																
Younger Lagoon								35									9	4	8		2											
August 18-19, 2020																																
Younger Lagoon								16		1		2							31	1												1
November 2017, 2020																																
Younger Lagoon										1		40																		1		2
February 23-26, 2021																																
Younger Lagoon	5			3						1		7					5															
May 1-2, 2021																																
Younger Lagoon																																
								4									8		24		1									1		

Site
April [illegible], 2010
Sand Flats
Younger Lagoon
Natural Bridges
August [illegible], 2010
Sand Flats
Younger Lagoon
Natural Bridges
November [illegible]
Sand Flats
Younger Lagoon
Natural Bridges
February [illegible], 2011
Sand Flats
Younger Lagoon
Natural Bridges
May [illegible], 2011
Sand Flats
Younger Lagoon
Natural Bridges
July [illegible], 2011
Sand Flats
Younger Lagoon
Natural Bridges
[illegible], 2012
Sand Flats
Younger Lagoon
Natural Bridges
May [illegible], 2012
Sand Flats
Younger Lagoon
Natural Bridges
August [illegible], 2012
Sand Flats
Younger Lagoon
Natural Bridges
November [illegible], 2012
Sand Flats
Younger Lagoon
Natural Bridges
January [illegible], 2013
Sand Flats
Younger Lagoon
Natural Bridges
May [illegible], 2013
Sand Flats
Younger Lagoon
Natural Bridges
July [illegible], 2013
Sand Flats
Younger Lagoon
Natural Bridges
October [illegible], 2013
Sand Flats
Younger Lagoon
Natural Bridges
February [illegible], 2014
Sand Flats
Younger Lagoon
Natural Bridges
April [illegible], 2014
Sand Flats
Younger Lagoon
Natural Bridges
July [illegible], 2014
Sand Flats
Younger Lagoon
Natural Bridges
November [illegible], 2014
Sand Flats
Younger Lagoon
Natural Bridges
January [illegible], 2015
Sand Flats
Younger Lagoon
Natural Bridges
April [illegible], 2015
Sand Flats
Younger Lagoon
Natural Bridges
July [illegible], 2015
Younger Lagoon
October [illegible], 2015
Younger Lagoon
February [illegible], 2016

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Younger Lagoon						3								3							3					6		4		7
May 1-2, 2016																														
Younger Lagoon			3			3											1						2			8				13
July 12, 2016																														
Younger Lagoon						3															6					2				7
November 9-10, 2016																														
Younger Lagoon			6														5									6				8
March 1-2, 2017																														
Younger Lagoon											1						6				6					2		1		16
April 25-26, 2017																														
Younger Lagoon						4											2									2		4		8
August 2-3, 2017																														
Younger Lagoon		6	3																											8
October 25-26, 2017																														
Younger Lagoon			8																		1		1			10				7
February 7-8, 2018																														
Younger Lagoon			6														9									9				8
May 2-3, 2018																														
Younger Lagoon			4														4											2		6
August 15-16, 2018																														
Younger Lagoon				1		1					5										4					5				8
November [illegible], 2018																														
Younger Lagoon			4									1								1	8					15				31
February 20-21, 2019																														
Younger Lagoon		5				4			2											3	2	1				3			2	13
May 14-15, 2019																														
Younger Lagoon			3			15			5		1								1			5			5					21
July 16-17, 2019																														
Younger Lagoon														3								3								8
October 30-31, 2019																														
Younger Lagoon											12									6						3				4
February 10-11, 2020																														
Younger Lagoon	7								2	2	17									2	1	4								32
May 20-21, 2020																														
Younger Lagoon						3				4	2										8	3								19
August 19-20, 2020																														
Younger Lagoon			11			4			1												6	2				1				27
November 16-17, 2020																														
Younger Lagoon			9							1																5				1
February 25-26, 2021																														
Younger Lagoon			5																		1					1				6
May 1-2, 2021																														
Younger Lagoon						4															1	11				1				8

Discussion

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

A parameter that we have mapped, and is evident from visual observation and photo documentation, is the presence of dune hummocks and downed woody material at YLR, both of which are almost entirely absent at Sand Plant Beach and Natural Bridges (Figure 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 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 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #1 (NW). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #1 (N). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #2 (S). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #2 (SW). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #2 (W). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #2 (NW). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (SE). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (E). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (W). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #3 (NW). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #3 (N). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #3 (NE). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #4 (N). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

Appendix 2. Compliance monitoring report

Compliance Monitoring Report for Coastal Prairie and Coastal Scrub Restoration Sites at Younger Lagoon Reserve – Spring 2021

Justin C. Luong

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 2021 monitoring data for 2015 coastal prairie and scrub habitat plantings, the 2017 scrub plantings and 2019 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, so it was recently included in a new restoration effort in 2021.

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™ 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 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 2015 and 2019 coastal prairie was measured using two 50 m transect, for a total of 20 quadrats in both areas (Figure 1, 3). The 2015 scrub habitat was measured with three transects of 30.0, 31.2 and 44.1 m (Figure 1, 3). The 2017 coastal scrub area was measured using three transects of 19.2, 24.8 and 25.9 m (Figure 1, 3). Because the 2017 coastal scrub had some gaps in the shrub line, we took four quadrat measurements of interspersed mixed prairie on two of three scrub transects. For analysis these measurements were separated into prairie-identified habitats, and scrub-identified habitats, consistent with analyses from previous years (Lesage 2015, 2016, 2017, 2018; Luong 2019, 2020). For each planted area, cover was averaged across quadrats within a transect.

Prior to 2019, species richness goals were assessed at based on average species richness per transect at a site. However, starting 2019 and on, species richness goals were assessed based on total species richness at a particular restoration site. To be consistent with older monitoring reports, species richness for each planted area is a count of all unique taxa found on average per transects and at the site level for restored habitat type by year (Table 1, 2). Sites were all relatively small and around the same acreage, so site level species richness were used to assess compliance targets.

All sites are expected to meet the targets laid out for the California Coastal Commission (UCNRS 2010). The 2015 coastal prairie and scrub plantings are expected to meet six-year targets, the 2017 coastal prairie sites should meet four-year targets, and the 2019 coastal prairie sites should meet two-year targets. Targets for all habitat types and year-post-planting are available in Appendix 1.

Results

Native species cover targets were surpassed in all restoration areas monitored in 2021 (Table 1). The 2015 coastal prairie had a native cover of 25.9 ± 3.6%, which just barely exceeds the ≥ 25% native cover and could fall below when accounting for the error margin. The 2019 coastal prairie site had a native cover value of 63.6 ± 13.3% greatly surpassing its post-year-two target of ≥ 5%. In the 2015 coastal scrub site, native cover goals of ≥ 40% were also met, with an average shrub cover of 136.0 ± 14.0%. The herbaceous cover at the 2015 scrub site was also above its targets, but similar to the 2015 coastal prairie could fall below the target with the margin of error (28.3 ± 18.8%; Table 1). Cover at the 2017 coastal scrub site was 121.0 ± 13.9%, which was well above the four-year target of ≥25%. Herbaceous cover within the 2017 coastal scrub areas were well above targets (Table 1).

Native species richness measurements were above defined target levels for all planted areas (Table 2). Transects in the 2015 coastal prairie area had an average native species richness of 13.5 ± 3.5 species, with a total of 18 species across at the site level, which meets the requirement of ≥ 8 species. The 2019 coastal prairie area had an average native species richness of 20.5 ± 1.5 species with a total of 27 native species observed across all transects which meets post-two-years monitoring targets. The 2015 coastal scrub areas met their ≥ 8 species target with an average of 14.0 ± 0.5 native species per transect and 22 total native species. There were 13.7 ± 0.9 native species on average at the 2017 coastal scrub area which exceeds compliance targets.

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

Discussion

All restoration areas monitored in 2021 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). The 2015 and 2019 coastal prairie areas, and the 2015 and 2017 coastal prairie and scrub mix areas all appear to successfully have restored native species cover and richness consistent with the monitoring report from 2019 (Luong, 2019). The restored 2012 area did not reached compliance since 2017 so it was completely scraped and restored again in 2021.

A comparison of monitoring data from 2019 and 2021 shows interesting trends in the coastal prairie and coastal scrub plantings (Luong, 2019). In 2019, the 2015 coastal prairie plantings had an average native cover of 24.6 ± 5.6%, which was above the target of ≥ 15% native cover. This year, the 2015 coastal prairie had an average of 25.9 ± 3.6% native cover per transect which barely exceeds the target of ≥ 25% native cover. The margin of error could cause the area to fall out of compliance in future years. However, cover did increase slightly from 2019 to 2021, which indicates non-native species management and supplemental native planting efforts in these areas have been somewhat successful. Additional management, both in terms of weed control and native reintroductions could be focused on this area to prevent future non-compliance. The 2019 coastal prairie area had a cover of 63.6 ± 13.3%. Although this far exceeds the target of ≥ 5% native cover, restored coastal prairies in past years often had high native cover during their first monitoring period, two-years after implementation, but then decreased native cover in subsequent years (Lesage 2015, 2016, 2017, 2018; Luong 2019, 2020). YLR could consider further management action in this area, particular if native cover starts to decline. In 2019, the 2015 restored prairie had 12.0 ± 2.0 species richness and a total of 20 unique species (Luong, 2019), whereas the 2015 prairie now has an average 13.5 ± 3.5 species with a total of 18 unique species. These changes in species richness indicate that supplemental planting has been successful in increasing average species richness, but overall species richness decline may be due to use of unsuitable plant species, consistent with past findings (Luong, 2020).

For coastal scrub plantings only, the 2015 scrub plantings achieved a native cover of 82.9 ± 5.2% in 2019 which increased in 2020 to 136.0 ± 14.0%. In 2019, species richness for 2015 scrub planting area was on average 11.7 ± 0.3 species per transect with a total of 19 unique species. In 2021, average species richness per transect increased to 14.0 ± 0.5 species per transect and total species richness in the area increased from 19 to 22. This indicates that management in the coastal scrub planting area was sufficient in helping the area far exceed its goal.

Overall, these findings suggest that coastal prairie may be difficult to maintain without more intensive management and maintenance work, whereas restored coastal scrub sites will not require as intensive methods or long-term maintenance.

Management Recommendations

In 2021, all restoration efforts at Younger Lagoon Reserve met their target goals. Management strategies, such as irrigation during the first year, targeted hand-weeding, and seasonal mowing are maintaining native cover and richness in restored coastal prairie and scrub areas. Exceedingly high values in coastal scrub areas (e.g. over 100%) indicate that labor could be partially shifted from maintenance of the scrub area to coastal prairie areas. For areas that may need greater native cover, additional planting of rhizomatous species such as *Achillea millefolium* or *Sidalcea malviflora* may aid in reaching native cover goals, especially as native cover continues to decline each year. Native grasses, such as *Elymus glaucus* and *Bromus carinatus*, occur in nearly every area and could also be used to supplement native cover and richness. Overall, species richness values tended to lean higher than past years.

Additional non-native species control and supplemental plantings are also recommended for the 2015 coastal prairie site in order to prevent it from falling below compliance standards. The 2015 coastal prairie just barely surpasses compliance standards, so if more intensive actions or adaptive management actions are not taken, this site may fall below compliance in the future as the margin of error causes the area to fall out of compliance. Previous years have all found that cover post-implementation decreased in the coastal prairies during the fourth year compared to the second year (Lesage 2018, 2017, 2016, 2015; Luong 2019, 2020). It is recommended that

Younger Lagoon Reserve supplement seasonal mowing in these areas with more intensive and targeted hand removal near the native species most at risk from being lost due to competition with undesirable species. Planting in these areas could also increase the likelihood these areas will exceed compliance standards in future years. The relatively stable amount native cover and species richness in the 2015 coastal prairie habitats indicates that coastal prairie restoration is feasible with additional management.

As all scrub planting areas are exceeding target goals, no further management recommendations for scrub sites are needed. Younger Lagoon Reserve may consider shifting some labor dedicated to coastal scrub management to coastal prairie management.

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Tables and Figures

Figure 1. Overview map of locations for compliance monitoring in 2020 which includes the wetland, coastal scrub and prairie transects and planting areas.

Figure 2. Map of locations for northern area in compliance monitoring in 2020.

Figure 3. Map of locations for southern area in compliance monitoring in 2020.

Table 1. Table of native species cover and richness targets and observed values (± SE) in the 2015 and 2019 coastal prairie and 2015 and 2017 coastal scrub restoration areas at Younger Lagoon Reserve. Cover can exceed 100% because multiple plant canopies are accounted for.

Restoration Area	Observed Native Cover (%)	Target Native Cover (%)	Average Native Richness (species/transect)	Observed Native Richness (species/habitat)	Target Native Richness (species/habitat)
2015 Coastal Prairie	25.9 ± 3.6	≥25	13.5 ± 3.5	18	≥8
2015 Coastal Scrub					
Shrub Cover	136 ± 14.0	≥40	14.0 ± 0.5	22	≥8
Herb Cover	28.3 ± 18.8	≥25	14.0 ± 0.5	22	≥8
2017 Coastal Scrub					
Shrub Cover	121 ± 13.9	≥25	13.7 ± 0.9	19	≥6
Herb Cover	48.3 ± 8.7	≥15	13.7 ± 0.9	19	≥6
2019 Coastal Prairie	63.6 ± 13.3	≥5	20.5 ± 1.5	27	≥6

Table 2. Table of the native species observed in the 2015 and 2019 coastal prairie and 2015 and 2017 coastal scrub 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 Gramminoid, S=Shrub, T=Tree). Part one contains annual forbs.

Scientific Name	Common name	Growth Form	2015 Coastal Prairie	2019 Coastal Prairie	2015 Coastal Scrub	2017 Coastal Scrub
Cardamine oligosperma	western bittercress	AF	X		X	
Erigeron canadensis	Canadian horseweed	AF		X		
Epilobium brachycarpum	willowweed	AF		X		
Epilobium cilatum	willow herb	AF				
Madia gracilis	coastal tar weed	AF	X	X	X	
Pseudognaphalium sp.	Cudweed	AF				

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

Scientific Name	Common name	Growth Form	2015 Coastal Prairie	2019 Coastal Prairie	2015 Coastal Scrub	2017 Coastal Scrub
Achillea millefolium	yarrow	PF	X	X	X	X
Artemisia douglasiana	Western mugwort	PF				
Baccharis glutinosa	marsh Baccharis	PF	X	X	X	X
Chlorogalum pomeridianum	soaproot	PF	X		X	X
Clinopodium douglasii	yerba buena	PF			X	X
Eschscholzia californica	California poppy	PF				X
Fragaria chiloensis	beach strawberry	PF			X	X
Grindelia stricta	gumweed	PF		X		X
Horkelia californica	California horkelia	PF		X		
Marah fabacea	California man-root	PF				
Oenthera elata	Hooker's primrose	PF				
Oxalis pilosa	California wood sorrel	PF			X	
Potentilla anserina	Silverweed	PF				
Prunella vulgaris	selfheal	PF		X		
Ranunculus californica	California buttercup	PF		X		
Sanicula crassicaulis	Pacific sanicle	PF			X	
Scrophularia californica	California bee plant	PF	X		X	X
Sidalcea malviflora	checker-bloom	PF		X		
Sisyrinchium bellum	western blue-eyed grass	PF		X		
Symphyotrichum chilense	Pacific aster	PF	X	X	X	X
Aesculus californica	California Buckeye	T				X
Frangula californica	Coffee berry	T				
Salix lasiolepis	Arroyo willow	T		X		

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

Scientific Name	**Common name**	**Growth Form**	**2015 Coastal Prairie**	**2019 Coastal Prairie**	**2015 Coastal Scrub**	**2017 Coastal Scrub**
Agrostis pallens	Seashore bent grass	PG		X		
Bromus carinatus	California brome	PG	X	X		
Danthonia californica	California oatgrass	PG		X		
Deschampsia cespitosa	Tufted hair grass	PG		X		
Elymus glaucus	blue wild rye	PG	X	X	X	
Elymus triticoides	creeping wild rye	PG	X		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	X		X
Cyperus eragrostis	Nutgrass	PGRM		X		
Juncus mexicanus	Mexican rush	PGRM	X	X	X	
Juncus patens	spreading rush	PGRM	X	X	X	
Juncus occidentalis	Western rush	AGRM				
Juncus bufonius	Toad rush	AGRM				
Artemisia californica	California sagebrush	S	X	X	X	X
Baccharis pilularis	coyote brush	S	X	X	X	X
Ericameria ericoides	Mock heather	S				X
Eriophyllum staechadifolium	Seaside golden yarrow	S	X		X	X
Lupinus arboreus	Bush lupine	S				
Lupinus littoralis	Many-colored lupine	S		X		

Diplacus aurantiacus	sticky monkey flower	S			X	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:			18	27	22	19
Target Native Species Richness:			≥ 8	≥ 6	≥ 8	≥ 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

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

RESPONSES OF FUNCTIONAL LEAF TRAITS TO FOG AND DROUGHT ARE GREATER FOR NATIVE COASTAL CALIFORNIA GRASSLAND THAN COASTAL AGRICULTURAL SPECIES

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

BACHELOR OF ARTS

in

ENVIRONMENTAL STUDIES

by

Ernesto Chavez-Velasco

August 2021

ADVISORS: Michael E. Loik, Karen D. Holl

ABSTRACT: The California central coast possesses a biologically and economically important vegetational matrix that is vulnerable to increased frequency and severity of extreme weather events due to anthropogenic climate change. The region receives summer precipitation inputs through coastal fog which can be used to alleviate the impacts of increased drought risk, but fog may be declining due to climate change.. Here, I aimed to determine which plant characteristics (growth, water potential, leaf traits) show significant responses to fog and drought,. I constructed a fog chamber and used a fog machine to simulate fog in a research greenhouse and recorded its effects on well-watered and drought stressed plants of three native coastal grassland and one agricultural species. I found that all species responded in some way to fog or drought, but there were no impacts on growth or survival. The native coastal grassland species *Stipa pulchra* was the only species to show reduced water potential under drought. Also, *S. pulchra* showed several leaf trait responses to fog and drought. Future work should calculate trait plasticity for agricultural or restoration species to help identify key traits that will be resilient to drought in a future drier climate. *Stipa pulchra* in particular may be a useful species for restoration in dry habitats where fog is becoming less common.

KEYWORDS: *Brassica oleracea capitata*, *Fragaria chiloensis*, *Eschscholzia californica*, *Stipa pulchra*, Specific leaf area, Major vein length per unit area, Leaf lobedness, Leaf thickness

INTRODUCTION

Central coastal California contains a matrix of vegetational communities that experience a typical Mediterranean-type climate with cool wet winters, hot dry summers, and summer water input from coastal fog (Azevedo and Morgan, 1974; Ingraham, and Matthews, 1995; Dawson 1998). The matrix consists of coastal prairies, coastal sage scrub, and a large portion of the agricultural sector. Grassland species richness and cover of native species is higher along the coast and coastal prairies are the most species-rich grassland type in North America which contains up to 40% of the state's native plant species (Stromberg et al., 2001 & 2007). Due to the region's climate, high primary productivity, and urban development, remnant native systems have undergone extensive landscape conversions from increased anthropogenic activity.

California coastal prairies are continuously being degraded and are threatened by unsustainable grazing practices, land development, and biological invasions (Hayes & Ford, 2007). As a result, coastal prairie conservation and restoration is of high priority to land managers. Many restoration projects are voluntary or otherwise mandated by the California Coastal Act of 1976 for disturbed coastal prairies (Luong et al., 2021). Therefore, achieving established restoration goals of improving native species cover characterized by perennial bunchgrasses and annual forbs is of increasingly high importance. However, restoration success is highly unpredictable (Suding, 2011), with increased precipitation variability (Swain et al., 2018) and increased frequency and severity of extreme climate events from climate change (Diffenbaugh et al., 2017). Intense water pulses (Loik et al., 2004) and increased drought risk (Diffenbaugh et al., 2015) particularly threaten viability of current and future restoration projects.

Central coastal California also contains a large portion of the California agricultural sector which consumes 80% of freshwater resources in the state (Baguskas et al., 2018), and is highly vulnerable to increased drought risk (Diffenbaugh et al., 2015) caused by climate change. Economically important crops such as strawberries occupy about 20,000 hectares of coastal farmlands and are additionally threatened by saltwater intrusion (Baguskas et al., 2018). However, coastal fog is rarely considered a critical component of water budgets for whole coastal agroecosystems despite extensive research in non-agricultural ecosystems.

Coastal fog in the summer is intercepted by plants where water droplets drip to the ground and increase surface soil moisture (Baguskas et al., 2018; Corbin et al., 2005). Fog also impacts leaves and is directly absorbed into the leaf through foliar water uptake (Berry et al., 2019; Slatyer, 1960; Simonin et al., 2009; Vesala et al., 2017). Although the mechanisms are unclear, this appears to contribute to whole plant rehydration (Baguskas et al., 2018; Eller et al., 2013). Therefore, there is great potential for summer coastal fog to contribute a large portion of precipitation input into coastal systems and be utilized by land managers of restoration projects and agroecosystems.

In this study, I tested the response of functional leaf traits under drought and fog treatments on two commonly used California grassland species in restoration and two common agricultural crops in a controlled greenhouse experiment to potentially match functional plant traits that maximize fog water uptake with those that promote survival of drought conditions. Plant traits show plasticity in changing environmental conditions (Valladares et al., 2006) and identifying compatible traits to our experimental treatments can inform land managers of traits best suited to meet restoration outcomes (Luong et al., 2021; Griffin-Nolan et al., 2018) as well as reduce irrigation inputs. I hypothesized that fog would alleviate drought stress across all species which would be reflected in responses of leaf traits. I predicted that fog would increase relative growth rates and mean biomass in the fog and interaction treatments with drought decreasing both.

METHODS AND EXPERIMENTAL DESIGN

I conducted a controlled greenhouse experiment in research greenhouses on top of the Interdisciplinary Sciences Building at the University of California, Santa Cruz. The experimental design consisted of a two-way treatment with, drought only, fog only, and the interaction of fog × drought. I selected two species commonly used for restoration *Stipa pulchra* Hitchc. Poaceae (*purple needlegrass*) and *Eschscholzia californica* Cham. Papaervaceae (California poppy), and two common agricultural crops in the region *Fragaria chiloensis* (L.) Mill. Rosaceae (strawberry) and *Brassica oleracea* L. Brassicaceae (cabbage). *S. pulchra* seed was sourced from Porter Meadow, on campus at the University of California Santa Cruz. *E. californica* seed was sourced from Bodega Bay. *B. oleracea* seed was purchased commercially, and stolons of *F. chiloensis* were transplanted from existing greenhouse plants. All plants were sowed in 10" square flats using Premier Pro Mix HP/ Mycorise Pro. After seeds germinated, they were grown for two to four weeks before being transplanted into 1-gallon pots.

I constructed a fog chamber (2.729 m^3) to simulate coastal fog and placed individual plants within the chamber after the drought treatment was initiated. I treated plants with consecutive cycles of three days with fog and three days without fog. Fog was applied between 21:00 and 07:00 to limit non-target shade effects. Fog treatment was initiated the same day as the drought treatment and followed the three-day cycle until the end of the experiment. The greenhouse was temperature controlled below 26.67° C and relative humidity fluctuated between high relative humidity during fog cycles overnight and lowered afterwards during the day.

I started with 8 replicates of each species per treatment and used three of each species to collect baseline aboveground and belowground biomass data prior to any treatments to compare experimental effects on relative growth rates and biomass, leaving five individual species for post-treatment measurements.

To measure biomass, I placed above ground biomass, belowground biomass, and individual leaves in an oven before weighing to remove any residual moisture present in plant tissues. calculated relative growth rates of above and below ground biomass using **Equation 1**.

$$\text{Relative Growth Rate} = (\ln M_2 - \ln M_1)/(t_2 - t_1) \qquad \textbf{Equation 1}$$

Equation 1: Average relative growth rate determined by two harvests at times t_1 and t_2, yield masses M_2 and M_2 (Pérez-Harguindeguy et al., 2013).

To measure specific leaf area (SLA), major vein length (major vLA), leaf thickness, and leaf lobedness, I collected leaves from each individual and refrigerated leaves in plastic bags up to 72 hours before scanning them. I scanned leaves using an Epson photo scanner at 400 dpi. Leaves with overlapping leaflets or highly dissected leaves were flattened and pressed with tape to allow accurate measurements of area and perimeter. Leaf area and perimeter were measured using ImageJ. SLA was measured by the one-sided area of a fresh leaf divided by its oven-dry mass. Major VLA was measured as a ratio of major veins length per unit leaf area. Leaf thickness was measured using a digital thickness gauge. I calculated leaf lobedness using Cadotte et al., 2015;

Equation 2. Feret diameter was calculated by treating the largest diameter on a leaf as if it were a circle; this is accomplished by dividing the leaf perimeter by π. (Cadotte et al., 2015).

$$\text{Leaf lobedness} = \frac{\text{perimeter}}{\text{area}} \times \text{feret diameter} \qquad \textbf{Equation 2}$$

To simulate drought, I did not water the drought treatment until they were drought stressed (stomatal conductance < 0.05 mmol $m^{-2}s^{-1}$ as determined using a LICOR LI- 6400 portable photosynthesis system). I measured leaf-level stomatal conductance to water vapor (g_s). I placed individual leaves in the leaf cuvette using the 6-cm^2 are of the leaf chamber. I set the flow rate at 500 µmol s^{-1} and maintained block temperature at 25°C. I kept the Photosynthetically Active Radiation (PAR; 400 – 700 nm) at light-saturating 1500 µmol m^{-2} s^{-1} and leaf-to-air Vapor Pressure Difference (VPD^L) remained between 0.74 and 3.7 kPa by adjusting desiccant. I recorded measurements when all stability criteria were met when the coefficient of variation for g_s and A combined was <0.5%. Plants were determined to be droughted when g_s was <0.005 mol m^{-2} s^{-1}. Once individuals in the drought treatment were identified as stressed, I rehydrated the plants and kept them at soil water field capacity for 10 days, and then implemented a second drought period until the plants again reached stress levels. In general, it took from 21 to 30 days for plants under the drought treatment to reach the threshold g_s value of 0.005 µmol m^{-2} s^{-1}

To measure leaf water potential, I approximated leaf water potential (Ψ^{Leaf}) using a Scholander-type pressure chamber (Soilmoisture Inc., Goleta, CA, USA). I took leaf segments from 09:00 to 14:30 local time and immediately measured after sampling. I randomized the position of the plants weekly to prevent random position effects.

All analyses were conducted in R (v 3.6.3; R Core team, 2021). I compared the responses across the treatments using ANOVA.

RESULTS

I found that *S. pulchra* was the only species that had significantly lower water potential in the drought treatment (df=1, F=6.0, P=0.0207 **Fig. 1**), and the application of fog had no effect on plant water potential for any of the species. Unexpectedly, I found no statistically significant differences in aboveground or belowground biomass in response to drought or fog treatments.

Although total biomass was not different, aboveground relative growth rates (ARGR) were affected by fog and drought. The fog treatment caused a decrease in ARGR for *E. californica* (df=1, F=10.3, P=0.0148, **Fig. 2 C**). Likewise, fog decreased ARGR for *F. chiloensis* under drought, but ARGR was increased for well-watered plants (df = 1, F = 8.88, P = 0.018, Fig. 2B). There was no effect of fog or drought on below-ground growth rate (BRGR) of three species. For *Stipa pulchra* there was a significant interaction between drought and fog. Fog had a positive effect on BRGR in droughted plants and a negative effect on well-watered plants (df=1, F=8.562, P=0.00943, **Fig. 2 H**).

The responses of leaf traits to fog and drought varied widely. Drought resulted in significantly lower SLA (df=1, F=4.486, P=0.0429, **Fig. 3 D**), lower leaf thickness (df=1, F=5.685, P=0.0239, **Fig. 3 L**), and higher leaf lobedness (df=1, F=16.7, P=0.0003, **Fig. 3 P**) for *Stipa pulchra*. The fog treatment caused lower SLA for *E. california* (df=1, F=11.6, P=0.004, **Fig. 3 C**), and fog caused an increase in leaf thickness for watered but not droughted plants (df=1, F=4.7, P=0.046, **Fig. 3 K**). For *F. chiloensis*, VLA was lower for drought than for controls (df=1, F=6.1, P=0.03, **Fig. 3 F**), but fog led to significantly lower leaf lobedness compared to controls (df=1, F=4.768, P=0.0496, **Fig. 3 N**). Fog led to significantly lower VLA for *B. oleracea* (df=1, F=5.3, P=0.036, **Fig. 3 E**), but no other traits were significantly affected by fog or drought.

DISCUSSION

Overall, all four species were significantly affected in some manner by drought or fog treatments. Notably, *Stipa pulchra* was the only species that showed a significant decrease in water potential in response to drought. Other studies suggest this can confer greater drought tolerance and ability to photosynthesize at low water potential without xylem cavitation, (Craine et al., 2013; Tucker et al., 2011). The water potential inside the leaf decreases in *S. pulchra* under drought conditions yet fog increases the vapor pressure in the air surrounding the leaves, creating a gradient that could favor foliar water uptake (Berry et al., 2019; Slatyer, 1960; Simonin et al., 2009; Vesala et al., 2017). However, there was no "rescue effect" of fog for droughted *S. pulchra* under my growth conditions.

Although I found no significant responses in overall productivity for any of the species, above- and belowground relative growth rates (ARGR and BRGR) responded differently to fog and drought. Aboveground RGR was responsive to fog (*E. californica*) or the combination of fog and drought (*B. oleracea*). Belowground growth rates should always be treated with caution, but my results for *S. pulchra* suggest that fog hindered ARGR for well-watered plants but increased ARGR for droughted plants. However, differences in growth rate may not mean much because the total productivity was not different for any of the four species at the end of my experiment. In a field experiment simulating drought in a California coastal prairie, higher growth rates correlated with higher mortality risk (Luong et al., 2021), but *E. californica* was found to have lower survival in drought treatments (Luong et al., 2021; Luong and Loik, 2021). Drought survival and dehydration avoidance strategies in perennial grasses are primarily associated with greater tolerance of dehydration in meristematic tissues rather than mature tissues (Volaire et al., 2014). The higher belowground relative growth rate for *S. pulchra* may also be related to ensuring a minimal water supply following rehydration treatments or periods (Volaire et al., 2014). Similar outcomes of allocation of resources in summer dormancy through high foliage senescence may help explain the lower leaf water potential observed in *S. pulchra*, and may be interpreted as an additional strategy for drought resistance (Volaire et al., 2014).

Patterns emerging from the leaf traits can help interpret adaptive responses to fog and drought. The lower SLA in fog for *E. californica* is consistent with the lower above-ground growth rate I noted above for this species, as SLA is positively related to potential relative growth rate (Pérez-Harguindeguy et al., 2013). Because lower SLA is often associated with drought resistance, increased life span, and high investment in leaf defenses, this result may be explained by other external factors. Possible explanations of this outcome could be the result of insufficient nutrient uptake, complications of foliar water uptake, effects of foliar pathogens, or perhaps a combination (Burkhardt, 2010).

Differences in leaf venation influence gas and hydraulic exchange abilities which affects biomechanics, sugar-transport and tradeoffs in investment and construction costs (Sack & Scoffoni, 2013). Major VLA can contribute to higher gas exchange, higher leaf conductivity (Sack & Scoffoni, 2013; Sommerville *et al*., 2012), greater resistance to system disruption as a result from damage, drought, or freeze-thaw embolism (Sack & Scoffoni, 2013; Sack & Holbrook, 2006; Scoffoni *et al*., 2011), equalizing water potential across the leaf (Sack & Scoffoni, 2013; Zwieniecki *et al*., 2004b; Ocheltree *et al*., 2012). Additionally, greater vein density, phloem cell size, and cell number per minor vein, changes the flux of exporting nutrients, hormones, and water to the leaf tissue while maintaining a greater ability to export amino acids, hormones, and photosynthates to the rest of the plant (Adams et al., 2018; Sack and Scoffoni 2013). Minimizing the distance from the location of sugar synthesis along with a greater overall flux capacity for transporting sugar from minor tributaries into major veins will most likely allow the leaves to exhibit maximal rates of photosynthesis (Adams et al., 2018). Plants acclimated to higher water availability such as in highly managed agricultural systems would therefore not have the increased ability to adjust stomatal closure to avoid water loss during drought stress due to lower leaf conductivity (Sack & Scoffoni, 2013). I found lower major VLA in *B. oleracea* when treated with fog, suggesting a reduced the need for greater conductivity for maximum photosynthesis or flux of sugars (Adams et al., 2018). I found significantly lower vLA in *S. pulchra* when fog interacted with drought, yet most of this species' responses were to the drought treatment. The lower major vLA I found for *F. chiloensis* would indicate lower leaf conductivity and gas exchange rates, however this remains to be tested.

Leaf thickness has been shown to be correlated with leaf water content (Afzal et al., 2017) and can be also used to quantify rehydration capacity (John et al., 2018), with thicker leaves being capable of storing more water. Leaf thickness is also an important factor in foliar water uptake, where it has been observed that foliar water uptake occurs less often in thicker leaves that have a greater water storage capacity (Berry et al., 2019; Gotsch et al., 2015). Fog increased leaf thickness of well-watered but not droughted *E. californica*, suggesting no rescue effect of fog on leaf water during experimental drought for this species. My fog treatment occurred at night consistent with local meteorological conditions, when stomata are more likely to be closed, and when the vapor pressure deficit is also the lowest. Foggy conditions cause the air to reach dew point at lower temperatures which would cause greater leaf wetness.

I also found leaf thickness in *S. pulchra* to be significantly lower under drought, but notably, not in the interaction of fog and drought. This result in *S. pulchra* coupled with a higher relative below ground growth rate may imply that fog water uptake occurs more through root uptake rather than foliar water uptake. Stable isotope studies would help in this regard.

Leaf lobedness determines the contribution of the leaf boundary layer thickness to heat loss by conduction and convection, thereby affecting water use in transpiration (Luong 2021; Nobel, 2009). I found *F. chiloensis* to have significantly lower leaf lobedness in fog treatments. Lower leaf lobedness infers a higher/thicker leaf boundary layer (Martorell & Ezcurra, 2007; Nobel and Nobel, 1999). This may be important for this species because it grows close to the ground where heat loss by conduction, convection and transpiration are important for leaf temperatures. Lower leaf lobedness also implies that the leaves of *F. chiloensis* experience cooling by transpiration rather than convection (Luong et al., 2021; Nobel, 2009).

Salt exposure from hard water used for the fog machine may cause damage to leaves, and cycles of high relative humidity followed by lower relative humidity may also increase salt-induced foliar injury (McCune & Silberman, 1991). Salt spray found along the coast also serves as condensation nuclei, where water vapor condenses and forms into the marine layer (Baguskas et al., 2018). However, an alternative explanation could be increasing resource partitioning in leaves to favor foliar nitrogen uptake (Sparks, 2009), but quantifying and confirming this is outside the scope of this study (Osone et al., 2008).

My results suggest that *Stipa pulchra*, which is native to the California central coast, exhibited several leaf trait responses to drought. Leaf traits for the other three species responded somewhat to drought and/or fog. However, none of the four species growth or survival was affected by fog or drought. Some of the growth rate and leaf trait responses may be due to other factors such as greenhouse conditions and the containers the plants were grown in. The responses of *S. pulchra* suggest that it can alter traits and withstand drought but that fog may not be as important for its short term leaf development. Restorationists could use this as a drought-tolerant species in places where fog becomes more variable.

FIGURES

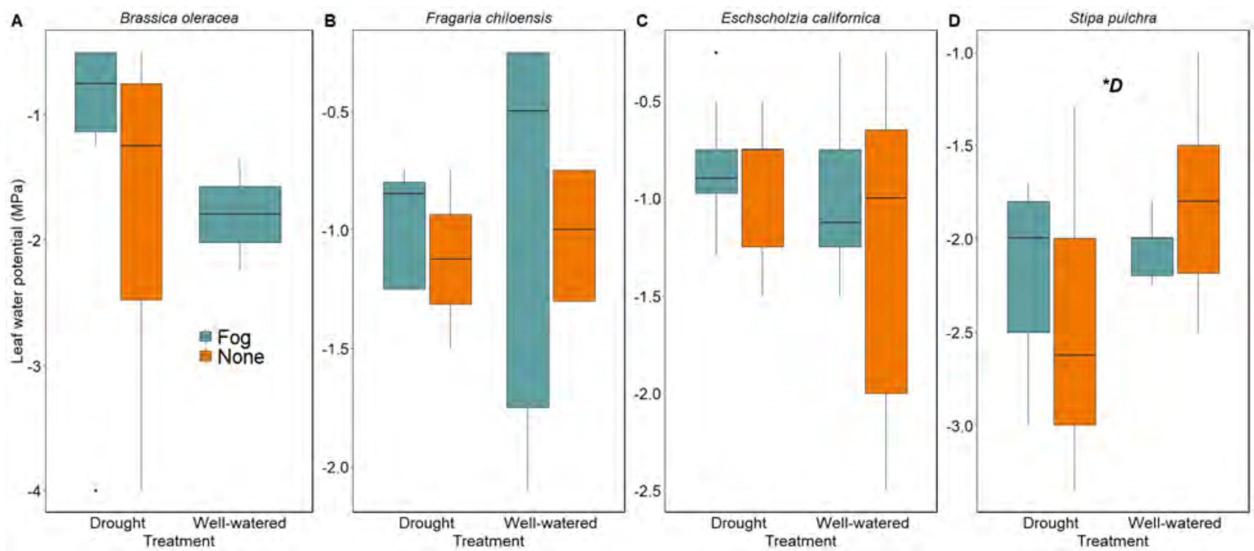

Figure 1: Water potential for each species as a function of drought or fog treatments. Data were collected after 110 days of treatment, then again after 40 days from the first measurement, when plants were drought stressed. Filled box plots represent interquartile ranges with a horizontal line denoting the median. Whiskers represent the maximum and minimum of each data set. Dots present represent outliers in the dataset. N = 111. “*D” indicates significant differences due to drought.

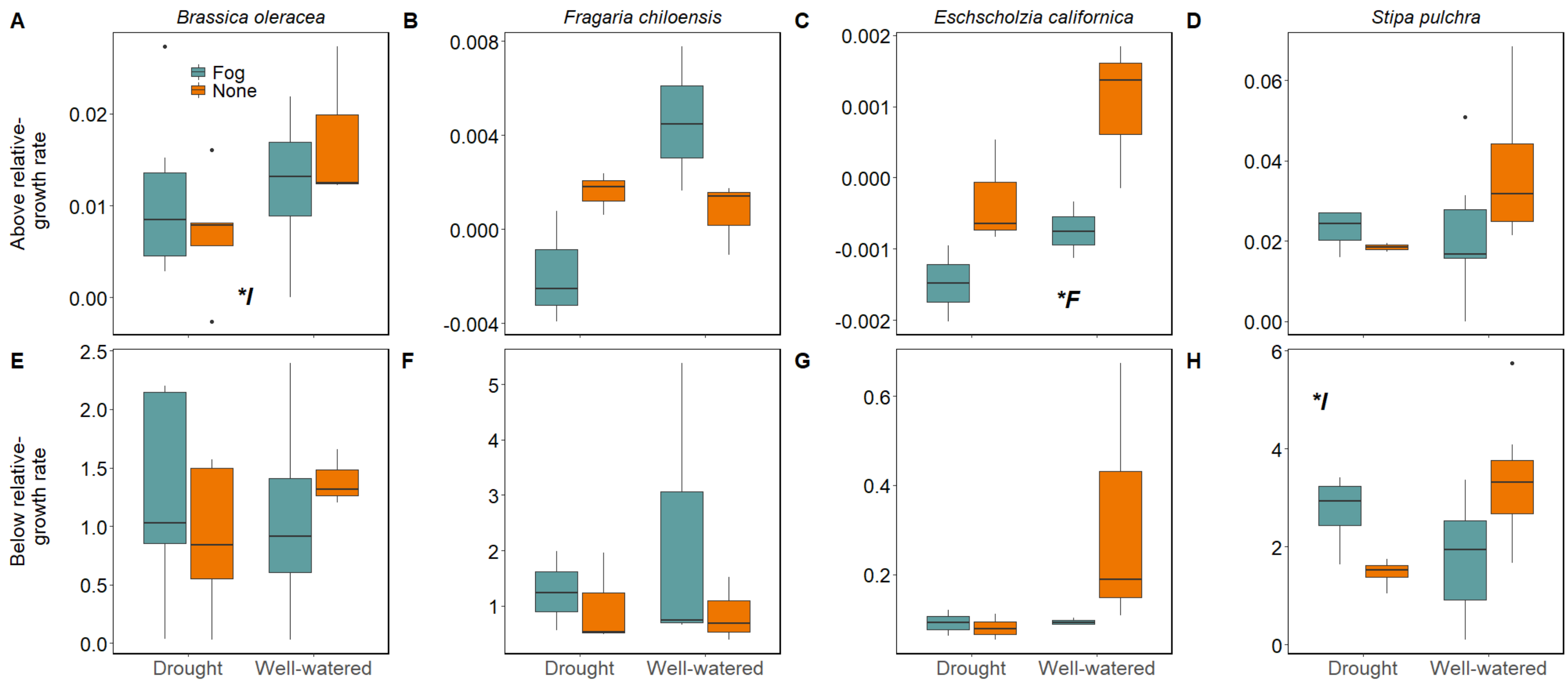

Figure 2: Relative above- and below=ground growth rates for all species across drought and fog treatments at the end of the treatment period. Filled box plots represent lower and upper quartiles, the median represented as a line. Whiskers represent the maximum and minimum of each data set. Dots indicate outliers present within the data set. "*I" indicates significant differences due to the drought × fog interaction, "*F" indicates significant differences due to fog treatment.

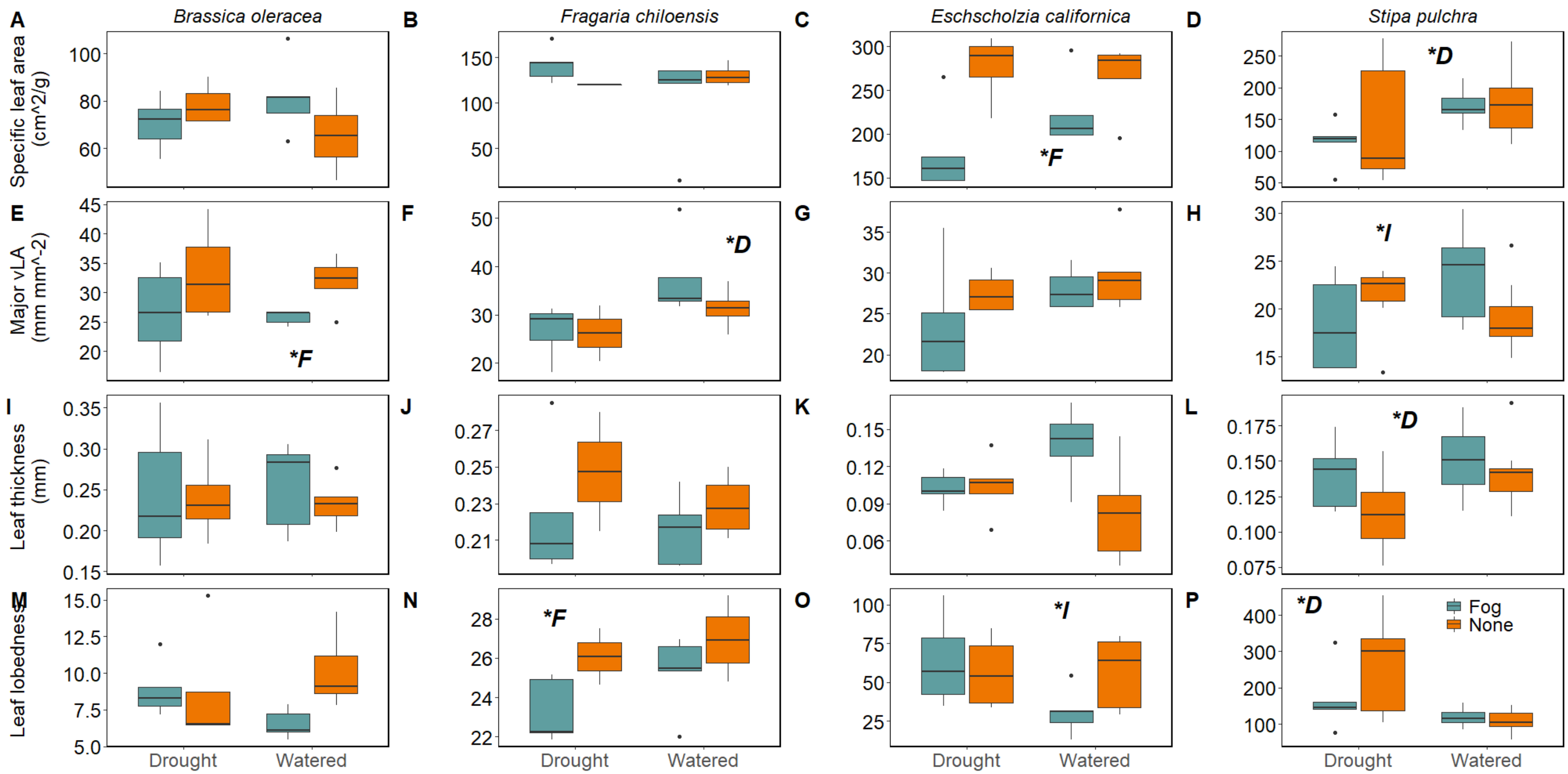

Figure 3: Functional leaf traits of each species in each treatment. A-D Specific Leaf Area, E-H major vein length per area (vLA), I-L Leaf thickness, and M – P Leaf lobedness. Filled box plots represent lower and upper quartiles, the median represented as a line.

Whiskers represent the maximum and minimum of each data set. Dots indicate outliers present within the data set. "*D", "*F", and "*I" indicate significant differences due to drought, fog or the drought × fog interaction, respectively

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Appendix 4. Photo monitoring


YLR Beach Photopoint #1 (W). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #1 (NW). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #1 (N). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #2 (S). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #2 (SW). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Beach Photopoint #2 (W). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #2 (NW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (SE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (E). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (W). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (NW). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (N). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #3 (NE). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Beach Photopoint #4 (N). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint # 1 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #1 (SW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #1 (W). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint # 1 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #2 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #2 (SW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #2 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #2 (W). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #3 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #3 (SW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #3 (W). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #3 (E). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #3 (N). May 6, 2021. Photographer: Vaughan Williams.
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YLR Terrace Photopoint #3 (NW). May 6, 2021. Photographer: Vaughan Williams.
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YLR Terrace Photopoint #3 (SE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #4 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #4 (NE). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #4 E). May 6, 2021. Photographer: Vaughan Williams. Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #4 (SE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #4 (SSE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #4 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #4 (SSW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #5 (E). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #5 (SE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #5 (SSE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #5 (W). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (NW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (NE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (E). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (SE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (SW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #6 (NW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #7 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #7 (SW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #7 (W). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #7 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #8 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #8 (NE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #8 (SE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #8 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #9 (S). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #9 (SE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #9 (E). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #9 (NE). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #9 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

YLR Terrace Photopoint #10 (W). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #10 (NW). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).


YLR Terrace Photopoint #10 (N). May 6, 2021. Photographer: Vaughan Williams.
Camera: Apple iPad Pro 9.7 (12 MP, 29mm).

Appendix 5. NOID 9 (18-1) & NOID 12 (20-1) Special Conditions Implementation Reports

UC Santa Cruz NOID 9 (18-1)
Special Conditions Implementation Report 4
July 1, 2020 – December 31, 2020

Burrowing owl on the Younger Lagoon Reserve Beach Dunes

UC Santa Cruz NOID 9 (18-1)
Special Conditions Implementation Report 4

Overview and Executive Summary

On September 13, 2018, the California Coastal Commission approved UCSC'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. 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. UCSC's report on the implementation of these special conditions for the period of July 1, 2020 through December 31, 2020 is detailed below. UCSC has included information from the previous three reporting periods and one-year prior, to provide historical and cumulative reference data. This is the final report under NOID 9 (18-1). The next Beach Access Management Plan [NOID 12 (20-1)] was approved by the Commission on October 8, 2020 and will go into effect on January 1, 2021. The first report under NOID 12 (20-1) is due by June 30, 2021.

UC Santa Cruz has successfully implemented all five special conditions. A summary of UC Santa Cruz's compliance with the five special conditions is below. Note that due to COVID-19 precautions, the Seymour Center was temporarily closed, and the free beach tour program temporarily suspended in early March 2020. The University will restart the free beach tour program when the Seymour Center reopens (see July 10, 2020 Coastal Act Section 30611 Commission waiver letter to UC Santa Cruz).

Special Condition	Status	Notes
1) Free Beach Tours	Completed	All beach tours are now offered for free without admission to the Seymour Center.
2) Beach Tour Outreach Plan	Completed & Ongoing	UCSC’s Beach Tour Outreach Plan was approved by the executive director in January 2019 and all beach tour outreach materials now clearly state that the beach tour is free. UCSC’s ongoing outreach efforts include regular social media postings and calendar listings, including listings in Spanish and publications that serve inland communities.
3) Beach Tour Signs	Completed	UCSC’s Beach Tour Signage Plan 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 now 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 continues to be collected. UCSC has submitted all of the required biannual reports on the beach tours on-time. This is the final report under NOID 9 (18-1).
5) Beach Access Management Plan Duration	In Progress	NOID 9 (18-1) is effective through December 31, 2020. UC Santa Cruz submitted their next Beach Access Management Plan NOID by July 1, 2020 as required. NOID 12 (20-1) was approved by the Commission on October 8, 2020. The first report under NOID 12 (20-1) is due by June 30, 2021.

Implementation of the 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 precautions, 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

In order to maintain public access and engagement during the COVID-19 pandemic, the University has created a virtual bilingual beach tour that will be available on the Seymour Center and Younger Lagoon Reserve websites in early 2021. The virtual tour will allow 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.

Condition 1.

FREE BEACH TOURS

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

Implementation Report

All beach tours are now offered for free (without admission fee). Beach tour sign-ups are available by phone and at the Seymour Marine Discovery Center (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 and the date of the tour being requested (see Appendix 1). The Younger Lagoon Reserve and the Seymour Marine Discovery Center websites have been modified to clearly identify that access to the beach is available for free via beach tours. Notice of the temporary closure of the Seymour Center and temporary cessation of the free beach tours due to COVID-19 has been posted to the Younger Lagoon Reserve and the Seymour Marine Discovery Center websites.

https://youngerlagoonreserve.ucsc.edu/about-us/index.html
https://youngerlagoonreserve.ucsc.edu/research-teaching-public-service/visit/public-tours.html
https://seymourcenter.ucsc.edu/visit/behind-the-scenes-tours/

Condition 2.

BEACH TOUR OUTREACH PLAN

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

Implementation Report

Outreach was conducted according to the following plan during the reporting period prior to the temporary closure of the Seymour Center and temporary cessation of the free beach tours due to COVID-19:

Venue	Language	Schedule
Seymour Center Website	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 14 participants. Call **831-459-3800**.	Permanent webpage: https://seymourcenter.ucsc.edu/visit/behind-the-scenes-tours/
YLR Website	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 14 participants. Call **831-459-3800**.	Permanent webpages: https://youngerlagoonreserve.ucsc.edu/research-teaching-public-service/visit/public-tours.html
Seymour Center Social Media o Facebook o Twitter o Instagram	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 14 participants. Call **831-459-3800**.	Facebook—Monthly Twitter, Instagram ---Once a quarter

YLR Social Media o Facebook o Instagram	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 14 participants. Call **831-459-3800**.	Once a quarter
Calendar Listings o UCSC Events o Good Times Newspaper (Santa Cruz) o KAZU public radio (Santa Cruz) o Register Pajaronian Newspaper (Watsonville) o The Californian Newspaper (Salinas) o La Network Campesina Radio 107.9 (Salinas)	Younger Lagoon Reserve tours are free and open to the public. Space is limited to 14 participants. Call **831-459-3800**. 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 14 participantes. Llame al **831-459-3800**.	Submitted monthly (calendar listings appear at the discretion of the media outlet.) Submitted monthly (calendar listings appear at the discretion of the media outlet.)

Condition 3.

BEACH TOUR SIGNS

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

Implementation Report

UCSC’s Beach Tour Sign Plan was reviewed and approved as part of the NOID 9 Special Conditions Implementation Plan on January 30, 2019. Per the approved sign plan, information on the free beach tours is currently displayed “day of” on a large sign in the front window of the Seymour Center and at the public admissions counter. The Seymour Center has also purchased and installed a large colorful monitor in the front window that displays “day-of” information on the free beach tours. “Day of” signage includes the brown and white footprints on wave logo, and the following language “Free Younger Lagoon Reserve Beach Tours Today” (Figures 1, 4, and 5). Signage has been added to the information kiosk outside of the Seymour Center (Figure 3) and to Overlooks A-F (Figures 6-12). Overlooks and kiosk signage include the brown and white footprints on wave logo and include the following language “Free Younger Lagoon Reserve Beach Tours, Call (831) 459-3800” (Figure 2).

Figure 1. “Day of” sign design.

Figure 2. Overlooks and kiosk sign design.

Figure 3. Signage installed at Seymour Center information kiosk.

Figure 4. Signage installed at Seymour Center front window.

Figure 5. Signage installed at the Seymour Center admissions desk.

Figure 6. Signage installed at Overlook A.

Figure 7. Signage installed at Overlook A (close-up).

Figure 8. Signage installed at Overlook B (Terrace Point).

Figure 9. Signage installed at Overlook C.

Figure 10. Signage installed at Overlook D.

Figure 11. Signage installed at Overlook E.

Figure 12. Signage installed at Overlook F.

Condition 4.

BEACH TOUR AVAILABILITY

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

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

Implementation Report

Prior to the temporary closure of the Seymour Center and temporary cessation of the free beach tours due to COVID-19, free beach tours were offered at least four times 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, and at least two times per month (of which at least one per month is a weekday tour and at least one per month is a weekend tour) otherwise (a minimum of 38 total beach tours per year). During 2020 free beach tours were scheduled to be offered twice a month in January and February, four times per month in March, April, May, June, July, August, and September, and twice a month in October, November, and December (38 total tours). Due to COVID-19 impacts, a total of six free beach tours were offered in 2020 (See Appendix 1). In 2020, beach tour participants were limited to 14 persons per tour on all but one tour. On January 2, 2020, at the discretion of the tour docent, the number of beach tour participants was increased to 15 persons to accommodate all persons who desired to take the beach tour that day. UCSC 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, and Appendix 1).

At least every six months (i.e., by June 30th and December 31st each year), UCSC 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 UCSC's activities under the approved Beach Tour Outreach Plan (see Condition 2), as well as the required information described in the previous paragraph and Condition 4 above. The first such report was submitted by June 30, 2019, the second by December 31, 2019, and the third by June 30, 2020.

UCSC offered 38 beach tours (265 participants) during 2019 (Appendix 1). All but one of these tours had at least one participant. Only one tour did not go out due to lack of sign-ups. Sixteen of the tours that went out included walk-in / "day-of" participants. Two tours were overbooked in 2019.

In comparison, UCSC offered 38 beach tours (224 participants) during 2018 (Appendix 2). Six tours did not go out due to lack of sign-ups, and one tour was canceled due to weather. Four of the tours that went out included walk-in / "day-of" participants. No tours were overbooked during 2018.

Although not required by the special conditions, in addition to tracking user data, UCSC 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 all but three 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 13).

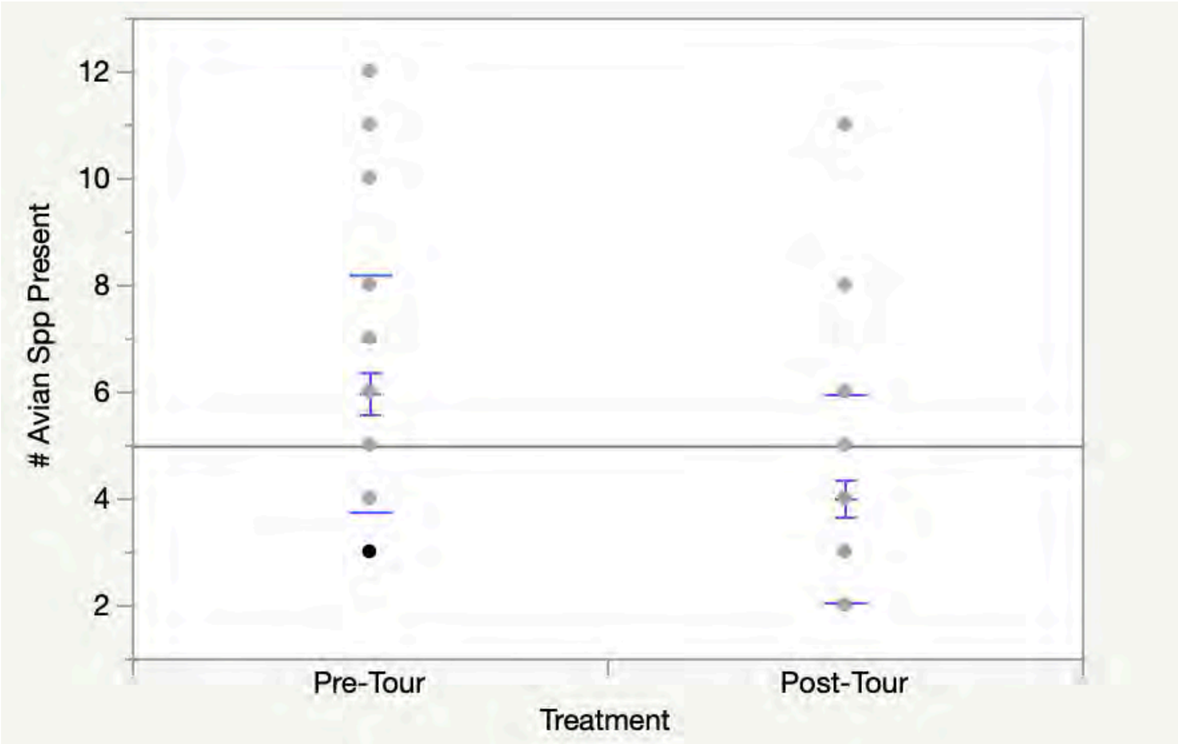

Figure 13. Effect of tours on avian species. Blue I-bars indicate mean, standard error, and standard deviation. The average number of avian species present pre-tour was 5.97 +/- 2.22 (+/- sd). The average number of avian species present post-tour was 4.00 +/- 1.95 (+/- sd). The average number of avian 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 24 months and currently paused due to COVID-19 impacts, the beach tours as specified by UCSC's NOID 9 special conditions appear to be meeting user demand. 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 (first full year post special conditions) and more than 350% higher than tour attendance during the same time period in 2018 (pre special conditions). Over the last 24 months, eight participants were denied a tour due to overdemand. The documented negative biological impacts to avian wildlife described above, along with ongoing quarterly beach monitoring efforts indicate that open access to the beach would result in the loss of the unique ecological characteristics of the site, reduce its effectiveness as a research area for scientific study, and likely have a negative impact on sensitive and protected species (See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017, 2017-2018, and 2018-2019 Annual Reports).

The next Beach Access Management Plan [NOID 12 (20-1)] was approved on October 8, 2020. NOID 12 (20-1) continues the five NOID 9 special conditions, increases the upper limit of tour attendees and requires additional outreach efforts. 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. 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 University-level 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 UCSC's public beach access management plan at Younger Lagoon Beach shall be effective through December 31, 2020. UCSC shall submit a complete NOID, consistent with all CLRDP requirements, to implement its next public beach access management plan at Younger Lagoon Beach (for the period from January 1, 2021 to December 31, 2025) no later than July 1, 2020. Such complete NOID shall at a minimum summarize the results of the Beach Tour Monitoring Reports (see Condition 4), and shall identify the manner in which UCSC's proposed management plan responds to such data, including with respect to opportunities to increase public access to the beach area (when considered in light of potential impacts to UCSC research and coastal resources). If such complete NOID has not been submitted by July 1,2020, then UCSC shall allow supervised (via beach and trail monitors only) general public access to Younger Lagoon Beach during daylight hours (i.e., one hour-before sunrise to one hour after sunset) until such NOID has been submitted.

Implementation Report

UCSC submitted a complete NOID, consistent with all CLRDP requirements, to implement its next public beach access management plan at Younger Lagoon Beach (for the period from January 1, 2021 to December 31, 2025) by July 1, 2020. NOID 12 (20-1) was approved by the Commission on October 8, 2020 and will go into effect on January 1, 2021.

Appendix 1. 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 - 12/6 – 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 - 6/28 – 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**
GRAND TOTAL	**-**	**325**	**51**	**353**	**71**	**8**

*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, 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 - 12/6 – 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 - 6/28 – Tours canceled due to COVID-19 impacts. 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, **BRAC** – 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, April 14, 2019 – June 30, 2019

Tour Date	Day	Species Present	Species Flushed
4/14/19	Sunday	AMCO, BLOY, BRAC, CCGO, GREG, MALL, SNEG, WEGU	BLOY, CCGO, MALL
4/18/19	Thursday	BLOY, BRAC, 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, BRAC, 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, BRAC, BRBL, CAGO, CLSW, GREG, MALL, PECO, PIGU, WEGU	CAGO, GREG, PIGU, WEGU
6/9/19	Sunday	BARS, BLPH, BRAC, KILL, PIGU, RWBL, SOSP, WEGU	BARS, BLPH, PIGU, RWBB
6/20/19	Thursday	AMCR, BARS, BLPH, BRAC, 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, **BRAC –** 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, **BRAC** – 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

UC Santa Cruz NOID 12 (20-1)

SCZ-NOID-0004-20

Special Conditions Implementation Report 1

January 1, 2021 – June 30, 2021

Burrowing owl on the Younger Lagoon Reserve Beach Dunes

UC Santa Cruz NOID 12 (20-1)

Special Conditions Implementation Report 1

Overview and Executive Summary

On October 7, 2020, the California Coastal Commission approved UCSC's NOID 12 (20-1) as consistent with UCSC'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), UCSC 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), UCSC shall submit two copies of a Beach Tour Monitoring Report for Executive Director review and approval. UCSC's report on the implementation of these special conditions for the period of January 1, 2021 through June 30, 20201 is detailed below. UCSC has included information from the previous four reporting periods covered under NOID 9 (18-1) and one-year prior, to provide historical and cumulative reference data. This is the first report under NOID 12 (20-1). The next report under NOID 12 (20-1) is due by December 31, 2021.

A summary of UC Santa Cruz's compliance with the five special conditions is below. Due to COVID-19 precautions, the Seymour Center was temporarily closed and the free beach tour program temporarily suspended in early March 2020. The Seymour Center has partially reopened with some limited outdoor programming and the Ocean Explorers summer camp; however, the Exhibit Hall remains temporarily closed and all of the Seymour Center's tour programs remain temporarily suspended. The University will restart the free beach tour program when the Seymour Center fully reopens (see UC Santa Cruz's Pub. Res. Code section 30611 notification letters to the Commission), anticipated during the next academic year in 2021/2022.

Special Condition	Status	Notes
1) Free Beach Tours	Completed	Upon resumption of the tours, all beach tours will continue to be offered for free without admission to the Seymour Center.
2) Beach Tour Outreach Plan	Completed & Ongoing	UCSC'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 resumption of the tours, UCSC'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	UCSC'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	Upon resumption of the tours, free beach tours will continue to be 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. UCSC submitted all of the previously required biannual reports on the beach tours covered under NOID 9 (18-1) on-time. This is the first 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.

Until the Seymour Center fully reopens, historical data from previous reports are provided below for context. When tours fully resume, subsequent reports will include up-to-date data on tour participation for the reporting period.

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 precautions, 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

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.

Condition 1.

FREE BEACH TOURS

All beach tours shall be offered for free, and UCSC shall not require that beach tour users pay any separate admission fee to any other facility in order to take the beach tour. This condition shall not be construed as affecting existing, already-allowed admission fees for UCSC's Seymour Marine Discovery Center. At a minimum, beach tour sign-ups shall be provided online (e.g., at UCSC Marine Science Campus and Seymour Marine Discovery Center websites), by phone, and at the Seymour Marine Discovery Center front desk. UCSC shall also identify and implement a mechanism for tracking the number of tour requests that are denied due to lack of tour availability or because tours are fully booked. All UCSC materials referencing the beach at Younger Lagoon and/or beach tours shall be required to be modified as necessary to clearly identify that access to the beach is available for free via beach tours.

Implementation Report

Due to COVID-19 impacts, no free beach tours were offered during the first six months of 2021. Upon resumption of the tours, all beach tours will continue to be offered for free (without admission fee). Beach tour sign-ups will be available online through the Seymour Marine Discovery Center (Seymour Center) website, by phone and at the Seymour Center public admissions counter. Seymour Center staff will 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 will 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 UCSC public materials referencing the beach at Younger Lagoon and/or beach tours, including the websites below, will clearly identify that access to the beach is available for free. (Note that there is no UCSC Marine Science Campus website; tour information will be posted to the Younger Lagoon Reserve and Seymour Marine Discovery Center websites). Notice of the temporary closure of the Seymour Center and temporary cessation of the free beach tours due to COVID-19 has been posted to the Younger Lagoon Reserve and the Seymour Marine Discovery Center websites.

https://youngerlagoonreserve.ucsc.edu/about-us/index.html
https://youngerlagoonreserve.ucsc.edu/research-teaching-public-service/visit/public-tours.html
https://seymourcenter.ucsc.edu/visit/behind-the-scenes-tours/

Condition 2.

BEACH TOUR OUTREACH PLAN

Within 30 days of this approval (i.e., by November 7, 2020), UCSC 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: UCSC Marine Science Campus and Seymour Marine Discovery Center websites, press releases, calendar listings with UCSC Events and local media (e.g., Good Times newspaper, 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 UCSC will monitor and track the Outreach Plan's execution so that UCSC and the Coastal Commission can note the effectiveness of the plan and make changes as needed. UCSC shall implement the updated approved Outreach Plan.

Implementation Report

Due to COVID-19 impacts, no free beach tours were offered during the first six months of 2021 and thus, no free beach tour outreach was conducted. Upon resumption of the tours, outreach will be 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*. Virtual	Permanent webpage: https://seymourcenter.ucsc.edu/visit/behind-the-scenes-tours/	Provide link to updated website and date that updates were made

	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/research-teaching-public-service/visit/public-tours.html	Provide link to updated website and date that updates were made
Seymour Center Social Media o Facebook o Twitter o 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
YLR Social Media o Facebook o 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
Calendar Listings o UCSC Events o Good Times Newspaper (Santa Cruz) o Register Pajaronian Newspaper (Watsonville) o The Half Moon Bay Review o The Monterey Herald o KAZU public radio (Santa Cruz) o KRML (Monterey Bay)	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	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)

	visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**		
Ads o Santa Cruz Sentinel Newspaper (Santa Cruz) o Good Times Newspaper (Santa Cruz) o 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 al **831-459-3800** o regístrese en línea. Las visitas virtuales están disponibles en línea. **seymourcenter.ucsc.edu**	Quarterly	Document date that ads ran, and verify that the ad ran by capturing a link to the website (if online)
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	Announce the virtual tours and resumption of free in-person beach tours post-COVID via two bilingual (English and Spanish) UCSC 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).

	disponibles en línea. **seymourcenter.ucsc.edu**		
Contacts who may facilitate promotional opportunities o SMDC Educator Email Mailing List (815 subscribers) o Homeschool Mailing Email List (124 subscribers) o Seymour Center E-newsletter list - 10,000 email recipients from all over California and beyond o UCSC Events Email-newsletter o Andy Carman at Enviroteers, weekly newsletter o CSUMB Outdoor Recreation Resources and Opportunities Website o Outdoor World Outdoor Resources Website: https://www.theoutdoorworld.com/info/outdoor-resources	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.

In addition, tour participants will be surveyed to determine how they heard about the tour. This information will be tracked with sign-up information (see Condition 1).

Condition 3.

BEACH TOUR SIGNS

UCSC 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. UCSC shall continue to implement the approved Beach Tour Sign Plan from NOID 9.

Implementation Report

Due to COVID-19 impacts, no free beach tours were offered during the first six months of 2021. Upon resumption of the tours, information on the free beach tours will continue to be displayed "day of" on a large colorful monitor 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 1, 4, and 5). Signage will continue to be displayed at the information kiosk outside (Figure 3) of the Seymour Center and at Overlooks A-F (Figures 6-12).

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), see below.

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 2).

<u>Figure 1.</u> "Day of" sign design.

<u>Figure 2.</u> Overlooks and kiosk sign design.

Figure 3. Signage installed at Seymour Center information kiosk (photo taken pre-pandemic).

Figure 4. Signage installed at Seymour Center front window (photo taken pre-pandemic).

Figure 5. Signage installed at the Seymour Center admissions desk (photo taken pre-pandemic).

Figure 6. Signage installed at Overlook A.

Figure 7. Signage installed at Overlook A (close-up).

Figure 8. Signage installed at Overlook B (Terrace Point).

Figure 9. Signage installed at Overlook C.

Figure 10. Signage installed at Overlook D.

Figure 11. Signage installed at Overlook E.

Figure 12. Signage installed at Overlook F.

Condition 4.

BEACH TOUR AVAILABILITY AND MONITORING

UCSC shall offer at least four beach tours per month (of which at least one per month is a weekday tour and at least two per month are weekend tours) from March 1st through September 30th each year and shall provide at least two beach tours per month (of which at least one per month is a weekday tour and at least one per month is a weekend tour) otherwise (totaling a minimum of 38 total beach tours per year). UCSC 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). UCSC shall document the date/time and number of participants for each beach tour, as well as the number of tour requests that are denied due to lack of tour availability or because tours are fully booked (see also Condition 1).

At least every six months (i.e., by June 30 and December 31 of each year), UCSC shall submit two copies of a Beach Tour Monitoring Report for Executive Director review and approval, where the Report shall, at a minimum, provide information regarding compliance with these conditions of approval, including a section identifying UCSC's activities under the approved 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 UCSC research opportunities at the site. UCSC shall implement any Executive Director-approved recommendations from each Beach Tour Monitoring Report.

Implementation Report

Due to COVID-19 impacts, no free beach tours were offered during the first six months of 2021 and no data were collected. Upon resumption of the tours, free beach tours will 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 will be limited to 18 persons per tour, but this number may be exceeded per tour on a case by case basis, and beach tours will not require any minimum number of participants to be provided (i.e., if at least one person signs up, the tour will be provided). UCSC will 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). In addition, tour participants will be surveyed to determine how they heard about the tour. This information will be 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), UCSC 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 UCSC'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 first such report under this implementation plan and has been submitted by June 30, 2021.

Due to COVID-19 impacts, a total of six free beach tours were offered in 2020 (See Appendix 1). In 2020, beach tour participants were limited to 14 persons per tour (previous NOID 9 (18-1) limit of 14 was increased to 18 under NOID 12) on all but one tour. On January 2, 2020, at the discretion of the tour docent, the number of beach tour participants was increased to 15 persons to accommodate all persons who desired to take the beach tour that day.

UCSC offered 38 beach tours (265 participants) during 2019 (Appendix 1). All but one of these tours had at least one participant. Only one tour did not go out due to lack of sign-ups. Sixteen of the tours that went out included walk-in / "day-of" participants. Two tours were overbooked in 2019.

In comparison, UCSC offered 38 beach tours (224 participants) during 2018 (Appendix 2). Six tours did not go out due to lack of sign-ups, and one tour was canceled due to weather. Four of the tours that went out included walk-in / "day-of" participants. No tours were overbooked during 2018.

Although not required by the special conditions, in addition to tracking user data, UCSC 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 all but three 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 13).

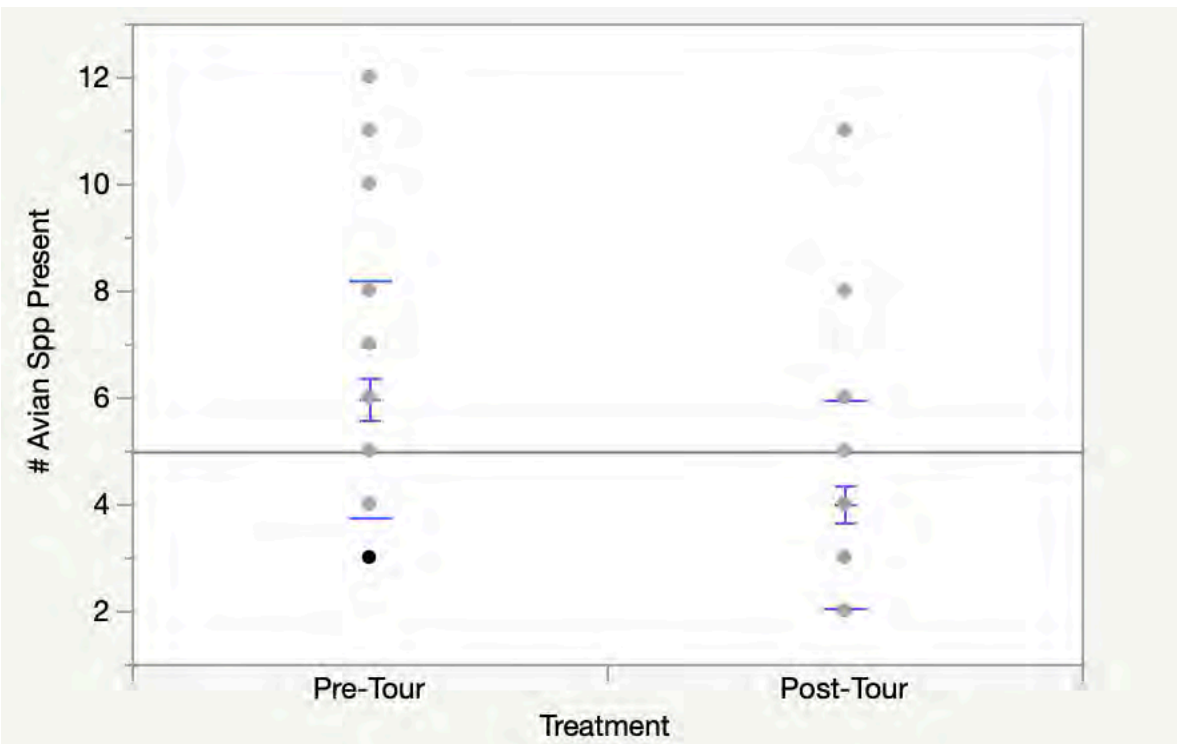

Figure 13. Effect of tours on avian species. Blue I-bars indicate mean, standard error, and standard deviation. The average number of avian species present pre-tour was 5.97 +/- 2.22 (+/- sd). The average number of avian species present post-tour was 4.00 +/- 1.95 (+/- sd). The average number of avian 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 30 months and currently paused due to COVID-19 impacts, the beach tours as specified by UCSC's NOIDs 9 (18-1) and 12 (20-1) special conditions appear to be meeting user demand. 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 (first full year post special conditions) and more than 350% higher than tour attendance during the same time period in 2018 (pre special conditions). During the 24 months covered by NOID 9 (18-1), eight participants were denied a tour due to overdemand. NOID 12 (20-1) continues the five NOID 9 special conditions, increases the upper limit of tour attendees and requires additional outreach efforts.

The documented negative biological impacts to avian wildlife described above, along with ongoing quarterly beach monitoring efforts indicate that open access to the beach would result in the loss of the unique ecological characteristics of the site, reduce its effectiveness as a research area for scientific study, and likely have a negative impact on sensitive and protected species (See 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017, 2017-2018, 2018-2019, and 2019-2020 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 UCSC's public beach access management plan at Younger Lagoon Beach shall be effective through December 31, 2025. UCSC shall submit a complete NOID, consistent with all CLRDP requirements, to implement its next public beach access management plan at Younger Lagoon Beach (for the period from January 1, 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 UCSC's proposed management plan responds to such data, including with respect to opportunities to increase public access to the beach area when considered in light of potential impacts to UCSC research and coastal resources. If such a complete NOID has not been submitted by July 1, 2025, then UCSC shall allow supervised (via beach and trail monitors only) general public access to Younger Lagoon Beach during daylight hours (i.e., one hour-before sunrise to one-hour after sunset) until such NOID has been submitted.

Implementation Report

UCSC 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, 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	-	-	-	-	-

*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**
GRAND TOTAL	**-**	**325**	**51**	**353**	**71**	**8**

*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, 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, **BARS** – Barn swallow, **BHCO** – Brown-headed cowbird, **BLOY** – Black oystercatcher, **BLPH** – Black phoebe, **BRAC** – 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, April 14, 2019 – June 30, 2019

Tour Date	Day	Species Present	Species Flushed
4/14/19	Sunday	AMCO, BLOY, BRAC, CCGO, GREG, MALL, SNEG, WEGU	BLOY, CCGO, MALL
4/18/19	Thursday	BLOY, BRAC, 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, BRAC, 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, BRAC, BRBL, CAGO, CLSW, GREG, MALL, PECO, PIGU, WEGU	CAGO, GREG, PIGU, WEGU
6/9/19	Sunday	BARS, BLPH, BRAC, KILL, PIGU, RWBL, SOSP, WEGU	BARS, BLPH, PIGU, RWBB
6/20/19	Thursday	AMCR, BARS, BLPH, BRAC, 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, **BRAC** – 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, **BRAC** – 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 6. Publications

STUDENT RESEARCH
CNGA Grassland Research Awards for Student Scholarship Winner, 2019 & 2020
JUSTIN LUONG

Selecting Coastal California Prairie Species for Climate-Smart Grassland Restoration

by Justin C. Luong[1] and Michael E. Loik[1]

Abstract

California is predicted to experience warmer temperatures and more frequent droughts in future years, which will increase local and regional climatic water deficit. Understanding how commonly used restoration species will respond to drought may help with approaches to mediate the negative impacts of changing climates on restoration. Associated plant functional traits can increase understanding of how a group of species responds to variable environmental conditions, and aid with selecting broader mixes of drought-tolerant plants for restoration. For this study, we established ambient rainfall, first-year watered and drought treatments (60% rainfall reduction), in a coastal grassland in Santa Cruz, CA. Drought was created using rain-out shelters that simulate a 1-in-100-year drought. We planted 12 California native coastal prairie species to determine which species and life-forms had greater survivorship. We monitored the survival of these plantings annually from 2016 to 2019 and assessed the plant community composition in 2018 and 2019. We found that rhizomatous forbs were ideal candidates for planting coastal prairie restoration sites, especially in terms of drought. Bunchgrasses were also successful in the drought treatment, but to a lesser degree. N-fixers and non-rhizomatous forbs had minimal survivorship by the fourth year. Our findings demonstrate variable survival of planted seedlings in terms of time and drought. Additionally, from our study, the most favorable candidates for restoring California coastal prairie in a drier climate were common yarrow (*Achillea millefolium*), prairie mallow (*Sidalcea malviflora*), and purple needle grass (*Stipa pulchra*).

Background

Interannual rainfall variability, and other site conditions in the planting year, can play an important role in determining the outcomes of grassland restoration (Groves et al. 2020). California is warming and experiencing longer dry periods, portending a greater frequency of drought in future years (Cayan et al. 2007). This will increase local and regional climatic water deficit and increase plant drought stress (Loik et al. 2004), which may negatively impact restoration outcomes. To improve the success rate of restoration efforts, it may prove useful to develop restoration strategies that account for environmental variation, particularly as the climate continues to change.

Plants have adapted by developing functional traits that allow them to survive abiotic and biotic stressors in the environment. Traits can help with selecting species for restoration that are more suitable for establishment in variable and changing climates (Pérez-Harguindeguy et al. 2016). Functional traits can include morphological features of leaves, shoots, or roots; physiological processes such as photosynthetic rates; or life-form descriptions like "bunchgrass" or "shrub." Life-form classification is a framework, readily accessible through the Jepson eFlora, for describing species that tend to have similar overall morphologies (Pérez-Harguindeguy et al. 2016).

The coastal prairie, a special type of grassland that receives coastal fog during the summer, is one of the most diverse grassland types in North America (Ford and Hayes 2007). Restoration of these habitats is often mandated by the California Coastal Commission through the California Coastal Act of 1976, so it is important to understand the factors that limit the success of these restoration efforts. Some species might be better adapted than others for drier conditions in coastal prairies and focusing on those species could help meet strict compliance goals.

In this study, we manipulated ambient rainfall to assess the impacts of extreme drought and first-year watering on 12 native California coastal prairie species. We planted experimental plots with seedlings in 2016 and monitored them for four years to compare survival, to determine whether certain prairie species or life-forms had higher survivorship. We hypothesized that drought would positively benefit planted native species, first-year watering would increase survival of seedlings, and non-rhizomatous forbs would have the lowest survivorship of the life-forms we studied.

Methods

Study Site

Younger Lagoon Reserve is a mesic coastal terrace prairie in Santa Cruz, CA, that has experienced various anthropogenic disturbances (grazing, tillage, row-crop agriculture) since the 1800s. It was protected as part of the UC Natural Reserve System in 1986. The reserve currently has ongoing restoration efforts that include non-native species control and plug plantings with local genotypes of native species. The area is dominated by non-native species such as Italian thistle (*Carduus pycnocephalus*, forb), brome fescue (*Festuca bromoides*, annual grass), Italian rye grass (*Festuca perennis*, annual grass), rip-gut brome (*Bromus diandrus*, annual grass), cutleaf geranium (*Geranium dissectum*, forb), and wild radish (*Raphanus sativus*, forb), with some remnant native species like coyote scrub (*Baccharis pilularis*, shrub) and coastal tarweed (*Madia sativa*, forb). Restoration efforts

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adjacent to the study site have successfully increased the abundance of native prairie species such as California brome (*Bromus carinatus*, bunchgrass), blue wild rye (*Elymus glaucus*, bunchgrass), creeping wild rye (*Elymus triticoides*, rhizomatous grass), purple needle grass (*Stipa pulchra*, bunchgrass), common yarrow (*Achillea millefolium*, rhizomatous forb), pacific aster (*Symphyotrichum chilense*, rhizomatous forb), and many coastal shrub species.

Younger Lagoon Reserve has a Mediterranean climate with summer coastal fog. During the four years of the experiment, rainfall in the hydrologic year (October–September) was around the long-term average (1981–2010) of 796 mm (Western Regional Climate Center: **https://wrcc.dri.edu**). Years 1, 2, and 4 had rainfall within 20% of the long-term average; specifically, years 1 (643 mm) and 4 (695 mm) had slightly below, and year 2 (954 mm) had slightly above average rainfall. Year 3 (521 mm) was a dry year and had 35% less rainfall than the long-term average.

Drought Manipulation

Drought shelters were constructed in summer 2015 following the standardized protocol from the International Drought Experiment (Knapp et al., 2015; **drought-net.colostate.edu**). Drought (rain-out) shelters exclude 60% of incoming rainfall, thereby simulating a 1-in-100-year drought based on historic Santa Cruz precipitation. Shelters were built with metal and wooden frames and polycarbonate troughs that lead water into gutters away from the plots (Loik et al. 2019). Drought plots were trenched 50 cm deep on all four sides and lined with 6-mil plastic to limit influence from lateral water flow and root growth. Drought shelters have little effect on air temperature, relative humidity, and reduce daily total photosynthetically active radiation by 20% (Loik et al. 2019). All plots were 4 × 4 m with a 0.5-m buffer on each side, creating a 3 × 3 m experimental area. Treatment effects on volumetric soil water content were confirmed using one soil moisture probe in each treatment 15-cm deep (METER Environmental; formerly Decagon, Pullman, WA, USA). We set up five plots of each treatment type: drought, ambient rainfall, and first-year watering. First-year watering is a common practice for restoration in arid regions when resources are available (Stromberg et al. 2007). First-year watering was used to determine if it could increase the long-term survivorship of native plantings. Planted natives in first-year watering plots were hand-watered with 4 liters twice in the first growing season (2016) during a rain-gap period in February, then March.

Plots were mowed to remove all standing biomass and then were planted with 12 native species (three to seven individuals per species) in January 2016. Seedlings were grown in containers in glasshouses for about three months at the UCSC Plant Growth Facility from seeds collected ≤40 km from our site (Table 1). Native species were selected based on reserve recommendations and to maximize life-form diversity. Native seedlings were planted in a randomized grid so that all plots had an identical planted species arrangement at the start of the experiment. Species life-forms were identified using the Jepson eFlora. After planting, research plots were weeded twice during the first growing season and not again after. Weeding included hand removal of non-native species using planks suspended above the plots to reduce plot disturbance.

Table 1. The 12 California native species planted for the study.

Taxa	Common Name	Life-Form
Achillea millefolium	common yarrow	rhizomatous forb
Artemisia californica	California sage scrub	shrub
Bromus carinatus	California brome	bunchgrass
Diplacus aurantiacus	sticky monkey flower	shrub
Ericameria ericoides	mock heather	shrub
Eschscholzia californica	California poppy	forb
Hosackia gracilis	harlequin lotus	N-fixer
Lupinus nanus	sky lupine	N-fixer
Lupinus variicolor	many-colored lupine	N-fixer
Sidalcea malviflora	prairie mallow	rhizomatous forb
Sisyrinchium bellum	blue eyed grass	forb
Stipa pulchra	purple needle grass	bunchgrass

Survivorship & Species Composition

We quantified survival annually every April from 2016 to 2019. Survivorship was determined as the proportion of individuals that survived, as a function of total individuals planted.

In 2018 and 2019 we surveyed plant community composition in six permanent quadrats (0.25 × 1 m) established through randomized grid selection in each plot. Absolute plant cover was estimated to the nearest 5% with a modified Braun-Blanquet method. Absolute plant cover includes multiple canopy heights to ensure that all species are surveyed, so cover values can exceed 100%. We also recorded thatch cover and depth, and the absence/presence of seedling recruitment from the 12 planted species.

Analyses

All analyses were completed with the statistical analysis package, R (v3.6.1). Data were tested for parametric assumptions before using analysis of variance (ANOVA) or generalized linear models (GLM). ANOVAs were used to test for differences between the mean survival of different treatments, and GLMs were used to test for linear relationships between variables. Thatch depth and cover were directly correlated ($R^2 = 0.21$, $p = 0.007$), so we used thatch depth for subsequent analyses. We used Bray-Curtis dissimilarities to compare treatment effects on plant communities between plots from 2018 and 2019, then used the similarity of percentages (SIMPER) analysis to determine the contribution of individual species to the overall degree of community dissimilarity (Qureshi et al. 2018).

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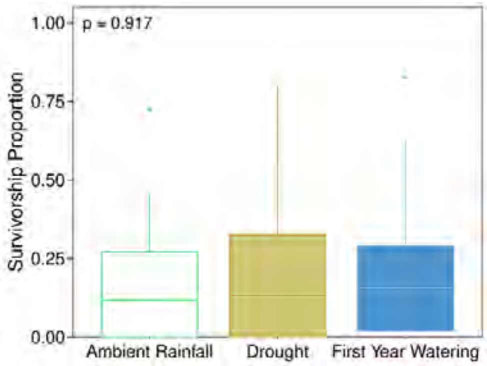

Figure 1. Survivorship compared across treatments for all 12 planted native species combined during year 4. Box represents interquartile range, the bar in the box represents the average, whiskers represent upper and lower quartiles of the data range, points represent outliers.

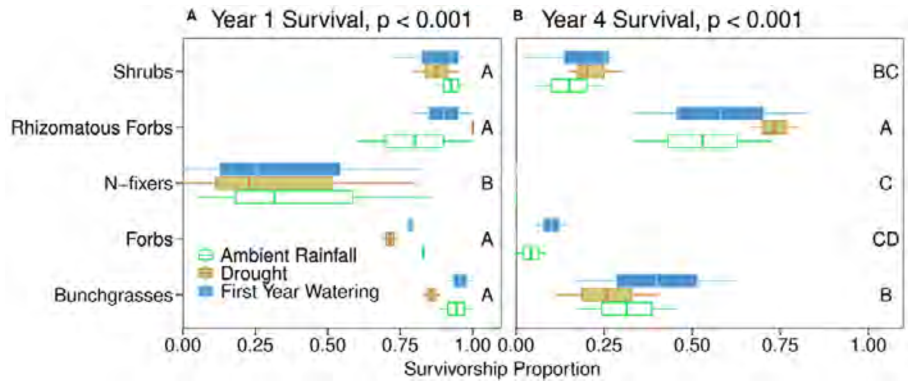

Figure 2. Survivorship in April of (A) year 1 (2016) and (B) year 4 (2019) compared across treatments for 12 planted species by life-form. Inset p-values are from the ANOVA model test: *'survival~life-form'*. Non-overlapping letters represent significant differences in survivorship between life-forms in respective panels. Survivorship of N-fixers (and forbs on drought plots) in year 4 was zero, thus it is plotted on the y-axis. Differences in survivorship by treatment within each life-form group are not noted in this figure. See Figure 1 for box-plot interpretation.

Selecting Coastal California Prairie Species for Climate-Smart Grassland Restoration *continued*

Results

Planting Survival

We found that both drought and first-year watering had no effect on survivorship compared to ambient rainfall plots four years after planting (Figure 1).

We found that there were significant differences in survivorship between life-forms by the end of the first (2016) and fourth (2019) growing seasons when treatments were combined (Figure 2). Nitrogen-fixing species had lower survivorship than all other life-forms ($p_{all} < 0.001$), but no other differences between life-forms were found at the end of the first growing season. By the end of the fourth growing season, rhizomatous forbs had the highest survivorship (70.1%) across treatments compared to other life-forms ($p_{bunchgrass} = 0.022$, $p_{N\text{-}fixer} < 0.001$, $p_{shrub} < 0.001$, $p_{forb} < 0.001$). Bunchgrasses had higher survivorship than forbs ($p = 0.031$) and N-fixers ($p = 0.004$), but not shrubs ($p = 0.409$). Shrubs, forbs, and N-fixers had similar survivorship by the end of the fourth growing season.

We then looked for treatment effects within each life-form grouping and found only forb survivorship was negatively affected by drought treatment after the first growing season ($F = 9.8$, $p = 0.044$), although not by the end of the fourth. No other survivorship differences by treatment within specific life-form groupings were noted in years 1 or 4.

The nitrogen-fixers (harlequin lotus, sky lupine, and many-colored lupine) and blue-eyed grass had no survivors nor any seedling

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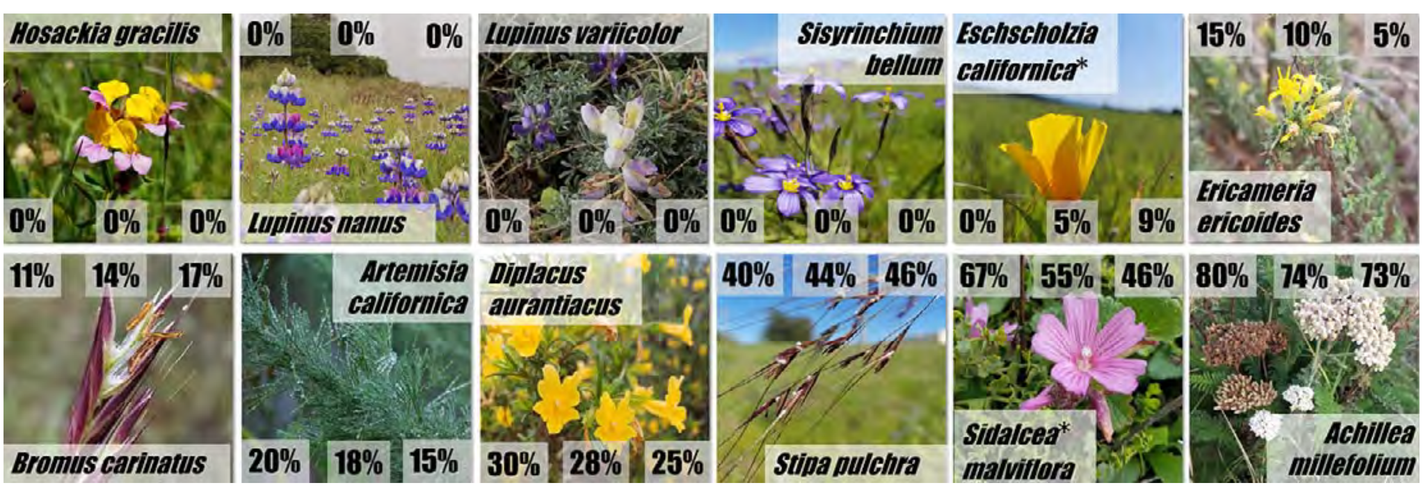

Figure 3. Survivorship of the 12 native species at the end of the fourth growing season. Survivorship from left to right in each panel represents drought (left), overall average for treatments combined (center), and ambient rainfall (right). Survivorship from first-year watering plants is not depicted since there was no effect. Significant differences in survivorship between drought and ambient rainfall plots occurred only for *S. malviflora*.

recruitment by the fourth year (Figure 3). The California poppy had some recruitment, but only 5% of the originally planted cohort survived at the end of the fourth growing season. Notably, the California poppy was the only planted species that was somewhat negatively affected by drought ($p = 0.069$). Mock heather, a fall-flowering shrub, also had low survival and no recruitment. The bunchgrasses, California brome and purple needlegrass, had moderate survivorship, and both showed some recruitment, especially *B. carinatus*. Summer-flowering shrubs, *Artemisia californica* and *Diplacus aurantiacus*, had moderate survival, though lower than bunchgrasses (Figure 3). The rhizomatous forbs, *Sidalcea malviflora* and *Achillea millefolium*, had high survivorship by the end of year 4. *Sidalcea malviflora* showed evidence of seedling recruitment and had higher survivorship in drought compared to other treatments ($p = 0.012$). Both rhizomatous forbs had considerable vegetative spread through rhizomes, especially *A. millefolium*. All other species were unaffected by drought, and the survivorship of no species showed signs of benefitting from first-year watering at the end of the fourth growing season.

Plant Community Differences

We used Bray-Curtis dissimilarities to compare community composition on the plots, and summarized the findings in Figure 4.

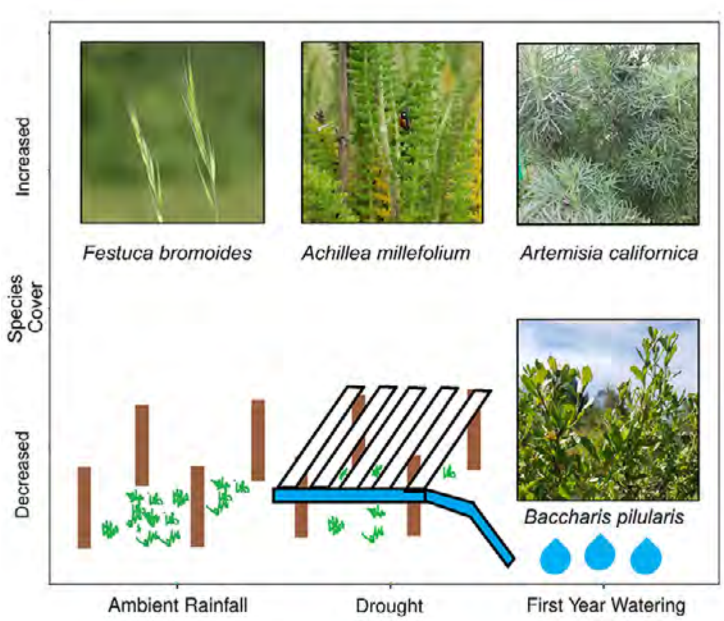

Figure 4. Certain species were found to underlie the differences in plant community composition between treatments (results from similarity percentage breakdown (SIMPER) analysis). Species in each treatment column are significant for determining how their plant communities are dissimilar from others. Species in the top row had greater cover in their respective treatment, and those in the bottom row had lower cover.

Plant communities on drought plots were significantly different from that of ambient rainfall and first-year watering plots, while the latter two had mostly overlapping plant communities ($k = 3$, stress = 0.117). We found that certain species explained the differences in community composition (SIMPER; $p < 0.001$). On drought plots, *Achillea millefolium* had 31% cover, which accounted for 21% of community difference between drought and ambient rainfall plots, which only had 6% *A. millefolium* cover ($p < 0.001$). *Achillea millefolium* explained 18% of the variance between drought and first-year watering plots, which had 11.3% average cover ($p = 0.003$). *Festuca bromoides* (a non-native annual grass) explained 12% of the plant community difference between ambient rainfall and drought plots ($p = 0.011$). Ambient rainfall plots had 21% *Festuca bromoides* where the cover and drought plots had 13% ($p = 0.011$). *Baccharis pilularis* explained 12% of community variation between first-year watering and ambient rainfall plots ($p = 0.050$). First-year watering plots had 9% cover and ambient rainfall had 14% cover. First-year watering plots had greater *Artemisia californica* cover (6%) which explained about 5% of the community difference compared to both drought (1%; $p = 0.011$) and ambient rainfall plots (1%; $p = 0.010$).

Native species cover was negatively correlated with thatch depth (Figure 5). We did not find any significant linear relationships between thatch and total non-native species cover, annual grass cover, nor any specific dominant extant non-native species.

Discussion

Overall, native plant survivorship decreased over the four years for the 12 native species, demonstrating the difficulty of restoring native coastal prairie. It is unlikely that precipitation patterns over the four

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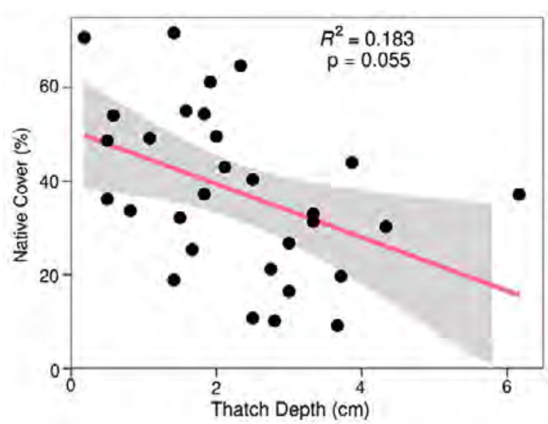

Figure 5. The relationship between native species cover and thatch depth. Points represent plots in 2018 and 2019. The shaded region represents a 95% confidence interval.

years led to this outcome, as survivorship trends do not match the inter-annual rainfall totals. Survival and cover were unaffected by the drought treatment for most of the native species. Low survivorship could have been a result of other things such as competition or diseases at earlier life stages. Alternatively, low survivorship could have been caused by background weather conditions which could have caused drought stress. But, the competition hypothesis is consistent with previous work that indicates California natives are sensitive to competition as seedlings which could result in low survival (Buisson et al. 2006). However, certain life-forms had higher cover or survivorship on drought plots than others. For example, the rhizomatous forb common yarrow had higher cover, whereas prairie mallow had high recruitment and was the only one of 12 species that had higher survivorship in drought plots. These rhizomatous forbs could be useful in establishing native cover to meet short- and long-term restoration targets or mandated compliance goals, even in drought years.

Some of the native species had minimal recruitment and establishment by year four, including the non-rhizomatous forbs, the California poppy, blue-eyed grass, and the N-fixing forbs. N-fixing forbs had lower survivorship than all other life-forms after the first growing season. Despite obvious benefits from nitrogen inputs, N-fixers may not be the best species for rapidly increasing native cover. The California state flower, the California poppy, was the only species to be negatively affected by drought compared to ambient rainfall plots during all four study years. This could indicate a need for future management of this species if there are more frequent or longer droughts. The responses of bunchgrasses were mixed, with purple needle grass having relatively high survivorship and California brome exhibiting high recruitment. These results are similar to past studies showing the general difficulty of establishing forbs in California grasslands (Copeland et al. 2016).

Since thatch depth is weakly and negatively associated with native species cover, periodic thatch or litter removal could help ensure the persistence of native prairie species. Other studies have found that thatch can suppress California native species growth, especially in the early years (Reynolds et al. 2001). Thatch is often associated with reduced recruitment of natives among non-native species (Hayes and Holl 2003). However, although thatch accumulation was unsurprisingly lower in drought plots (Zavaleta and Kettley 2006), we found no correlations between the native and non-native species and thatch at the study site.

Managing species that drive community change may be a good starting point for restoration actions. In this experimental system, this happened to be common yarrow and brome fescue. Common yarrow accounted for the higher native cover in drought plots, while ambient rainfall plots had a high cover of brome fescue, a non-native annual grass. Brome fescue may be an important target for weed management during average rainfall years whereas common yarrow could be useful for increasing native plant cover in dry years.

Management Recommendations

Our results demonstrate that certain plant species or life-forms may be better suited than others for the restoration of coastal prairies. We recommend managers that have short-term native compliance goals to use life-forms with high survivorship such as the rhizomatous forbs *Achillea millefolium* and *Sidalcea malviflora*. Bunchgrasses can persist for years after planting, and some, like *Bromus carinatus*, had high seedling recruitment. Managers with an immediate compliance goal in the second year might consider avoiding life-forms with low survival and/or seedling recruitment, such as non-rhizomatous and N-fixing forbs. When possible, coastal grassland managers should consider how to further incorporate non-rhizomatous forbs into their planting plans. Lastly, managers may also consider periodic thatch removal to promote higher native species cover.

Acknowledgments

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RESEARCH ARTICLE

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Leaf traits and phylogeny explain plant survival and community dynamics in response to extreme drought in a restored coastal grassland

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Abstract

1. Climate change will increase uncertainty in restoration outcomes due to greater water stress and other abiotic filters that limit plant survival. Drought-related plant functional traits can help species withstand filters in a semi-arid environment. Our objective was to provide guidance for selecting species to improve restoration success in a changing climate.
2. We planted 12 native species in ambient rainfall and under 60% rain-out shelters in an invaded coastal grassland in central California. We measured survival and size annually for 4 years and quantified plant community and trait composition in the third and fourth years. We measured growth rate, specific leaf area (SLA), leaf C:N, leaf lobedness and leaf $\delta^{13}C$ of all planted species and dominant extant species, and evaluated the effect of treatments, traits and phylogenetics on mortality risk using Cox proportional hazards.
3. Native perennial species cover was greater, whereas thatch depth and per cent cover of shrubs and non-native annual grasses were lower, on drought plots. Drought plots had lower community-weighted leaf C:N and higher leaf lobedness.
4. Planted species with resource conservative traits, such as higher leaf lobedness and lower growth rate, had lower mortality risk. Increased plasticity of morphological traits (SLA and lobedness) was associated with decreased mortality risk, whereas increased plasticity of physiological traits (leaf C:N and $\delta^{13}C$) and risk was positively correlated. Trait plasticity explained a greater degree of plant mortality risk compared to absolute trait values.
5. Plants that were more phylogenetically related to the surrounding plant community had lower mortality risk. Traits of planted species that were important for determining plant mortality in this coastal grassland may be conserved, which was supported by a phylogenetic signal (Blomberg's $K = 0.380$, Pagel's $\lambda = 0.830$) in leaf C:N.
6. *Synthesis and applications*. Our results suggest that leaf traits and phylogenetics could serve as plant selection criteria for reducing plant mortality risk during drought, thereby improving restoration outcomes. Because some traits have a phylogenetic signal that explains drought survival, restoration practitioners could

expand the use of trait-based selection for closely related species when restoring other arid- and semi-arid ecosystems.

KEYWORDS

Cox proportional hazard, environmental filter, leaf C:N, leaf lobedness, leaf $\delta^{13}C$, phylogenetic signal, relative distance plasticity index (rdpi), trait plasticity

1 | INTRODUCTION

Ecological restoration is expensive and funding is often limited (Holl & Howarth, 2000), so new approaches are needed to improve restoration success. Restoration currently suffers from unpredictable outcomes (Suding, 2011) and climate change will likely increase restoration variability (Harris et al., 2006), as models forecast that precipitation will become more temporally and spatially variable (Swain et al., 2018). One reason for uncertain restoration outcomes is a focus on taxonomic composition without consideration of how species respond to changing environments (Funk et al., 2008). Incorporating community metrics that directly respond to environmental conditions when selecting species may decrease some of the uncertainty faced by restoration practitioners (Carmona et al., 2016; Verdu et al., 2012).

Precipitation timing and magnitude in California and many parts of the world will likely vary more within and across years in the future (Swain et al., 2018). This variability will result in more rainfall being lost as run-off during large rain pulses and less infiltration to replenish soil-water (Loik et al., 2004). This will cause longer time periods between rainfall events during the wet season, contribute to increasing climatic water deficit and enhance plant drought stress (Loik et al., 2004). Therefore, it may help to draw from trait-based coexistence and community assembly theory that focus on methods for matching plant traits to changing environmental conditions to maximize restoration efficacy (Adler et al., 2013; Funk et al., 2008; Verdu et al., 2012). Because plant traits exhibit plasticity which causes traits to change in response to environmental conditions (Valladares et al., 2006), understanding how a range of traits adjust can help identify key traits that drive plant survival, community composition and restoration outcomes (Griffin-Nolan et al., 2018).

Plants must pass through a series of abiotic and biotic environmental filters in order to establish at a new site and persist (Funk et al., 2008). Abiotic filters can select for multiple and overlapping traits among species (Verdú et al., 2003). Abiotic filters may become more selective in a changing climate, driving communities towards trait convergence in order to survive the enhanced filters. By contrast, biotic filters tend to cause traits to diverge (Funk et al., 2008). For example, competition may cause traits to adjust resource acquisition strategies or to escape shared natural enemies and facilitate niche-based coexistence (Chesson, 2018).

Phylogenetics can improve understanding of competitive dynamics and aid with species selection for restoration (Hipp et al., 2015; Tucker et al., 2017). For example, species that are less phylogenetically related are more likely to coexist because they are less likely to share pests, diseases or similar vulnerabilities (Gilbert et al., 2012; Parker et al., 2015). Phylogenetic niche conservatism predicts that closely related species that have recently diverged in a particular climate tend to have a greater number of similar traits (trait convergence) than expected under Brownian evolution (Losos, 2008). If traits are conserved in plant communities (Kraft et al., 2008; Webb et al., 2002), this could help in identifying candidate species for restoration. For example, when species with certain traits are unavailable for restoration efforts, related species with similar traits could be used instead (Verdu et al., 2012).

California coastal prairies are a rare type of grassland that receive winter rainfall and summer water input from coastal fog (Baguskas et al., 2018). These grasslands are dominated by perennial bunchgrasses and annual forbs. Coastal prairies are one of the most diverse grassland types in North America but are threatened by land development, over-grazing and non-native species invasions (Ford & Hayes, 2007). Because restoration is mandated for disturbed coastal prairies under the California Coastal Act of 1976, identifying strategies that reduce planting mortality and improve native cover is crucial for achieving restoration goals.

We tested the role that leaf traits play in structuring plant communities and how mortality risk of planted native seedlings is affected by traits and phylogenetic relationships. We used a field drought experiment at a coastal grassland in Santa Cruz, California, USA to measure survival and growth of native species over a 4-year span. We quantified trait values for surviving individuals of the planted seedlings and for the 11 dominant extant species (2 native and 9 non-native) in years 3 and 4. We hypothesized that native species would have greater cover than non-natives in drought plots due to adaptations to low rainfall conditions that frequently occur in this Mediterranean climate region. We predicted that native plants that survived through the fourth year would have functional traits associated with drought tolerance (e.g. low SLA, high C:N, low N and high $\delta^{13}C$ (a proxy for water-use efficiency, WUE); Nobel, 2009). We also hypothesized that surviving individuals would be less phylogenetically related to nearby plants. Last, we anticipated that plant communities (composed of native and non-native species) would shift towards species with drought-adapted traits on drought plots compared to ambient rainfall treatments.

2 | MATERIALS AND METHODS

2.1 | Study site

Our study was conducted at the University of California Younger Lagoon Reserve (YLR) in Santa Cruz, California (36.951918°N, 122.063116°W). The site is a highly degraded coastal prairie located on the first marine terrace adjacent to the Pacific Ocean. The area was historically utilized for cattle grazing between the 1820s and the 1920s, for row crop agriculture (using tillage) between the 1920s and the 1980s, and entered the UC Natural Reserve System in 1986. The site is dominated by non-native annual grasses and forbs, and is part of ongoing habitat restoration efforts (Holl et al., 2014).

The climate is Mediterranean with wet, cool (but not freezing) winters and hot, dry summers. This region receives water input 30%–40% of summer days from coastal fog (Baguskas et al., 2018). During the study period (2016–2019), the site experienced mean annual precipitation near the 100-year average with some interannual variability (796 mm, CV = 0.259; Figure 1), and was emerging from a major drought (Swain et al., 2018). Meteorological data were measured on the roof of a building <500 m from the field site (Campbell Scientific UT-30).

2.2 | Experimental design

2.2.1 | Drought treatment

We constructed drought (rain-out) shelters in August 2015 using the standardized protocol of the International Drought Experiment (IDE; Knapp et al., 2015). The structures exclude 60% of incoming rainfall to simulate a 1-in-100-year drought, based on 100 years of rainfall records for this area. Each shelter is 4 × 4 m and built with polycarbonate troughs, metal electrical conduit and wooden support frames. Shelters produce minimal impacts on microclimate and photosynthesis of well-watered potted plants (used as phytometers; Loik et al., 2019). We trenched and lined all drought plots with 6-mil plastic, 50-cm deep, to reduce lateral water flow and root growth. We included a 0.5-m buffer around each edge of the research plots allowing for a 3 × 3 m central research area. Five plots each were assigned to drought (60% rainfall exclusion) and ambient rainfall treatments. The reduction in soil moisture caused by drought plots was confirmed with two soil volumetric water sensors (METER Environmental GS1 VWC, Pullman, Washington, USA) placed in each plot type (Figure S1).

2.2.2 | Restoration plantings

We selected plant species (Table 1) from a list of those that likely occurred historically at Younger Lagoon Reserve. Seeds were collected in 2015 from local reference sites (<40 km from the field site) and were grown in the UCSC Jean H. Langenheim Greenhouses. Plots were mowed prior to planting to remove all standing biomass and then planted in January 2016. The 12 species were randomly assigned to standard planting positions on a grid for each plot. Non-native plants were removed from the all plots once early (January 2016) and once late in the growing season (April 2016) of the first year of the experiment, but not thereafter. Non-natives were removed by hand from wooden planks suspended above the plots to minimize soil compaction.

2.3 | Monitoring protocol

2.3.1 | Plant community composition

We assessed plant community composition in April of years 3 and 4. We randomly selected and permanently marked six locations within 0.25 × 1 m quadrats and estimated cover of all species to the nearest 5% for cover values >10%, and to the nearest 1% for cover values ≤10%. We estimated absolute cover at the ground level and at multiple leaf canopy heights to ensure all species were represented, so total cover may exceed 100%.

2.3.2 | Native seedling survival and biometrics

We quantified survival and growth-form-specific biometrics in April of years 1–4, and recorded survival using a right-censored method

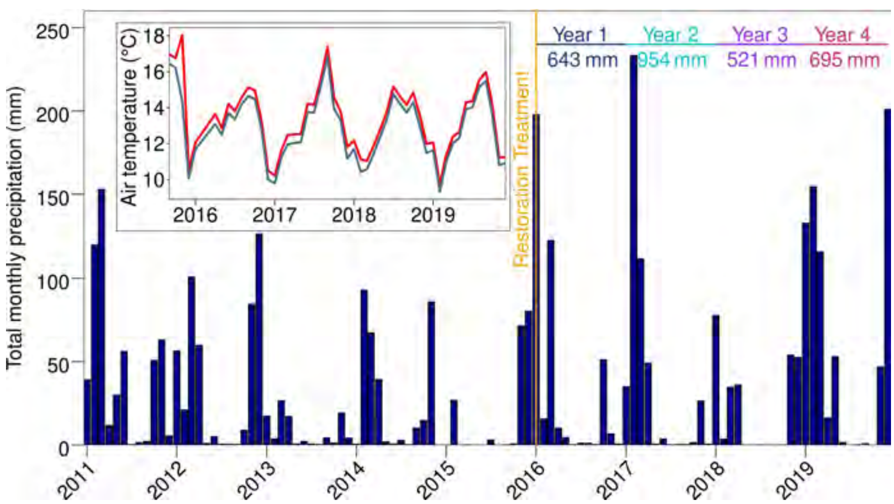

FIGURE 1 Monthly precipitation totals at the site from 2009 to 2019. Ticks on the x-axis correspond to January of each year. Precipitation totals on the top right of the figure are for the hydrologic year. Inset shows average monthly air temperature. Red = maximum temperature; Blue = minimum temperature

TABLE 1 Functional groups and sample sizes of the California native species planted in this experiment. Total per plot indicates the number of replicates of each species planted per plot

Scientific name	Family	Functional group	Total per plot
Achillea millefolium L.	Asteraceae	Perennial rhizomatous forb	8
Artemisia californica Less.	Asteraceae	Shrub	8
Bromus carinatus Hook. & Am.	Poaceae	Perennial bunchgrass	7
Diplacus aurantiacus Curtis	Phrymaceae	Shrub	8
Eschscholzia californica Cham.	Papaveraceae	Perennial rosette forb	7
Ericameria ericoides (Less.) Nutt.	Asteraceae	Shrub	8
Hosackia gracilis (Fabaceae) Benth.	Fabaceae	Annual N-fixer	4
Lupinus nanus (Fabaceae) Benth.	Fabaceae	Annual N-fixer	7
Lupinus variicolor (Fabaceae) Steud.	Fabaceae	Perennial N-fixer	7
Sidalcea malviflora (DC.) A. Gray	Malvaceae	Perennial rhizomatous forb	3
Sisyrinchium bellum S. Watson	Iridaceae	Perennial rosette forb	7
Stipa pulchra Hitchc.	Poaceae	Perennial bunchgrass	7

TABLE 2 Family and functional group of extant plants on which trait measurements were measured

Scientific name	Family	Functional group
Avena barbata Pott ex Link	Poaceae	Non-native annual grass
Baccharis glutinosa Pers.	Asteraceae	Native rhizomatous forb
Bromus hordeaceus L.	Poaceae	Non-native annual grass
Carduus pycnocephalus L.	Asteraceae	Non-native annual forb
Erigeron canadensis L.	Asteraceae	Native annual forb
Festuca bromoides L.	Poaceae	Non-native annual grass
Festuca perennis (L.) Columbus & J.P. Sm.	Poaceae	Non-native annual grass
Geranium dissectum L.	Geraniaceae	Non-native annual forb
Medicago polymorpha L.	Fabaceae	Non-native annual N-fixer
Raphanus sativus L.	Brassicaceae	Non-native annual forb
Sonchus asper (L.) Hill	Asteraceae	Non-native annual forb

(Harrington & Fleming, 1982). We grouped species by growth forms (Table 1): for bunchgrasses and rosette forbs we measured basal circumference; for woody or semi-woody shrubs and N-fixing forbs we measured stem diameter; for rhizomatous forbs we measured spreading distance. Growth-form-specific measurements were used to calculate growth rates between each sampling period (where *i* is the time step prior to *j*), then averaged across the entirety of the project (Equation 1).

$$\text{Growth Rate} = \left\{ \frac{\text{size}_j - \text{size}_i}{\text{time}_j - \text{time}_i} \right\}. \qquad (1)$$

2.3.3 | Functional traits

We quantified the functional traits for surviving planted native species (Table 1) and for the 11 most abundant extant species (Table 2) in years 3 and 4. These accounted for 22 of 41 species and 70%–90% of overall cover in the plots. We collected leaves from each surviving planted individual (ranging from three to seven individuals per species). For dominant extant species we collected leaves from four individuals from each plot. *Hosackia gracilis* has no trait data because it had zero survivors after year 1 and relevant trait data were not available on the TRY Plant Trait Database.

Leaves from herbaceous basal species were removed distally from the centre; leaves from shrubs and herbaceous cauline species were taken distally two to three levels of leaves from the apical meristem. Leaves were refrigerated and scanned within 72 hr using an Epson photo scanner at 400 dpi. Leaves with overlapping leaflets were dissected to allow accurate measurements of area and perimeter. We collected two leaves from each plant to account for variability.

We selected drought-related traits (specific leaf area, leaf C:N ratios, $\delta^{13}C$, leaf lobedness and growth rate) based on the trait literature, and measured them using standardized protocols (Cadotte et al., 2015; Pérez-Harguindeguy et al., 2016). Low SLA in plants can be related to drought resistance and is generally correlated with high investments in structural leaf defences and increased leaf life span (Pérez-Harguindeguy et al., 2016). Leaf area and perimeter were measured using ImageJ. Specific leaf area (SLA) was measured as the ratio of fresh leaf area by oven-dried mass. Increased leaf lobedness decreases the boundary layer by decreasing the effective length that wind travels at the leaf surface, which facilitates leaf cooling by conduction/convection instead of transpiration (Nobel, 2009). Leaf lobedness was calculated using

Equation 2, where the feret diameter is the largest leaf diameter if it was a circle, which is calculated by dividing the leaf perimeter by π (Cadotte et al., 2015).

$$\text{Leaf Lobedness} = \frac{\text{perimeter}}{\text{area}} \times \text{feret diameter}. \tag{2}$$

C:N ratios in leaves can predict survival during drought, as increased C:N is associated with greater energy investment in individual leaf development, higher leaf longevity (Nobel, 2009) and lower palatability (Loiola et al., 2012). Leaf $\delta^{13}C$ is highly correlated with intrinsic water-use efficiency (WUE; Nobel, 2009). Leaf elemental C:N and $\delta^{13}C$ content were quantified using mass spectrometry (ThermoFinnigan Delta Plus XP) after Dumas combustion (Carlo Erba 1108 Elemental Analyzer) at the UCSC Stable Isotope Laboratory.

Trait plasticity can enhance drought tolerance by allowing for rapid changes in certain traits within an individual's life span to match changing environments. We quantified plasticity for the traits described above with the relative distance plasticity index (rdpi; Equation 3; Valladares et al., 2006) for planted species that had more than 1 year of trait data (8 of 12 species). We were interested in the magnitude, and not direction of trait variability, so we used absolute values for rdpi. The rdpi ranges from zero (no plasticity) to one (maximum relative plasticity).

$$\text{Relative Distance Plasticity Index} = \frac{\text{mean (drought traits)} - \text{mean (control traits)}}{\text{mean (control traits)}}. \tag{3}$$

2.3.4 | Phylogenetic relationships

A dated phylogenetic tree containing all 41 species present at the site was created using PHYLOCOM BLADG (Figure S2; Webb et al., 2008). To determine relationships between the planted species, we used ages from Parker et al. (2015), who sequenced and aged California taxa at species and genus levels, and added them to the super tree R2G2_20140601. We calculated phylogenetic signal based on Blomberg's K (Blomberg et al., 2003) and Pagel's λ (Pagel, 1999), using the PICANTE and APE packages in R (Kembel et al., 2010; Paradis et al., 2017). Phylogenetic signal was tested only for traits collected for both planted and extant species.

2.4 | Analyses

All analyses were conducted in R (v3.6.1; R Core Team, 2020). We quantified Pearson's correlation between traits with the CORRPLOT (Wei et al., 2017) and HMISC packages (Harrell, 2020). When traits were highly collinear (Variance Inflation Factor >3), we selected the more ecologically relevant trait based on the literature to use for analysis (Figure S3). In order to compare traits and phylogenetic distances (PD) at different scales of magnitude, we used a z-standardization for hazard models (Zhu et al., 2016). Traits from planted species (Table 1) were used for all analyses and traits from extant species (Table 2) were incorporated into community composition and phylogenetic signal analyses, but not hazard models.

2.4.1 | Plant community composition

We calculated Bray–Curtis dissimilarity indices and used non-metric dimensional scaling (NMDS) ordination to compare compositional differences between drought and ambient rainfall plots using the VEGAN package (Oksanen et al., 2018). Plant functional groups were determined using the Jepson eFlora (Jepson eFlora, 2020). We used a permutational analysis of variance (PERMANOVA) to test whether leaf traits and functional groups were associated with plant communities from different treatments (Laughlin et al., 2012). Community abundance-weighted trait values were calculated as the cross-product of species trait and species cover matrices (Laughlin et al., 2012). We used canonical correspondence analysis to determine the variance that could be explained by leaf traits and functional groups (Oksanen et al., 2018). We combined data collected in 2018 and 2019 because prior results from annual California grasslands were not necessarily auto-correlated between years (Zhu et al., 2016).

2.4.2 | Survival analysis

We used the SURVIVAL package in R to compare Kaplan–Meier survival estimates across treatments (Kaplan & Meier, 2013; Kassambara et al., 2020; Therneau, 2018). This nonparametric approach compares empirical estimates using log-rank tests against the null hypothesis that survival of all groups is equal (Harrington & Fleming, 1982). After examining empirical species survival at an individual level, we pooled all species to model Cox proportional hazard risk at a community level and compared risk for drought and ambient rainfall plots. Hazard risk (hereafter referred to as plant mortality risk) indicates the likelihood that a planted seedling will experience mortality. Trait values for this analysis were averaged for each planted species in a plot. The mortality risk associated with trait plasticity was modelled separately from trait values because only one rdpi value can be calculated per species. We analysed mortality for drought-only and ambient rainfall-only plantings separately since we hypothesized that drought-related traits would respond differentially across treatments.

2.4.3 | Phylogenetic analyses

We calculated the cumulative phylogenetic distance metrics at quantile zero (PD_0) and 50 (PD_{50}) to describe the distribution of evolutionary relationships within a community of species, and their relationships to plant survival and growth (Parker et al., 2015; Verdu et al., 2012). Phylogenetic distance at quantile zero (PD_0) represents the nearest neighbour distance. PD_{50} is a common measure of the median phylogenetic distance and often represents the maximum distance between groups of related genera or families (taxonomic scale depends on scale of phylogeny). Phylogenetic distances were abundance weighted with community plant cover.

3 | RESULTS

3.1 | Community composition and plant cover

Plant community composition differed in drought and ambient rainfall plots in both 2018 and 2019, and a significant amount of the variation was explained by abundance-weighted community trait values (k = 3, stress = 0.138; Figure 2). Leaf C:N (PERMANOVA; R^2 = 0.20, p = 0.008), and leaf lobedness (R^2 = 0.12, p = 0.002) explained the most variance in community composition. Leaf $\delta^{13}C$ (a measure of water-use efficiency (WUE)) and SLA were not significantly related to plant community composition. Canonical correspondence analysis (CCA) showed that abundance-weighted traits explained 48.2% of the variation in community composition between drought and ambient rainfall treatments.

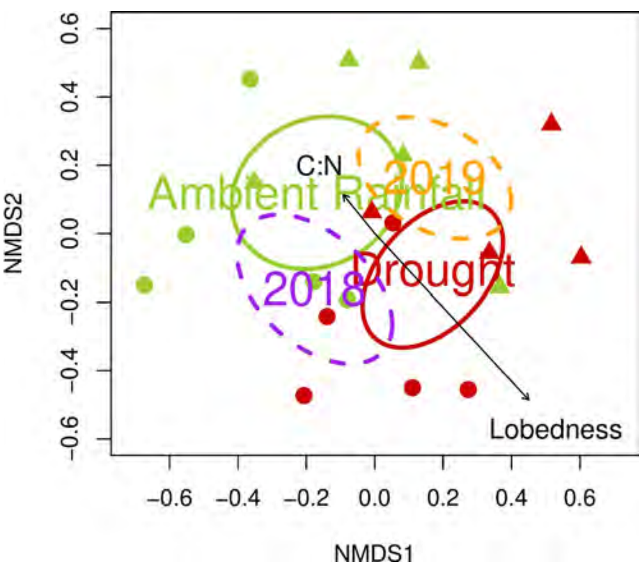

FIGURE 2 Non-metric multidimensional scaling ordination of plant community composition. Each point represents a plot (red = drought, green = ambient rainfall) monitored in 2018 (circle) or 2019 (triangle). Separation of ellipses indicates distinctive community composition between groups. Arrows represent CCA of the traits that explain variance between communities. The arrow direction indicates the highest values of a particular trait

Plant functional groups explained 68.8% of variation in plant community composition. Even though plant communities were dissimilar between 2018 and 2019 (Figure 2), we found that native rhizomatous forbs (PERMANOVA; R^2 = 0.26, $p \leq 0.001$) and native perennial grasses ($R^2 = 0.07$, $p = 0.002$) had greater cover on drought plots compared to ambient rainfall plots. Ambient rainfall plots had greater cover of non-native annual grasses (R^2 = 0.16, $p \leq 0.001$), non-native N-fixers (R^2 = 0.08, $p \leq 0.001$) and shrubs (primarily *Baccharis pilularis*, R^2 = 0.13, $p \leq 0.001$). Annual forbs did not vary between treatments.

Drought plots had higher native species cover, but lower non-native species cover and litter depth (Figure 3).

3.1.1 | Plant survival

Three planted native species (*Lupinus nanus*, *Ericameria ericoides* and *Sidalcea malviflora*) had higher survivorship on drought plots, while four others (*Eschscholzia californica*, *Hosackia gracilis*, *Sisyrinchium bellum* and *Stipa pulchra*) had higher survivorship in the ambient rainfall treatments in years 1 and 2 (Table S1). In year 3, planted natives had lower community-level mortality risk on drought plots (p = 0.007). The only species that had significantly higher survivorship on drought plots was *S. malviflora*, whereas *E. californica* showed the opposite trend. By year 4, community-level mortality risk for natives did not differ between treatments, and survivorship was similar for all species except *S. malviflora* (Figure 4; Table S1).

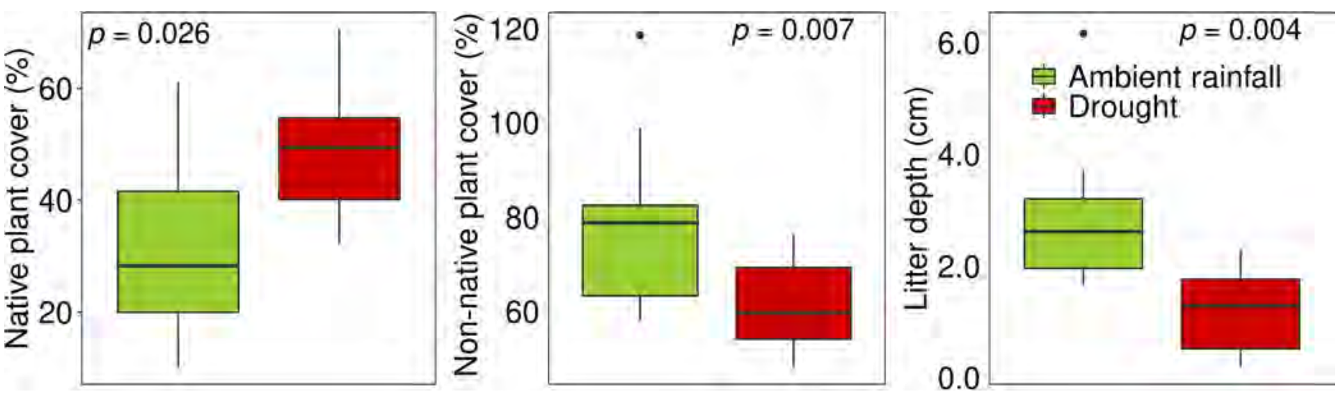

FIGURE 3 Native and non-native plant cover, and litter depth for 2018 and 2019 data combined. Boxes represent the interquartile range; the inner horizontal line represents the median. Lines extending out of the box represent the upper and lower quartiles. Points represent outliers

3.1.2 | Functional traits

Functional traits and phylogenetics explained a significant portion of the variation in mortality risk at a community-level in both years 3 and 4, when all species were pooled ($p_{global} \le 0.001$, concordance = 0.710). The traits that explain mortality risk differed for plants on drought compared to ambient rainfall plots (Figure 5). For both treatments, increased growth rates were correlated with elevated plant mortality, whereas higher leaf lobedness was related to lowered mortality risk. Leaf $\delta^{13}C$ (WUE) was correlated with decreased plant mortality risk on drought ($p = 0.006$), but not ambient rainfall plots ($p = 0.290$). Increased leaf C:N was associated with a 25% reduction in mortality risk for native plantings in the ambient rainfall treatment only ($p \le 0.001$).

Increased trait plasticity of leaf C:N and $\delta^{13}C$ was associated with increased mortality risk, whereas plasticity in SLA and lobedness was associated with decreased mortality risk ($p_{global} \le 0.001$, concordance = 0.680; Figure 6). Variability in $\delta^{13}C$ and lobedness was negatively correlated (Pearson's $R = -0.64$, $p = 0.026$), as was the variability in SLA and growth rate (Pearson's $R = -0.61$, $p = 0.045$; Table 3).

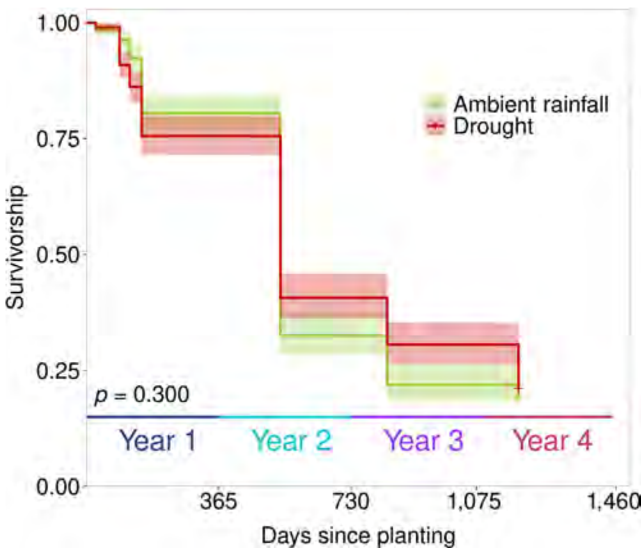

FIGURE 4 Kaplan–Meier survival estimates for all native species combined. Solid lines = average survivorship. Shaded areas = 95% confidence interval

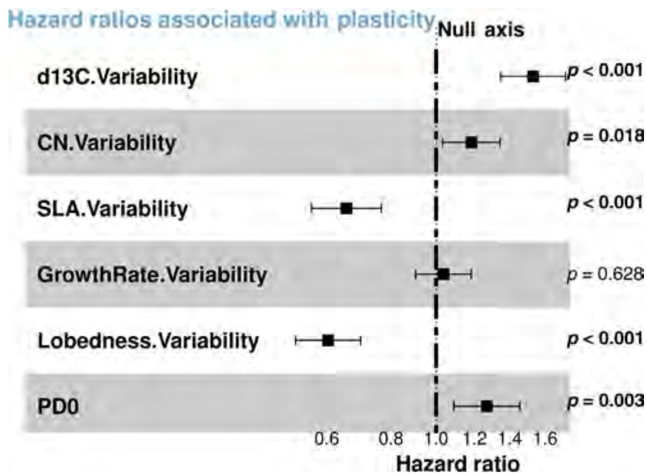

FIGURE 6 Cox proportional hazard models for native species relating mortality risk associated with relative distance plasticity index of leaf traits (Equation 3). PD_0 informs how trait rdpi may be related to phylogeny

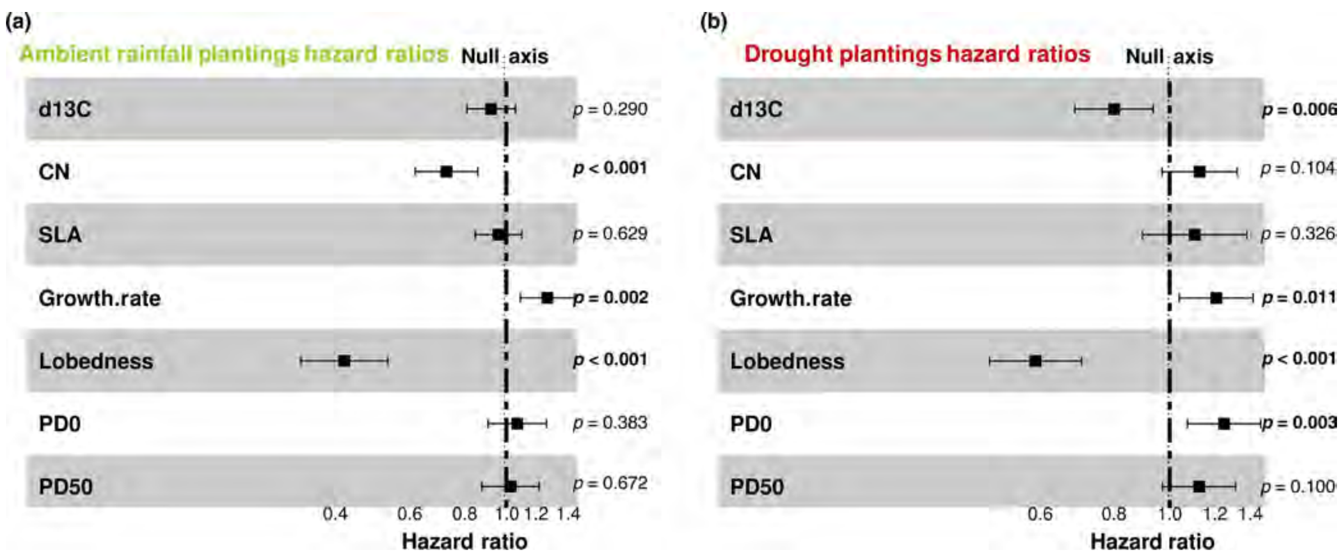

FIGURE 5 Cox proportional hazard models for native species cumulative to year 4 (2016–2019) on (a) ambient rainfall plots and (b) drought plots. Hazard ratio is a multiplier for mortality risk. Factors are significant when the confidence interval does not cross the null axis. The mortality risk decreases to the left and increases to the right of the null axis

TABLE 3 Relative distance plasticity index (rdpi) in relation to drought for species with traits collected in 2018 and 2019. Values range from 0 (no plasticity) to 1 (maximum relative plasticity)

Species	$\delta^{13}C$	C:N	Growth rate	Lobedness	SLA
Achillea millefolium	0.002	0.161	0.186	0.596	0.010
Artemisia californica	0.026	0.226	0.237	0.242	0.008
Bromus carinatus	0.014	0.020	0.346	0.119	0.056
Eschscholzia californica	0.027	0.007	0.026	0.169	0.395
Diplacus aurantiacus	0.039	0.080	0.002	0.020	0.105
Sisyrinchium bellum	0.015	0.255	0.122	0.254	0.194
Sidalcea malviflora	0.040	0.240	0.146	0.066	0.012
Stipa pulchra	0.006	0.067	0.070	0.122	0.078

TABLE 4 Blomberg's *K* and Pagel's λ; Values range from 0 (no phylogenetic signal) to 1 (high phylogenetic signal)

Functional trait	Blomberg's *K*	Pagel's λ
Specific leaf area	0.100	<0.001
Leaf lobedness	0.150	<0.001
$\delta^{13}C$	0.120	<0.001
Leaf C:N	0.380	0.830

3.1.3 | Phylogenetics

Although phylogenetics did not explain mortality risk of plants on ambient rainfall plots (Figure 5), plants that were less related to their nearest neighbour (higher PD_0) had higher mortality risk on drought plots ($p = 0.003$). Blomberg's *K* and Pagel's λ both indicated that leaf C:N is phylogenetically conserved or convergent, at least among these species (Table 4). Because increased relatedness at PD_0 was related to decreased mortality in drought plots, but PD_{50} had no effect on mortality, leaf C:N is likely convergent, not conserved.

4 | DISCUSSION

Several planted species had greater survivorship on drought compared to ambient rainfall plots in year 2 after experiencing their first dry season, a trend that persisted into year 3, but survival differences across treatments were minimal by year 4. Our results showing lower mortality risk of planted species (Table S1) and lower cover of non-native species (Figure 3) on drought compared to ambient rainfall plots before year 4, suggest that at early life stages planted native species could have been experiencing competitive release from non-native species. Native California grassland species are negatively affected by non-native species competition, particularly in the first year or two of growth (Buisson et al., 2006), and non-native species may respond more negatively to drought compared to natives (Valliere et al., 2019), which could have reduced non-native competition. Differences in survival across treatments may have faded by the fourth year as planted species increased in size, both above- and below-ground, and were better able to compete with non-native species (Corbin & D'Antonio, 2004; Seabloom et al., 2003). Furthermore, the area had recently experienced a major drought (2011–2014) at the start of the study, which may have resulted in lower propagule pressure from non-native annual grasses early in the experiment (Copeland et al., 2016). Annual grass cover and litter are often positively related, so lower litter depth in drought plots in years 3 and 4 suggests lower productivity of non-native annual grasses in prior years.

Although survivorship of planted individuals on drought and ambient rainfall plots was similar for nearly all species by the fourth growing season (Figure 4), overall species composition (i.e. cover of planted and unplanted species) still differed substantially (Figure 2). This difference was largely explained by the lower cover of unplanted, non-native annual grasses in drought plots, as noted above. In addition, native perennial grasses and rhizomatous forbs had greater cover in drought plots. These functional groups typically invest substantial resources below-ground that enable them to better withstand variable rainfall conditions (Kooyers, 2015).

Leaf lobedness, which explained a substantial amount of variation in both mortality of planted species and community cover, is not included within the 'trait handbook' (Pérez-Harguindeguy et al., 2016). Yet leaf shape and lobedness determine the contribution of boundary layer thickness to leaf energy balance, and affects plant water use in transpiration (Nobel, 2009). Unlike leaf WUE (via $\delta^{13}C$) and C:N, which are more expensive to measure, lobedness helped explain variance in plant cover and mortality risk regardless of treatment. Measuring lobedness does not require specialized equipment but can be labour intensive because dissection is needed for compound leaves that are divided into many fine leaflets, such as for *Achillea millefolium* and *E. californica*. We recommend that lobedness be further evaluated as a criterion for restoration plant selection in other abiotically driven ecosystems.

Across species in these communities, increased plasticity of measured physiological traits that we measured (i.e. C:N and WUE) were associated with increased mortality, yet decreased mortality was associated with more plastic morphological traits (i.e. leaf lobedness and SLA). Notably, SLA, which is commonly associated with drought tolerance, was not a significant driver of mortality risk, but *variability* in SLA reduced plant mortality risk on drought plots (Figure 6). In other words, the ability to adjust investment into individual leaves was key for survival of the planted native seedlings. Morphological traits last for a leaf lifetime and can provide important fitness value, thus plasticity in these traits can allow plants to better survive constantly changing environmental conditions (Valladares et al., 2006). Increased plasticity of physiological traits could be related to mortality risk because changes in physiological processes may occur faster than morphological changes, which could enhance plant stress. For example, a rapid decrease in WUE without a change in SLA could lead to increased plant water stress (Haworth et al., 2013). For some traits (e.g. C:N), increased plasticity may not provide adaptive survival value for resource conservative species. In this regard, we found a negative correlation between lobedness and WUE (Figure S3), which could indicate trade-offs between morphological and physiological traits in relation to drought.

Increased relatedness of planted species with neighbours was associated with lower mortality risk on drought, but not ambient rainfall plots. This could indicate that there are key traits related to drought survival that are convergent across native and non-native plants in this semi-arid coastal grassland. Our results are consistent with studies in other semi-arid grasslands (Loiola et al., 2012) and more general observations (Gilbert & Parker, 2016) that show water-use efficiency is often not phylogenetically conserved. Leaf C:N and WUE showed parallel trends with PD_0 in hazard models, but phylogenetic signal analysis found that only leaf C:N appeared to be phylogenetically convergent. This may make it possible to assume a similar range of C:N values for closely related taxa used for restoration in semi-arid grasslands (Verdu et al., 2012). Although we found no signal in any other trait we tested (Table 4), Larson et al. (2020) reported that SLA had a weak phylogenetic signal for native annual California coastal sage scrub seedlings. Even with strong a phylogenetic signal, however, low phylogenetic diversity in a particular plant community may make phylogeny less instructive for restoration planning (Funk & Wolf, 2016).

Our findings, along with studies from other ecosystems such as arid shrublands (Ackerly, 2004), tropical forests (Kraft et al., 2008) and other grasslands (Loiola et al., 2012), suggest that quantifying functional traits can help improve understanding species-specific survival and growth with increasingly variable climatic conditions. Trait plasticity can sometimes be more important than absolute trait values for survival and growth (Carmona et al., 2016). Therefore, restoration practitioners could select plants with traits suitable for particular climate scenarios or extant plant communities. In our case, this would likely include species with low above-ground growth rates and small leaf boundary layers (via leaf lobedness), like *A. millefolium* or *S. pulchra*. Moreover, phylogenetics has informed restoration practices by suggesting which species are most likely to survive surrounding competitors in tropical rainforests (Kraft et al., 2008), midwestern grasslands (Barak et al., 2017) and chaparral (Verdú et al., 2003). Similarly, our result that closely related species are more likely to survive in drought suggests that planting species from drought tolerant families can lead to higher plant establishment. We recognize that quantifying functional traits and phylogenetics is expensive, technically complex and labour intensive. Nonetheless, such information is becoming increasingly accessible through online databases such as TRY-TRAIT (Kattge et al., 2020), and could be helpful for selecting species for ecological restoration in a changing climate.

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AUTHORS' CONTRIBUTIONS

M.E.L. and K.D.H. conceived the experimental design; J.C.L., M.E.L. and K.D.H. conceived the research ideas; J.C.L. collected and analysed the data; J.C.L. led the writing of the manuscript with editorial contributions from M.E.L. and K.D.H. All authors contributed critically to the drafts and gave final approval for publication.

DATA AVAILABILITY STATEMENT

Plant trait data were deposited in the TRY-TRAIT database. Data presented in this manuscript are all available on Pangaea Earth and Environmental Sciences Data Publisher https://doi.org/10.1594/PANGAEA.922919 (Luong et al., 2020).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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Appendix C

Annual Mitigation Monitoring Report

UC Santa Cruz Marine Science Campus
CLRDP EIR
2021 Annual Mitigation Monitoring Report

Introduction

The California Environmental Quality Act (CEQA) requires that a Lead Agency establish a program to monitor or report on mitigation measures adopted as part of the environmental review process to avoid or reduce the severity and magnitude of potentially significant environmental impacts associated with project implementation. CEQA (Public Resources Code Section 21081.6 (a) (1)) requires that a mitigation monitoring or reporting program be adopted at the time that the agency determines to carry out a project for which an EIR has been prepared to ensure that mitigation measures identified in the EIR are implemented.

The Regents of the University of California (The Regents) approved the Coastal Long Range Development Plan (CLRDP) for the UC Santa Cruz Coastal Science Campus and certified the Environmental Impact Report (EIR) in September 2004; a Mitigation Monitoring Program (MMP) for the CLRDP EIR was adopted at the same time. The CLRDP MMP, which is presented in Table 5-1 of the Final EIR, describes monitoring and reporting procedures, monitoring responsibilities, and monitoring schedules for mitigation measures identified in the EIR analysis of the environmental effects of the CLRDP, as well as the measures included in the CLRDP to avoid or minimize environmental effects. Table 5-1 is divided into two sections: Part A describes procedures for the EIR mitigation measures; Part B covers the CLRDP measures.

The MMP includes the following components:

Mitigation Measures: The mitigation measures in the MMP are taken verbatim from the Final EIR, and the numbers assigned to the mitigation measures are the same as those presented in the Final EIR.

CLRDP Measures: Individual CLRDP policies and implementation measures in the MMP are taken verbatim from the CLRDP, and the numbers assigned to the mitigation measures are the same as those presented in the CLRDP. Other CLRDP measures in the MMP, such as the Drainage Concept Plan, Resource Management Plan, and the Design Guidelines, are summarized.[1]

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[1] After The Regents certified the CLRDP EIR, approved the September 2004 draft of the CLRDP and adopted the MMP, minor changes were made to the text and numbering of some of the CLRDP measures included in the MMP. The title of Appendix B to the CLRDP, “Stormwater Concept Plan,” was also changed to “Drainage Concept Plan.” The Regents approved the final CLRDP, including these changes, in December 2008. Additional revisions to the CLRDP were made as part of CLRDP Amendment #1, which was approved by The Regents in January 2012 and by the Coastal Commission in October 2013. In this Annual Report, the text and numbering of the CLRDP measures are consistent with the December 2008 final CLRDP as revised by Amendment #1 and therefore may differ from the MMP as presented in the Final EIR. The Amendment #1 revisions are shown in strikeout/underline format in Table 1.

General versus Project-Specific Measures: The MMP specifies whether the mitigation measure or CLRDP element is a general Campus measure, which is implemented by the Campus on an ongoing basis, or a Project-Specific measure, which is triggered by and implemented in conjunction with the development of individual projects.

Mitigation Timing: Identifies the timing for implementation of each action.

Monitoring and Reporting Responsibility: Identifies the UCSC office responsible for undertaking the required action and monitoring the measure.

As indicated above, the measures included in the MMP are divided into two categories: *general campus measures*, which are implemented by the campus on an ongoing basis, and *project-specific measures*, which are implemented in conjunction with the development of individual campus construction projects. Examples of general campus mitigation measures are: 1) public access policies, and 2) the Campus' transportation demand management (TDM) program, which is designed to reduce the number of vehicle trips to the campus. Examples of project-specific mitigation measures are: 1) the protection of specific biotic resources or cultural resources during construction of a building, and 2) siting and design parameters for new development. In addition to project-specific measures identified in the CLRDP EIR, the mitigation monitoring program for a development project may also include mitigation measures identified in the project-level CEQA document, which apply only to that project.

Monitoring and Reporting Procedures

The responsibilities of mitigation implementation, monitoring and reporting extend to numerous UC Santa Cruz departments and offices. The unit director or department lead officer of the identified unit or department is directly responsible for ensuring that the responsible party complies with the mitigation. Physical Planning Development and Operations is responsible for the overall administration of the program and for assisting other campus staff with their responsibilities, to ensure that they understand their charge and implement the required measures accurately, completely, and on schedule.

In addition to overseeing the specific procedures identified in the following table for implementation of each mitigation measure, Physical Planning Development and Operations is responsible for preparing this Annual Mitigation Monitoring Report. The purpose of the Annual Mitigation Monitoring Report is to report on progress of implementation of general campus mitigation measures (that is, those measures that are not tied to specific development projects) and, for each project under development during the reporting period, to identify applicable mitigation measures and document the status of compliance for each project. The Annual Mitigation Monitoring Report is available for review by appointment at the office of Physical Planning Development and Operations on campus, is posted on the Campus' LRDP website (https://ppc.ucsc.edu/planning/LRDPs.html), and is submitted to the Executive Director of the California Coastal Commission as part of the CLRDP Annual Report.

For each general campus measure, a representative of the responsible campus unit provides an annual status report to Physical Planning Development and Operations staff. For each project, a checklist is prepared for all CLRDP EIR and project-level mitigations applicable to the project. Reporting on the status of project-specific mitigations is the responsibility of each project manager, who updates the checklist on a quarterly basis.

The annual report also provides a description of activity undertaken by each responsible department relative to each mitigation measure and, if applicable, links to detailed reports or other supporting documentation of mitigation activity.

Summary of 2021 Mitigation Activities

General Campus Mitigation Measures

Table 1, *Status of General Campus Measures*, lists all of the general campus measures and describes their status in 2021.

Project Mitigation Monitoring

In 2021, the Campus implemented the mitigation monitoring programs for NOID 6 (13-1) Specific Resource Plan (SRP) Phase 2. The annual mitigation monitoring reports are attached. Separate mitigation monitoring reports are included for NOID 6 (13-1), Coastal Biology Building and Marine Science Campus Infrastructure Project, and Specific Resource Plan (SRP) Phase 2.

Table 1: Status of General Campus Measures

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
Mitigation 4.2-1	Install landscaped fence along Younger Ranch property line.	Install fence and landscaping. Prior to ground-breaking of any CLRDP project components, document that fence and landscaping have been installed prior to construction.	--	COMPLETED Fence has been constructed.
Mitigation 4.15-1	Contribute fair share towards cost of improvements to Mission/Bay intersection	During project-level environmental review, analyze number of peak hour trips added to this intersection by the project. When City and/or Caltrans proposes improvement at this intersection: Negotiate with City and Caltrans to determine an appropriate fair share contribution towards necessary road improvements.	Per 2008 Comprehensive Settlement Agreement, UCSC share of the cost of City intersection improvements will be paid on a project-by-project basis based on the number of trips projected to be generated by each project.	COMPLETED UCSC paid the fee to the City in April 2016.
Mitigation 4.15-2	Contributed fair share towards construction of Delaware Ave. pedestrian path.	Prior to occupancy of first project: Negotiate with City to determine an appropriate fair share contribution towards necessary road improvements.		Not triggered. City was not planning for construction of pedestrian path in 2021.
Mitigation 4.15-4	Contribute fair share to improvements at Mission/Chestnut intersection	During project-level environmental review, analyze number of peak hour trips added to this intersection by the project. When City and/or Caltrans proposes improvement at this intersection: Negotiate with City and Caltrans to determine an appropriate fair share contribution towards necessary road improvements.	Per 2008 Comprehensive Settlement Agreement, UCSC share of the cost of City intersection improvements will be paid on a project-by-project basis based on the number of trips projected to be generated by each project.	NOT APPLICABLE Not triggered. Coastal Biology Building Project would add trips to this intersection but MSC Projects EIR determined that the Project would not contribute to a significant cumulative impact at Mission St./Chestnut intersection.

Table 1: Status of General Campus Measures

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
Mitigation 4.15-6	Contribute fair share to improvements at High/Western, Empire Grade/Heller, SR1/SR intersections	During project-level environmental review, analyze number of peak hour trips added to these intersections by each project. When appropriate jurisdiction proposes improvements at the affected intersection: Negotiate with appropriate jurisdiction to determine an appropriate fair share contribution towards necessary road improvements.	Per 2008 Comprehensive Settlement Agreement, UCSC share of the cost of City intersection improvements will be paid on a project-by-project basis based on the number of trips projected to be generated by each project.	COMPLETED UCSC paid the fee for trips associated with the Coastal Biology Building in April 2016.
Mitigation 4.16-1b	Compliance with City water demand reduction policies	Following the adoption of pertinent policies by the City of Santa Cruz. Procedure to be determined, based on City policy.	Note: Per 2008 Comprehensive Settlement Agreement, if City implements its 2009 Drought Contingency Plan, University will reduce water consumption in accordance with that plan.	As identified in the City of Santa Cruz 2020 Urban Water Management Plan, Water Shortage Contingency Plan, UCSC voluntarily complied with the City's 9% demand reduction actions, as part of a Stage 1 water shortage declaration in 2021.
IM 3.8.2	Agricultural hold-harmless and indemnity restrictions	Before construction of facilities located north of existing NMFS facility: Initiate negotiations with owners of Younger Ranch to enter into agreement.	--	COMPLETED The agreement was recorded with Santa Cruz County in November 2017.
General-RMP	Implement RMP	As specified in Table 13 of the Resource Management Plan: Implement monitoring procedures specified in Tables 1, 4, 5, 6, 7, 8, 11, and 12 of the Resource Management Plan. Document results and include documentation in annual mitigation monitoring report.	--	Resource Management Plan is being implemented. See CLRDP Annual Report for description of activities in 2021.

Table 1: Status of General Campus Measures

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
IM 3.5.1	Protection and enhancement of Original YLR habitats.	Implement Resource Management Plan (see above for procedures). Implement Drainage Concept Plan (see Hydrology and Water Quality, below, for procedures). Control and remove weeds, plant native plants	--	Resource Management Plan is being implemented See CLRDP Annual Report for description of activities in 2021.
IM 3.5.2	Protection of special status species in Original YLR.	Implement Resource Management Plan (see above for procedures). Implement EIR Mitigations PS 4.4.1, PS 4.4.2 and PS 4.4.3 (see Table 5-1, Part A)	--	Resource Management Plan is being implemented See CLRDP Annual Report for description of activities in 2021. Implementation of project-specific mitigation measures is documented in the project mitigation monitoring checklists.
IM 3.6.1	Provision of controlled access within Original YLR.	See IM 6.2.1 under Recreation, below. No additional procedures required.	--	NOT APPLICABLE

Table 1: Status of General Campus Measures

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
IM 3.10.1	EH&S manage use, containment and cleanup of hazardous materials and petroleum	Ongoing: For UC entities, continue to implement UCSC Environmental Health and Safety programs involving oversight of individual units' compliance efforts and advising on improvements in procedures related to storage, disposal, and transportation of hazardous substances. Annually: Document activity of relevant Environmental Health and Safety programs. For non-UC entities, see EIR Mitigation PS 4.7-1 (see Table 5-1, Part A)	--	UCSC EH&S provides guidelines, consultation and oversight to ensure hazardous materials are stored, transported and disposed in accordance with federal and state regulations. Personnel are trained to call EH&S for assistance if there is a large spill of hazardous materials or if they are not equipped to clean up a small spill safely. Spill emergency instructions are posted in areas where hazardous materials are stored or used.
Drainage Concept Plan-General	Implement BMPS in Drainage Concept Plan	Annually: Document implementation of best management practices.		In 2021, no BMPs were constructed. The campus implements source control BMPs on an ongoing basis. See CLRDP Water Quality Report, Appendix A, for details.
Water Quality Monitoring	Sample stormwater as specified in Drainage Concept Plan	As specified in the Drainage Concept Plan (procedures and timing in the MMP are from the Draft CLRDP and no longer apply).		A structural BMP monitoring plan was developed by 2NDNATURE dated October 18, 2019 to meet CLRDP water quality standards.

Table 1: Status of General Campus Measures

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
Maintain stormwater system	Maintain storm water system as specified in Drainage Concept Plan	As specified in the Drainage Concept Plan (procedures and timing in the MMP are from the Draft CLRDP and no longer apply).		Treatment BMPs were constructed under NOID 6 in 2019. A structural BMP monitoring plan was developed by 2nd Nature dated October 18, 2019.
IM 7.1.8	Irrigation and use of chemicals for landscaping.	Before occupancy of first project developed under the CLRDP: Establish polices for irrigation and use of chemicals in landscaping to minimize erosion potential and runoff into habitat areas or the ocean.	--	The Campus currently uses pesticides only within the context of an Integrated Pest Management Program, to limit the use of chemicals for fertilizer and/or weed and pest control to the maximum extent possible.
IM 7.2.1	Drainage system monitoring and maintenance.	After major storm events, during occupancy: Conduct and document inspections.		The campus implements source control BMPs on an ongoing basis. See CLRDP Water Quality Report, Appendix A, for 2021 BMP Maintenance and Monitoring Report.
IM 6.1.1	Free public access for visitors.	Annually, following approval of the CLRDP: Document consistency of procedures with Policy 6.1.	--	Access to the Marine Science Campus is free. A fee is charged for access to the Seymour Center.
IM 6.1.4	Public access overlooks.	Construct overlooks per schedule in CLRDP Chapter 9. Annually, document status.	--	See CLRDP Annual Report, Section 7.1.

Table 1: Status of General Campus Measures

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
IM 6.1.5	Docent-led tours and education programs for the public.	Annually: Document continued educational programs and docent-led tours.	--	Supervised site tours of parts of Long Marine Lab, as well as the Seymour Center exhibits halls and outdoor areas are offered three times a day on the days when the Seymour Center is open.The Seymour Center also offers a variety of field trips for K-12 and community college groups. See CLRDP Annual Report, Section 2.
IM 6.2.3	Access to resource protection areas.	Annually: Document access policies and procedures. Ongoing: Enforce access policies.		Public access to the original Younger Lagoon is limited to 90-minute tours, which are offered 38 times a year. Access to other resource protection areas is not controlled at this time.
IM 6.2.8	Bicycles on the Marine Science Campus.	Annually: Document access policies and procedures.	--	Consistent with this requirement, bicycles are allowed on the Marine Science Campus except on controlled access trails.

Table 1: Status of General Campus Measures

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
IM 6.2.9	Domestic pets.	Include prohibition on pets in lease agreement for on-site housing. Within one year of approval of CLRDP: Use signs and other media to inform public that pets are not permitted on the campus.	--	COMPLETED Campus began implementing a prohibition on pets on the campus in May 2015. Each of the existing Coastal Access trail signs was updated with the pet prohibition language and one new sign at the campus trail entrance area. The UCSC Police department deployed their Police Department Student Ambassadors to the Coastal Science Campus to contact and explain the policy to visitors.
IM 6.2.10	Public access signage.	As new trails are developed: Maintain existing signs and provide new signage and other media. Document their content and distribution.		COMPLETED Signage was installed in conjunction with the development of new trails under NOID 6 in 2017 and 2018.
General-TDM	Implement Transportation Demand Management (TDM) measures as detailed in Policies 5.3 through 5.8.	Annually: Document implementation of TDM measures	--	TDM measures are being implemented as required. See CLRDP Annual Report for more details.

Mitigation/ Implementation Measure ID	Mitigation/Implementation Measure Description	Procedures and Timing	Notes	2021 Status
IM 8.2.2	Seawater system.	The seawater system shall be operated in a manner that will protect against spillage and that will sustain the biological productivity and quality of coastal waters, streams, and wetlands.	--	The seawater system was operated in compliance with NPDES permit requirements. See CLRDP Annual Report, Appendix A, Water Quality Report, for documentation of compliance with permit requirements.

Mitigation/CLRDP Implementation Measure ID	Brief Description	2021 Status
CLRDP EIR General Mitigation Measure 4.2-1	Fence at Younger Ranch Boundary	Completed
CLRDP Mitigation 4.11-4	Construction noise mitigation	Completed
CLRDP Mitigation 4.15-1	Fair share, Bay/Mission Intersection	Completed
CLRDP Mitigation 4.15-2	Fair share contribution, Delaware Av. pedestrian path.	Not yet required
CLRDP Mitigation 4.15-6	Fair share, various intersections	Completed
CLRDP Mitigation 4.16-1a	Water-efficient fixtures.	Completed
CLRDP Mitigation 4.2-2	Nesting bird surveys and avoidance	Not applicable to project as approved/designed
CLRDP Mitigation 4.3-1	Standard construction dust control measures	Not applicable to project as approved/designed
CLRDP Mitigation 4.4-1	CRLF monitoring and avoidance	Not applicable to project as approved/designed
CLRDP Mitigation 4.5-1	Discovery of human remains	Completed
IM 3.10.1	Hazardous Materials Management	Completed
IM 3.2.12	USFWS Consultation Required	Completed
IM 3.2.14	Non-Invasive Native Plant Species Required	Completed
IM 3.8.2	Agreement to Indemnify and Hold Harmless	Completed
IM 3.9.1	Construction Monitoring—Archaeological/Paleontological I	Completed
IM 4.3.3	All lighting	Completed
IM 7.1.17	Designation of Treatment Train	Active
IM 7.2.1	Drainage System Monitoring and Maintenance	Active
IM 7.2.3	Drainage system sampling	Active
IM 7.2.4	Long-Term Maintenance of Stormwater System	Active
IM 7.3.1	Discharge to YLR	Completed
IM 7.3.2	Discharge Siting and Design	Active
MSC Mitigation Measure TRA-2	Fair share payment, Western Dr./High St. intersection	Completed
MSC Mitigation Measures LU-1, LU-2A, LU-2B	CLRDP Amendment #1	Completed
MSC Project Mitigation Measure BIO-1	Botanical survey, special-status plant avoidance	Completed
MSC Project Mitigation Measure BIO-2c	Staging area, invasive plant assessment	Not applicable to project as approved/designed
MSC Project Mitigation Measure CULT-2B:	Interpretive sign for Ocean Shore Railroad	Completed
MSC Projects Mitigation BIO-9B	Woodrat nest relocation	Completed
MSC Projects Mitigation HYD-2	Hydrologic monitoring W4 and W5	Completed
MSC Projects Mitigation Measure AIR-1	Project-specific dust control requirements.	Completed
MSC Projects Mitigation Measure BIO-10A	Fencing design and inspection	Completed

Mitigation/CLRDP Implementation Measure ID	Brief Description	2021 Status
MSC Projects Mitigation Measure BIO-10B	Construction-phase parking limitations	Completed
MSC Projects Mitigation Measure BIO-10C	Night-time restrictions on construction activity	Completed
MSC Projects Mitigation Measure BIO-11	Shades on greenhouses	Completed
MSC Projects Mitigation Measure BIO-12A	Inspection for erosion in W1 outflow channel	Not applicable to project as approved/designed
MSC Projects Mitigation Measure BIO-12B	Silt fence at Delaware Ave. Extension	Completed
MSC Projects Mitigation Measure BIO-12C	Scope of NOAA outfall improvements	Completed
MSC Projects Mitigation Measure BIO-12D	Design of DeAnza trail crossing at W4 culvert	Completed
MSC Projects Mitigation Measure BIO-15	Biological Mitigation Coordinator required	Completed
MSC Projects Mitigation Measure BIO-2a	Staging area restoration	Completed
MSC Projects Mitigation Measure BIO-2b	Staging area weed management	Not applicable to project as approved/designed
MSC Projects Mitigation Measure BIO-3A	Biological resources training, construction crew	Completed
MSC Projects Mitigation Measure BIO-3B	CRLF and western pond turtle exclusion	Completed
MSC Projects Mitigation Measure BIO-3C	CRLF surveys	Completed
MSC Projects Mitigation Measure BIO-3D	Daily CRLF surveys during construction	Completed
MSC Projects Mitigation Measure BIO-3E	Additional CRLF avoidance measures	Completed
MSC Projects Mitigation Measure BIO-4	Burrowing owls surveys and avoidance	Completed
MSC Projects Mitigation Measure BIO-5	Pre-construction surveys, badger dens	Completed
MSC Projects Mitigation Measure BIO-6	Exclusion fencing, western pond turtle	Completed
MSC Projects Mitigation Measure BIO-7A	Nesting bird survey and buffer	Completed
MSC Projects Mitigation Measure BIO-7B	Scheduling in Subareas 6 and 7 to protect nesting birds	Completed
MSC Projects Mitigation Measure BIO-7C	Timing of berm construction, subarea 7	Completed
MSC Projects Mitigation Measure BIO-7D	Staging in subarea 6	Completed
MSC Projects Mitigation Measure BIO-8	Bat survey, greenhouses	Completed
MSC Projects Mitigation Measure BIO-9A	Pre-construction survey, woodrats	Completed
MSC Projects Mitigation Measure CULT-2A	Archaeological monitoring at Delaware Ave. Extension	Completed
MSC Projects Mitigation Measure HYD-3	Trench plugs required for sewer line	Completed
MSC Projects Mitigation Measure TRA-1B	Parking utilization surveys	Active
MSC Projects Mitigation Measure TRA-1C	Parking demand management	Active
MSC Projects Mitigation Measure TRA-5A	Timing of closure of Delaware Ave. Extension	Completed
MSC Projects Mitigation Measure TRA-5B	Contract requirements to minimize traffic blockage	Completed
MSC Projects Mitigation Measure TRA-5C	Construction lane closure notifications	Completed

Mitigation/CLRDP Implementation Measure ID	Brief Description	2021 Status
MSC Projects Mitigation Measure TRA-5D	Contract schedule coordination	Completed
MSC Projects Mitigation Measure TRA-5E	Construction coordination/communication with off-campu	Completed
MSC Projects Mitigation Measure TRA-5F	Construction impact complaint procedures.	Completed
MSC Projects Mitigation Measure UTIL-9	Water efficiency study of existing MSC facilities	Completed
MSC Projects Mitigation Measures TRA-4C	Railroad caution signs on pedestrian routes	Completed
MSC Projects Mitigation NOIS-4	Mitigate cumulative construction noise	Not applicable to project as approved/designed
MSC Projects Mitigation TRA-1A	Transportation dissemination information	Active
MSC Projects Mitigation TRA-4A	Stop signs at parking lot entrances	Completed
MSC Projects Mitigation TRA-4B	Stop sign and traffic-calming measures at campus exits.	Completed
Policy 5.9	Impacts offset	Completed
Policy 8.4	Impacts to City Water and Sewer Systems Offset	Completed

Specific Resource Plan Phase 2,
Annual Mitigation Monitoring Report, 2021: Mitigation Status Summary

Mitigation/CLRDP Implementation Measure ID	Brief Description	2021 Status
CLRDP Policy 3.2	Protection and restoration of habitat areas	Active
CLRDP Mitigation 4.4-1	CRLF monitoring and avoidance	Active
CLRDP Mitigation 4.4-3	Nesting birds monitoring and avoidance	Active
CLRDP Mitigation 4.5-1	Discovery of human remains	Not triggered
IM 3.9.1	Archaeological/Paleontological Resources	Not triggered
IM 3.10.1	Use, containment and cleanup of hazardous materials	Not triggered
IM 7.1.8	Irrigation and use of chemicals for landscaping	Active
Policy 7.1	Productivity and quality of coastal waters	Active