University California, Santa Cruz

Younger Lagoon Natural Reserve

Annual Report 2010-2011

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Introduction

This report provides an overview of the activities that were conducted at Younger Lagoon Natural Reserve (YLR) during the 2010-2011 fiscal year (July 1, 2010 - June 30, 2011). Younger Lagoon continued to see increases in use and activity in general. Providing an outdoor classroom and living laboratory allows for experiential learning opportunities. These opportunities have profound impacts on students both professionally and personally. This was the third year we had fulltime staff on site managing the Reserve. As a direct result, the level of academic and public engagement increased and the Reserve is on target for implementing its obligations required under the Coastal Long Range Development Plan (CLRDP).

Younger Lagoon represents a unique reserve within the UCSC's Natural Reserve portfolio as it has open public access to a portion of the Reserve. Along with the challenges of public access (i.e. impacts to resources, protecting research equipment, protecting endangered and threatened species, implementing regulations, etc.) having public present on-site provides opportunities for outreach and education. During the past year, we continued to implement restoration activities on the Terrace 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 Marine Science Campus.

CLRDP Activities

Overview

This year represented the third year of CLRDP related activities at Younger Lagoon Natural Reserve. The CLRDP for the "Terrace Point" property was certified by the California Coastal Commission 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 Marine Science Campus development.

The CLRDP requires that entire Reserve be protected 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 is providing expanded opportunities for undergraduate experiential learning opportunities via class exercises, research opportunities, and internships.

NOID 10-1 Beach Access Management Plan

This year represented the first full year of Beach Access Management Plan related activities at Younger Lagoon Natural Reserve. 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 it's 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 are to be compiled and included in a report that summarizes and assesses the effect of controlled beach access on flora and fauna. The report will be submitted to the California Coastal Commission. 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 10-1). Seymour Marine Discovery Center docent-led tours of the beach began in the spring of 2010 and were offered twice a month throughout FY2010-2011 and biological monitoring of the lagoon and adjacent beach was conducted quarterly in FY2010-2011. A detailed report on activities under the Beach Access Management Plan is included as an appendix to this report.

NOID 10-3 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 MSC 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 and 1B of restoration (first 7 years) was approved by the CCC in September 2010 (Appendix I). Phase 1A projects include Priority 1 weed removal, re-vegetation, baseline monitoring and selection of reference systems. Phase 1B projects include work in wetland areas which will require further permitting from outside agencies (e.g. ACoE, USFWS, CDFG).

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). SAC members met with reserve staff at YLR during the fall of 2010. SAC member Bryan Largay met with reserve staff at YLR twice during the winter of 2011 to observe hydrological conditions during the rainy season.

At the SAC's recommendation, Professor Karen Holl, doctoral student Lewis Reed and undergraduate students Megan Hatch and Kira Valenta conducted baseline monitoring in the wetland areas of Younger Lagoon Reserve, and monitored five northern coastal scrub and five seasonal wetland reference sites (the number of available sites is quite limited due to habitat destruction and/or degradation). The goal of this work was to establish baseline conditions, evaluate and refine reference targets for restoration, refine the sampling methodology, and make

recommendations for species to be planted as part of the restoration of coastal sage scrub and seasonal wetlands at YLR. A copy of their complete report, entitled "Reference site characterization and restoration goals for northern coastal scrub and seasonal wetlands at Younger Lagoon Reserve," is included as Appendix 2 to this report. Their findings and recommendations are summarized here.

Northern Coastal Coyote Brush Scrub Reference Site Results

Reed et al. found that total shrub cover was fairly consistent within and between northern coastal coyote brush scrub sites with the exception of Año Nuevo which had both higher mean cover and higher variance. All sites had cover greater than the 40% cover requirement specified by the SRP. Canopy composition varied among sites. *Baccharis pilularis* was common at all sites, which is not surprising since Reed et al. selected sites with high *B. pilularis* cover, but secondary canopy dominants varied among sites and included species such as *Artemisia californica*, *Eriophyllum staechadifolium*, *Toxicodendron diversilobum*, and *Mimulus aurantiacus*. Average transect level richness across all sites was 10.5 ± 1.6 (SE) and varied greatly among sites; herbaceous species accounting for an average of 55.2 ± 6.6% (SE) of the species present on a transect.

All sites Reed et al. surveyed had important native herbaceous components. The spaces between shrub patches often included native grassland species such as *Nassella pulchra*, *Danthonia californica*, and *Carex harfordii*. Openings within shrub patches were often occupied by species such as *Scrophularia californica*, *Achillea millefolium*, and *Satureja douglasii*. These were mostly captured in the belt transects and their cover was not quantified since there were few frames that were left uncovered by shrub canopy.

The goals detailed in the SRP, include eight appropriate native plant species for the habitat and 40% shrub cover where coyote brush scrub is the primary target. The goal for non-shrub cover is only applied to grassland areas, but Reed et al. recommend creating a non-shrub cover goal for scrub areas too (described in recommendations below). In the baseline sampling at Younger Lagoon, there is substantial native shrub cover, primarily *Baccharis pilularis*, in many areas, but there is little to no native herbaceous cover in the spaces between the shrubs (Holl & Reed 2010). At reference sites, Reed et al. found a diverse assemblage of herbaceous species existing in and around the shrubs that dominate these communities. The California Natural Diversity Database (2003) likewise recognizes several northern coastal scrub associations between *Bacharis pilularis* and various native herbaceous species. In surveys of northern coastal scrub communities of Santa Cruz County, Pollock and Dolmon (1991) frequently encountered herbaceous species, particularly *Scrophularia californica* and *Achillea millefolium*. It is important to note that while the dominant species of northern coastal scrub are shrubs, much of the richness is comprised of herbaceous species and most of the special status species of these communities are herbs (Ford & Hayes 2007). Clearly, coastal scrub restoration efforts should include herbaceous components of these communities.

Cover of native shrub species at the reference sites was consistently higher than the 40% required by the SRP, so Reed et al. consider this to be a reasonable target. The seven year old restored coastal scrub at YLR had 90.5% total shrub cover. While this was a slightly different system (located on steep slopes in immediate proximity to the ocean as opposed to extending

inland along the more flat portions of the coastal terrace) the achievement of such high cover over within seven years provides some reference for what might be attainable at YLR. Reed et al. suggest shifting the focus slightly in the direction of herbaceous richness which is likely to be a more difficult restoration goal than shrub cover. Reed et al point toward richness here rather than cover because these sites are ultimately intended to be dominated by native shrub cover. Having a richness target for herbaceous species will ensure that these important functional guilds are represented within the restored community. Reed et al e also recommend working towards diversifying the shrubs, as the current shrub cover at YLR almost solely consists of *Baccharis pilularis* (Holl & Reed 2010).

Reed et al. state that the goal of eight native plant species also seems feasible at the reserve based on their monitoring at reference sites. Average transect level richness across all sites was 10.5 ± 1.6 species. The transect in the 7-yr old coastal scrub restoration at YLR had 11 native species. Reed et al. state that it is important to recognize the contribution of both shrubs and herbaceous species to overall richness in the scrub habitat. Herbaceous species comprised over half of the species across all sites at the transect level and shrub richness never exceeded six species per transect. While Reed et al. recognize the current richness target of eight species as desirable, they further suggest that at least four of the eight species be herbaceous natives observed in their reference sites.

Seasonal Wetland Reference Sites

Wetland reference sites varied in their native cover and richness. Native cover was highest at Point Lobos (94.4 ± 4.6%) and lowest at White House Creek (50.8 ± 10.4%). Transect-level richness ranged from 11.0 ± 1.2 species at Whitehouse Creek to 5.3 ± 1.2 species at Wilder Ranch. Dominant species that were present at all sites included *Juncus phaeocephalus*, *J. patens*, *J. occidentalis*, *Carex harfordii*, and *Hordeum brachyantherum*. *Juncus balticus* and *Eleocharis macrostachea* were also important in some sites. Transect level wetland indicator scores were consistent among the four reference sites ranging from 3.1±0.2 (SE) at Año Nuevo to 3.4± 0.1 (SE) at Whitehouse Creek.

The current restoration goals at YLR require that three native species are present and 30% native cover is achieved three years after planting, and 4 native species and 30% cover with signs of recruitment ten years after planting. All the reference sites Reed et al. visited had >50% cover suggesting that 30% cover is a reasonable target. Relative native cover in wetland 5 at YLR is currently >60% on average, although native cover in wetland 4 is ~10%. Reed et al. do not recommend increasing the cover value given the challenge of recreating wetland hydrology at a site that has been heavily used for agriculture. Additionally, YLR has been heavily tilled for much of the past 100 years, whereas there was no evidence or record of tilling at any of the reference sites.

The observed transect level richness varied among the reference sites Reed et al. visited; however, it was notably higher than the goal stated in the plan with >8 native species per transect in three of the four reference sites. The average five species per transect observed at wetland 5 represents the lower end of richness observed at our reference sites. Again, Reed et al. recommend planting additional species in the existing wetlands to better match observed characteristics of reference sites, although they think that a higher richness criteria across all

transects is unrealistic given the extensive past hydrologic alterations at YLR. Reed et al. state that it is important to note that hydrological alterations to some of the wetlands at YLR would be needed before they are likely to support facultative and obligate wetland species. If this management strategy is not implemented, a reduced success target would be appropriate. The current plan does not specify the scale at which richness should be assessed. We suggest that richness be considered in terms of means and variability at the transect level.

Reed et al. state that recruitment (the establishment of new individuals) may not be a good parameter to monitor in this habitat since many of the species are asexually reproducing, rhizomatous species and, therefore, we recommend focusing on cover and transect-level species richness.

Calculating the wetland indicator status of reference sites, as well as wetlands 4 and 5 at YLR, provides an interesting insight into the degree to which each of these wetlands host obligate and facultative wetland species. Reed et al. do not, however, recommend establishing criteria for overall wetland indicator status for two reasons. First, this index is largely determined by abiotic factors that may be difficult and inappropriate to create at YLR. Second, there are many non-native species that are obligate or facultative wetland species, so restoration goals should focus on native cover and richness. However, selecting potential native species for planting at YLR that are obligate or facultative wetland plants can help guide selection of species to include as part of wetland planting efforts.

<u>Recommendations for Modifications to and Notes on Sampling Protocol</u>
Few changes were made to the previously established protocol. Below, we outline the three changes Reed et al. recommend.

1. In the shrub transects Reed et al. recommend measuring absolute cover of canopy species meaning that an observer could report the same transect segment for two or more species if those species were overlapping.
2. In wetland sites where suitable habitat patches were too small to fit a continuous 50-m transect, Reed et al. recommend that the entire length of habitat be surveyed and the remaining transect length be surveyed four meters from the transect parallel to the starting segment.
3. Reed et al. recommend reporting herbaceous cover values in all habitat types as relative cover to correct for difference in total cover in different quadrats and sites.

<u>Recommendations for Restoration Goals</u>
Reed et al. make the following recommendations regarding the restoration targets:

1. The current cover targets for each habitat seem reasonable based on comparison with reference sites.
2. Richness should be assessed at the transect level in all habitats at YLR to provide a spatial context for target numbers.
3. In the coyote brush scrub areas, the current goal of eight species is appropriate but Reed et al. note from their surveys the importance of herbaceous species within the scrub habitat and further specify that at least four of the eight species be herbaceous natives.

4. The current target for wetland richness is reasonable but Reed et al. recommend planting additional species in areas with appropriate hydrological conditions to better meet levels observed in reference sites (5-7 species per transect).
5. Reed et al. recommend adding several species to the potential restoration pallet based on species lists from reference sites summarized in Tables 2 & 3 and Appendix 1 of their report.

Monitoring efforts in 2012

During the 2011-2012 field season Reed and Holl will conduct the first round of restoration compliance monitoring at restoration sites planted in year 1 under the CLRDP.

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 July 28, 2011. 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 as an appendix to this report.

Restoration Activities

Restoration activities continued on the Terrace area of YLR and throughout the lagoon portion of the Reserve (Figure 1). 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. Here we summarize some of the restoration activities that occurred on YLR during the past year.

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 FY2010-2011, 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 from the terrace, and removed Cape Ivy from the west arm of the lagoon. In FY2011-2012, reserve staff will continue weed control projects and patrols. Due to the long-lived seed bank of French

Broom, proximity of mature Jubata grass 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.

Figure 1. Iceplant coastal bluff restoration site.

Seed Collection and Plant Propagation

In the summer and fall of 2010, reserve staff consulted with local experts to determine appropriate seed collection sites and collected seeds for restoration growing. These seeds were propagated at the UCSC Teaching Greenhouse and Arboretum in the fall and winter of 2010/2011.

Restoration Planting

In FY2010-2011, areas along the beach cliff formerly covered with ice plant continued to be planted with native seedlings. Upland areas adjacent to the beach cliffs were planted with native seedlings. As required by CLRDP Mitigation Measure 4.2.1, a 'living fence' consisting of native shrubs was planted along the north east boundary of the upper terrace lands.

Education

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

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. In 2010-2011 the reserve hosted classes in Invertebrate Zoology, Freshwater Ecology, Environmental Field Methods, Restoration Ecology, Freshwater / Wetland Ecology, Animal Tracking, Marine Botany, Ecological Field Methods, Development and Physiology, Plant Physiological Ecology and Basic SCUBA (Table 1).

In Spring 2010, YLR hosted students from Professor of Environmental Studies, Karen Holl's Senior Seminar in Coastal Habitat Restoration (ENVS 196). This seminar fulfilled the senior exit requirement for ten graduating seniors in UCSC's Department of Environmental Studies. The students met weekly at the reserve during the 10-week quarter. Students were expected to design, carry out, analyze data for and write up an independent experiment. Projects included baseline vegetation monitoring, plant physiological monitoring, wetland mapping and soil sampling. Each student presented their findings at the Environmental Studies Department Undergraduate Research Symposium.

Internships and Senior Theses

In FY 2010-11, YLR staff sponsored over 45 undergraduate interns through the UCSC Environmental Studies Internship Office. The students ranged from entering freshman to graduating seniors and spent between 6 and 15 hours a week working on on-going restoration projects at the reserve. These projects included invasive species removal, re-vegetation with native species, seed collection, and propagation. Student-interns report a deep appreciation for the opportunity to obtain hands-on experience in their field of study.

Table 1. Younger Lagoon Courses

Course Title	Institution *(Department)*	Instructor's Name
Ecological Field Methods (BIO 151)	UC Santa Cruz *(Ecology and Evolutionary Biology)*	Don A Croll
Restoration Ecology (ENVS 160)	UC Santa Cruz *(Environmental Studies)*	Suzanne M Langridge
Freshwater Ecology (BIOE 155)	UC Santa Cruz *(Ecology and Evolutionary Biology)*	Walter N Heady
Basic Scuba	UC Santa Cruz *(OPERS/SCUBA)*	Cecilia Shin
Invertebrate Zoology Lab (BIOL 136)	UC Santa Cruz *(Dept of Ecology and Evolutionary Biology)*	Baldo Marinovic
Freshwater / Wetland Ecology (ENVS 167)	UC Santa Cruz *(UCSC - Dept of Environmental Studies)*	Carol Shennan
Freshwater Ecology (BIOE 155)	UC Santa Cruz *(UCSC - Dept of Ecology and Evolutionary Biology)*	Jonathan W Moore
Environmental Studies Internship (ENVS 183)	UC Santa Cruz *(UCSC - Dept of Environmental Studies)*	William Spangler
Intro to Environmental Field Methods (ENVS 104A/L)	UC Santa Cruz *(Environmental Studies)*	Erika S Zavaleta
Animal Tracking class	UC Santa Cruz *(Environmental Studies)*	Chris m Lay
Plant Physiological Ecology (ENVS 162/L)	UC Santa Cruz *(Environmental Studies)*	Michael E Loik
Senior Seminar in Restoration Ecology (ENVS 196)	UC Santa Cruz *(UCSC - Dept of Environmental Studies)*	Karen Holl
Marine Botany / Lab (BIO 120/L)	UC Santa Cruz *(Ecology and Evolutionary Biology)*	Dawn Hart
Restoration Ecology (ENVS 160)	UC Santa Cruz *(UCSC - Dept of Environmental Studies)*	Karen Holl
Development and Physiology (BIO 20B)	UC Santa Cruz *(BIO 20B - Development and Physiology)*	Jennifer Yost

Research

Due in part to its relatively small size and lack of facilities, YLR is unlikely to host many single-site research projects in biology or ecology. However, as one of the few remaining coastal lagoons in California, YLR is well suited to act as one of many research sites in a multi-sited project. Additionally, the close proximity to campus makes it an ideal place for faculty to conduct pilot and our small-scale studies as well as for undergraduate research opportunities. In FY1011 we approved 20 research applications.

US Geological Survey Groundwater Study

In FY 2010-2011, a team of researchers from US Geological Survey continued to use YLR as one of several diverse coastal sites to study submarine groundwater discharge (Figure 2). One component of their research focused on levels of monomethlymercuru (MMHg) in lagoon waters. There results show that levels of mercury that coastal lagoons can be a source of MMHg to nearshore environments (Figure 3).

Figure 2. USGS research at Younger Lagoon

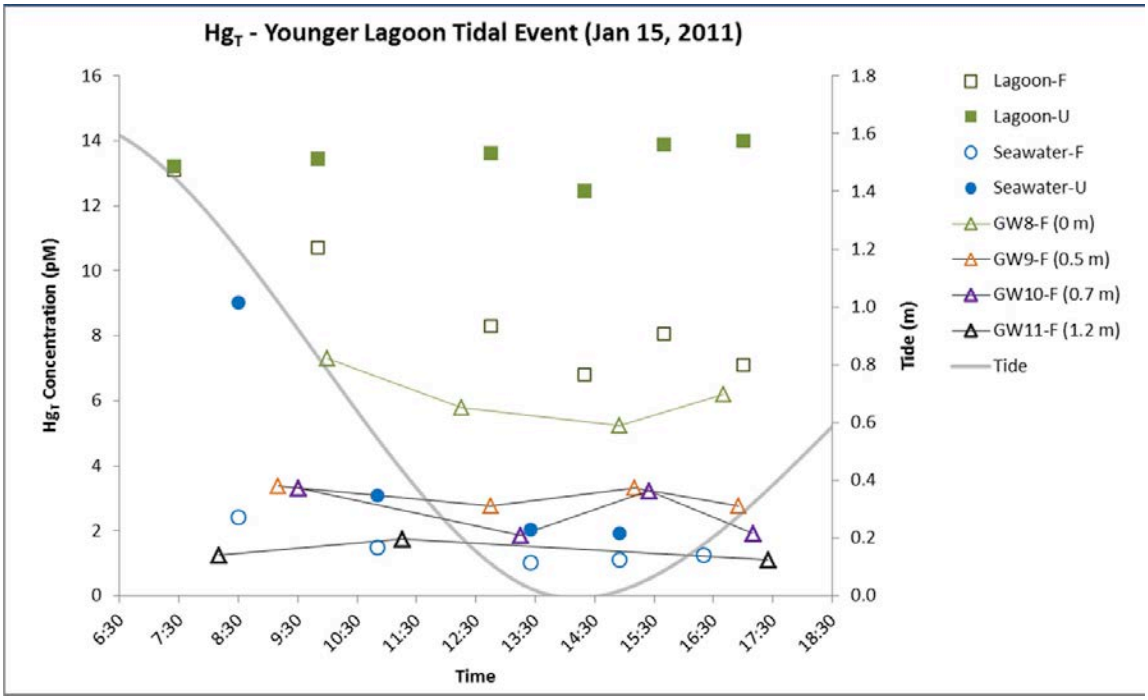

Figure 3. Mercury concentrations in groundwater at Younger Lagoon during a tidal event.

Dietary Ecology of Coastal Coyotes Study
In FY 2010-2011, UCSC Department of Earth Sciences graduate student researcher Rachel Brown chose YLR as one of several diverse coastal sites to study the dietary ecology of coastal coyotes (*Canis latrans*). Brown is working at an array of coastal sites including Año Nuevo Island Reserve and Fort Ord Natural Reserve.

Marine and terrestrial environments are linked through the cross-habitat transfer of energy and nutrients, the flux of which can subsidize a diverse array of consumers and have significant consequences for local communities and food webs. Although marine subsidies may enter recipient habitats at any trophic level, coastal or riparian predators in particular often act as agents of energy transfer from sea to land. For example, brown bears feeding on anadromous salmon in inland environments aid in transferring significant marine-derived nutrients from aquatic to terrestrial habitats. In many cases, resource subsidies originating from outside the area they are consumed allow predator populations to flourish, which can in turn have profound impacts on other species, as illustrated by the influence anthropogenically subsidized mountain lions have on bighorn sheep demographics.

Coyotes (*Canis latrans*), which have a rapidly expanding North and Central American range, have been shown to facilitate and benefit from marine subsidies and can also have cascading impacts on other predators and prey. Identifying the past and present role coyotes play in linking land and sea, and whether those links are lost or gained through time, will have important implications for the future management of this expanding species.

Brown plans to quantify terrestrial versus marine resource use by California coastal coyotes using the stable carbon and nitrogen isotope composition of modern coyote scat and Holocene coyote bone collagen. The temporal dynamics of marine-terrestrial linkages have been little studied. This research will therefore be instructive in evaluating the potential long- and short-term impacts of a rapidly expanding species on newly colonized coastal ecosystems.

Testing Wireless Acoustic Sensors for Wildlife Monitoring - Matthew McKown
Acoustic sensors are a novel and potentially cost-effective way to monitor wildlife over large spatial and temporal scales. McKown et al. are developing new low–cost wireless sensors based on Android cellphones. In order to test their first prototype sensors they have deployed three sensors in the field just east of the Center for Ocean Health at the Long Marine Lab. To test and compare detection rates we will broadcast a series of sounds every 30 minutes from 8:00 - 18:00. During each playback, we will play 3, 1-second tones of different frequencies (500, 1000, 2000, 4000, and 8000 Hz), 5 Forster's Tern calls, and short calls (~5 seconds) from 3 other species (songbirds, orthopterans, anurans). The total broadcast time each 30 minutes will be 3.5 minutes. All tones/calls will be broadcast at 80 dB SPL measured at 1m from the speaker, a level at which that should attenuate to levels indistinguishable from background noise (~ 30 dB) at around 250m. Two other types of acoustic sensors - ARUs and SongMeters -will be placed along side the cell-phone sensors for comparison.

Social Behavior of Brewers Blackbirds – Bruce Lyon
This is a pilot study was conducted to assess the feasibility of studying sexual selection, signal evolution and mating tactics in Brewer's Blackbirds. Blackbirds such as red-winged blackbirds, yellow-headed blackbirds and grackles have been the focus of intense interest in the evolution of mating systems and have been used to test basic theory into the evolution of mating systems. Most studies to date involve territorial species. Surprisingly, Brewer's Blackbirds, one of the most abundant blackbirds have never been studied with respect to mating behavior. They are unusual compared to the above-mentioned blackbirds in that they are nonterritorial—they nest in small social groups. This nesting behavior could fundamentally alter mating patterns, alternative male mating tactics and patterns of

Undergraduate Research Highlights
Three undergraduate students, Robert Chan, Tara Sepali de Silva, and Allie Sennett completed senior internship projects with the UCSC Natural Reserves in June 2011 (Figure 4). Robert's project, entitled 'Restoration strategies to control non-native grasses and forbs in California coastal prairie' was a comprehensive case study of weed control strategies for ecological restoration in coastal prairie systems. Tara's project, entitled 'Effect of different exotic control strategies on growth and survival of native grasses in coastal prairie' investigated the impacts of weed control efforts on restoration plantings. Allie's project, entitled 'Effects of slug herbivory and exotic vegetation removal on seedling survivorship in coastal prairie' investigated the effects of slug and snail herbivory and weed control on restoration plantings, as well as the feasibility of slug and snail exclusion in restoration plantings. All three students conducted their research during the winter and spring of 2010 at YLR. Their work included a thorough literature review, experimental design, greenhouse propagation, field plantings, vegetation monitoring, and data collection and analysis. The two students worked closely with UCSC NRS Director Gage Dayton, reserve Field Manager, Elizabeth Howard and faculty Advisor Karen Holl to ensure that their results and recommendations would influence future restoration activities.

Figure 4. Experimental plots for restoration studies. Checkerboard pattern is an experiment examining efficacy of different weed control methods on native grass survivorship. Aluminum fencing is an experiment examining the impact of slugs on native grass establishment.

Reserve Use

The greatest educational user group for YLR in 2010-2011 was once again undergraduate education, breakdown of all user groups are included in Table 2. YLR was used by UC Santa Cruz, UC Davis, UC Berkeley, Stanford University, Yerba Buena High School, Delta High School, US Geological Survey, NOAA Protected Resources Division, Seymour Marine Discovery Center, Santa Cruz Bird Club, California Native Plants Society, Society for Conservation Biology, Audubon California, Wildlight Pictures Inc. / Redwoods to the Sea GeoVentures, and several local and regional volunteer groups (Table 3).

Table 2. Younger Lagoon Total Use

	Home Institution		UC Campus		CSU Campus		Community College		Other CA Campus		Out of State		International		Government		TOTALS	
Days	Users	UDays	Users	UDays	Users	UDays	Users	UDays	Users	UDays	Users	UDays	Users	UDays	Users	UDays	Users	UDays
UNIVERSITY-LEVEL RESEARCH																		
Research Faculty	9	28	0	0					0	0					1	1	**10**	**29**
Research Scientist	3	21	3	21					3	3					8	8	**17**	**53**
Research Assistant	4	4	0	0					0	0					0	0	**4**	**4**
Research Graduate Student	19	79	2	11					0	0					1	1	**22**	**91**
Research Undergraduate Student	21	345	1	1					0	0					1	1	**23**	**347**
Subtotal	*56*	*477*	*6*	*33*					*3*	*3*					*11*	*11*	*76*	*524*
UNIVERSITY-LEVEL INSTRUCTION																		
University Instructor	34	67	0	0					0	0					0	0	**34**	**67**
University Student	523	1669	0	0					0	0					0	0	**523**	**1669**
Subtotal	*557*	*1736*	*0*	*0*					*0*	*0*					*0*	*0*	*557*	*1736*
PUBLIC SERVICE																		
K-12 Instructor	0	0	0	0					0	0					9	14	**9**	**14**
K-12 Student	0	0	0	0					0	0					160	160	**160**	**160**
Government (Fed/State/Local)	0	0	0	0					0	0					7	7	**7**	**7**
NGOs / Non-profits Organization*	0	0	0	0					0	0					29	100	**29**	**100**
For Profit / Business	0	0	0	0					0	0					3	9	**3**	**9**
Volunteer	132	138	0	0					0	0					157	172	**289**	**310**
Other*	1	20	15	15					0	0					2409	2417	**2425**	**2452**
Subtotal	*133*	*158*	*15*	*15*					*0*	*0*					*2774*	*2879*	*2922*	*3052*
TOTALS	**746**	**2371**	**21**	**48**					**3**	**3**					**2785**	**2890**	**3555**	**5312**

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

Table 3. Younger Lagoon Group Affiliations

University of California Campus	**Other Universities**
University of California, Santa Cruz	Stanford
University of California, Davis	
University of California, Berkeley	
Government (Federal and State)	**Non-governmental organizations**
NOAA Protect Resources Division	Santa Cruz Bird Club
United States Geological Service	Seymour Center
	California Native Plant Society
K-12 system	Audubon California
Delta High School	Society for Conservation Biology
Yerba Buena School	
Volunteer Groups	
UCSC Wilderness Orientation	

Summary

FY 2010-2011 was a successful year for YLR. The reserve continued to move forward with restoration, initiated new projects, strengthened collaborations, and developed new relationships. The increase in student and course use is a direct result of having superb staff on sight that are actively engaged with students, faculty, and the public. In turn, we are able to achieve our mission of supporting education, research, and public education as well as meet the environmental stewardship obligations the University of California has committed to with the California Coastal Commission and the State of California in general. We look forward to continuing this exciting and important work in FY 2011-2012.

UCSC Natural Reserves Advisory Committee

Charge
The committee provides oversight of on- and off-campus natural reserves of instructional and research interest. It is responsible for developing program vision and policy for the management and use of the UCSC Campus Reserve and of the four UC Natural Reserves System holdings: Año Nuevo Island Reserve, Landels-Hill Big Creek Reserve, Younger Lagoon Reserve and Fort Ord Reserve. The committee coordinates with the systemwide NRS Advisory Committee that advises on policy for all NRS reserves.

In addition to the chair (Faculty Director), membership of the committee is comprised of faculty advisors to each reserve, one faculty representative at large, one non-senate academic appointment, one staff representative, one graduate student and two undergraduate students. The Faculty Director, in consultation with the Dean and the Administrative Director of the UCSC Natural Reserves, appoints the committee. Membership terms begin September 1 unless otherwise specified.

DURATION OF APPOINTMENTS

Faculty Director: 5 years

Faculty Advisors: 3 years

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

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

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

MEMBERSHIPS

Faculty Director of the Natural Reserve System	Don Croll Associate 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 EE Biology/Earth & Marine Sciences (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 Assistant Professor, Environmental Studies Environmental Studies Department (831) 459-5011 – zavaleta@ucsc.edu
1 Non-Senate Academic	Chris Lay Lecturer and Museum Curator, Environmental Studies Environmental Studies Department (831) 459-4763 – cml@ucsc.edu
1 Staff	James Velzy Greenhouse Manager Greenhouse/MCD Biology (831) 459-3485 – jhvelzy@ucsc.edu
2 Graduate Student	Kathy Hilimire Environmental Studies Department khilimir@ucsc.edu Lewis Reed Environmental Studies Department lewiskreed@hotmail.com
2 Undergraduate Students	Mike Geneau Environmental Studies Michaelgeneau@ucsc.edu Tara De Silva Environmental Studies tdesilva@ucsc.edu

4 Ex-Officio	Gage H. Dayton, Advisory Committee Convenor Administrative Director, UCSC Natural Reserves c/o Environmental Studies Department (831) 459-4867 - ghdayton@ucsc.edu Mark Readdie Resident Director, Landels-Hill Big Creek Reserve Big Creek Reserve Big Sur, CA 93920 (831) 667-2543 - readdie@biology.ucsc.edu Steve Davenport Assistant Director, Institute of Marine Sciences Long Marine Lab, Center for Ocean Health (831) 459-4771 – sldaven@ucsc.edu Kathie Kenyon Assistant Dean, Planning and Academic Programs Division of Physical and Biological Sciences (831) 459-2614 – kmk@ucsc.edu

Publications

Sennett, Allie Elizabeth. 2011. Effects of slug herbivory and exotic vegetation removal on seedling survivorship in coastal prairie. A Senior Thesis submitted in partial satisfaction of the requirements for the degree of Bachelor of Arts in Environmental Studies, UC Santa Cruz. Faculty Advisor: Dr. Karen D. Holl, Environmental Studies.

Sepali de Silva, Tara. 2011. Effect of different exotic control strategies on growth and survival of of native grasses in coastal prairie. A Senior Thesis submitted in partial satisfaction of the requirements for the degree of Bachelor of Arts in Environmental Studies, UC Santa Cruz. Faculty Advisor: Dr. Karen D. Holl, Environmental Studies.

Appendices

Appendix 1. California Coastal Commission NOID-3: Specific Resource Plan

CALIFORNIA COASTAL COMMISSION
CENTRAL COAST DISTRICT OFFICE
725 FRONT STREET, SUITE 300
SANTA CRUZ, CA 95060
PHONE: (831) 427-4863
FAX: (831) 427-4877
WEB: WWW.COASTAL.CA.GOV

W16a

Prepared August 25, 2010 (for September 15, 2010 hearing)

To: Coastal Commissioners and Interested Persons

From: Dan Carl, District Manager
Susan Craig, Coastal Planner

Subject: **UCSC Marine Science Campus Coastal Long Range Development Plan (CLRDP) Notice of Impending Development Number 3 (Younger Lagoon Reserve Terrace Lands Phase 1A Restoration).** Coastal Commission consideration of UCSC's notice regarding their intent to implement the first phase of Younger Lagoon Reserve terrace lands restoration, including vegetation management, restoration, and enhancement of habitats over about one-third of the Campus' natural terrace areas, pursuant to the certified CLRDP.

A. Staff Recommendation

1. Summary of Staff Recommendation

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

The CLRDP includes a comprehensive Resource Management Plan (RMP) that sets goals and objectives to guide habitat restoration and enhancement in the natural areas of the Marine Science Campus that are protected from development. UCSC proposes to implement the first phase of the CLRDP's required restoration, called Phase 1A, under of the RMP consisting of the removal of invasive non-native plants and hand planting to improve about 16 acres of habitat within the terrace portion of Younger Lagoon Reserve (YLR), one of 36 reserves in UC's Natural Reserve System. The project includes placing signage in the publicly-accessible areas of the YLR terrace area to interpret and explain the restoration work and related research. Additional signage and low fencing (if necessary) would also be installed along the Campus's public trails that are adjacent to active restoration areas to protect new plantings from being trampled. The project also includes a monitoring and maintenance program that will apply over a period of at least seven years to ensure that the restoration efforts meet the success criteria outlined in the CLRDP. If at the end of seven years the restoration project has been unsuccessful in achieving the CLRDP's success criteria for habitat restoration and enhancement (in part or in whole), then remediation measures would be implemented to compensate for those portions of the original plan that do not meet the approved success criteria.

The CLRDP envisions and requires overall restoration, enhancement, and management of the various

habitats that make up the YLR terrace area outside of allowed development nodes, including the removal of non-native invasive plant species, the planting of appropriate coastal native plant species, management of the areas for habitat purposes, the installation of appropriate fencing and signage to protect and interpret the ongoing restoration activities, and a long-term commitment to monitoring and maintenance of these natural areas to meet the success criteria of the CLRDP. The CLRDP requires all of the Campus' terrace natural areas to be restored/enhanced within 20 years of CLRDP certification, with interim benchmarks that at least one-third of the restoration and enhancement be completed within seven years of CLRDP certification and that at least two-thirds be completed within 14 years of CLRDP certification. The proposed Phase 1A project is structured to address one-third of the natural areas within the allowed first seven-year time frame. The Phase 1A project satisfies the standards of the CLRDP, and will provide for the restoration and enhancement of a number of sensitive habitats on the Marine Science Campus site as is envisioned in and required by the certified CLRDP . **Staff recommends that the Commission determine that the project is consistent with the certified CLRDP.** The necessary motion and resolution are found at the bottom of the page below.

Staff Note - NOID Action Deadline: This NOID was filed as complete on August 11, 2010. The 30-working day action deadline is September 23, 2010. Thus, unless UCSC's Director of Campus Planning (or his/her designee) waives the University's right to a hearing by September 23, 2010 and agrees to extend the deadline to a date certain (up to three months is allowed per the CLRDP), the Commission has until September 23, 2010 to act upon this NOID or it will be deemed consistent with the CLRDP.

2. Staff Recommendation on CLRDP Consistency

Staff recommends that the Commission, after public hearing, find the proposed development project consistent with the certified CLRDP.

Motion. I move that Commission determine that the development described in UCSC Notice of Impending Development Number 3 is consistent with the certified University of California at Santa Cruz Coastal Long Range Development Plan.

Staff Recommendation of Concurrence. Staff recommends a **YES** vote. Passage of this motion will result in a determination that the development described in the UCSC NOID-3 is consistent with the certified UCSC CLRDP, and adoption of the following resolution and findings. The motion passes only by affirmative vote of a majority of the Commissioners present.

Resolution to Find CLRDP Consistency. The Commission hereby determines that the development described in UCSC Notice of Impending Development Number 3 is consistent with the certified University of California at Santa Cruz Coastal Long Range Development Plan for the reasons discussed in the findings herein.

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B.Findings and Declarations

The Commission finds and declares as follows:

1. UCSC CLRDP

A. General CLRDP Background

As an alternative to project-by-project coastal permit review, Coastal Act Section 30605 allows for universities to develop long range development plans for Coastal Commission certification. Once certified, each university is the primary entity responsible for ensuring that future development on the site is consistent with the certified long range development plans, subject to ongoing Commission oversight. UCSC's Marine Science Campus CLRDP was certified by the Coastal Commission on January 7, 2009.

B. UCSC's Marine Science Campus

UCSC's Marine Science Campus site is located directly adjacent to the Monterey Bay National Marine Sanctuary just within the western border of the City of Santa Cruz in Santa Cruz County (see Exhibit A for a location map). The Campus site has been known locally for many years as Terrace Point. The main UCSC campus is located roughly two miles inland of the Marine Science Campus in the rolling foothills

northwest of downtown Santa Cruz. The Marine Science Campus is located at the outskirts of the City, seaward of Highway One, at the transitional boundary between the urbanized City area to the east and the rural north coast of the unincorporated County to the west. The Santa Cruz County north coast area is well known to the Commission for its sweeping vistas of both coastal agricultural fields and natural landscapes framed by the undulating coastal range. Much of this area is in extensive State Park and other rural public land holdings, and all of it is traversed by a rural stretch of Highway One. Although there are some limited residential enclaves (e.g., Davenport along the coast, and Bonny Doon in the mountains) in these mostly pastoral areas, this north coast area is part of the stretch of largely agricultural and undeveloped coastal lands extending nearly 50 miles to Half Moon Bay upcoast. The Campus site is located at the beginning of this stretch of coast as one heads upcoast out of the City of Santa Cruz and, by extension, out of the urbanized portion of northern Monterey Bay.[1]

The Campus is primarily made up of a relatively flat terrace area (roughly 73 acres) sloping gently from north to south (to the ocean) with the remainder occupied by a large arroyo feature (roughly 25 acres) on the west of the site, at the base of which lies Younger Lagoon, an estuarine lagoon that connects (at times) to the ocean. A sandy beach area fronts Younger Lagoon below the terrace. The lagoon, the beach, the arroyo and a portion of the terrace[2] make up Younger Lagoon Reserve (Reserve). The terrace portion of the site includes within it a 2.5 acre federally-owned parcel completely surrounded by UCSC property. Altogether, the Campus (including the federal in-holding and the Reserve) is about 100 acres.

In the general Campus vicinity, agricultural land extends to the west along the coast beyond the Reserve and the western Campus boundary. To the north are the Union Pacific Railroad tracks, the Raytek industrial facility, and Highway One. To the south lies the Sanctuary and the Pacific Ocean, and to the east is Antonelli Pond (above, or north of, Delaware Avenue) and the densely packed De Anza Mobile Home Park (residential) (below Delaware Avenue) beyond which is Natural Bridges State Park and past that West Cliff Drive in the City of Santa Cruz.

C. UCSC's Marine Science Campus CLRDP

UCSC's Marine Science Campus CLRDP was certified by the Coastal Commission on January 7, 2009. The CLRDP provides a blueprint for future development of the site including a maximum increase of about 600,000 square feet of new Campus facilities mostly within four distinct development zones (occupying about one-third of the terrace area) for an expanded Marine Science Campus. The CLRDP provides for roughly 340,000 gross square feet of potential new facilities within the four development zones in new one- and two-story buildings up to 36 feet tall, with the remainder in outdoor research and

---

[1] The City of Santa Cruz is located at the upcoast end of the larger urban portion of northern Monterey Bay that extends downcoast through unincorporated Live Oak, the City of Capitola, and the more urban portion of south Santa Cruz County (i.e., the Aptos-Rio del Mar-Seascape areas). Though defined by city limit boundaries, these more urban areas all blend somewhat together as a larger urban "zone."

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

support areas. The CLRDP also accounts for additional areas of roads, and some natural drainage ponds, outside of the four development nodes. Overall, and at full buildout, the CLRDP allows for the Campus to grow by about three times its size at certification. In addition to the building program, the CLRDP also provides for an expanded public access trail system and natural habitat restoration in those wetland and open space areas on the terrace that are not part of the proposed development zones (roughly 47 acres) that, per the CLRDP, have been recently added to Younger Lagoon Reserve.

D. Younger Lagoon Reserve Terrace Lands

Younger Lagoon Reserve (YLR) was established in 1987 and is one of the 36 reserves that make up the University of California's Natural Reserve System of protected lands available for university-level instruction, research, and public outreach. The original reserve consisted of approximately 25 acres encompassing the lagoon itself and the upland habitat on the slopes surrounding the lagoon. An additional 47 acres of natural area located on the terrace portion of the Campus outside of the allowed development zones were incorporated into YLR in July 2008, bringing the current size of the reserve to approximately 72 acres.

Much of the Reserve, including portions of the terrace area, have been identified as environmentally sensitive habitat area (ESHA) by the CLRDP. Five distinct habitat types occur on the terrace: coastal bluff, coastal prairie, seasonal wetlands, forested wetlands, and grasslands. The terrace natural area supports a number of vegetation types, in both wetland and upland habitats, which in turn support a variety of resident and non-resident wildlife. Wildlife on the terrace includes a variety of species, ranging from amphibians and reptiles to small and large mammals and birds. The CLRDP Resource Management Plan (RMP) outlines parameters for the restoration, enhancement, and management of the natural areas on the terrace, including maintenance and enhancement of open space habitats, protection and enhancement of sensitive biotic elements, controlled public access, and long-term maintenance and monitoring.

2. Notices of Impending Development

Under a certified CLRDP, University development of specific projects contained in the CLRDP can proceed without a coastal permit provided the University sends a Notice of Impending Development (or a "NOID") to the Commission prior to undertaking development, and either the Commission deems the identified development project consistent with the CLRDP (with or without conditions to make it so) or does not respond in a timely manner to the NOID.[3] Pursuant to Coastal Act Sections 30605 and 30606, the Commission may impose conditions on such development project proposals only if it finds them inconsistent with the certified CLRDP.

[3] Coastal Act Section 30606 requires that the University provide notice of an impending development at least 30 working days prior to pursuing it. CCR Section 13549 provides that a NOID is only filed following Executive Director review of the NOID and any supporting materials to ensure there is sufficient information for making the consistency determination. CCR Section 13548 requires that the Commission take action on the notice within 30 working days of filing of the NOID. In sum, if the Commission does not take action within 30 working days of filing of the NOID, the identified development project is deemed consistent and can proceed.

UCSC NOID 3 was filed as complete on August 11, 2010, and the 30-working day action deadline is September 23, 2010. Thus, unless UCSC's Director of Campus Planning or his/her designee waives the University's right to a hearing within thirty working days and agrees to extend the deadline to a date certain (up to three months is allowed per the CLRDP), the Commission has until September 23, 2010 to act upon this NOID or it will be deemed consistent with the CLRDP.

3. CLRDP Consistency Analysis

A. Applicable CLRDP Provisions

The CLRDP includes multiple provisions that require protection, enhancement, and restoration the natural areas of the Campus outside of development zones, including specific requirements applicable to YLR:

> ***Policy 2.5 - Ensuring Appropriate Land Uses on the Marine Science Campus.*** *All development and uses on the Marine Science Campus shall be limited to marine/coastal research and education, resource protection, and public access development and uses, including primarily coastal dependent and coastal related development and uses. All other development and uses on the Marine Science Campus shall be prohibited.*
>
> ***Policy 3.2 - Protection and Restoration of Habitat Areas.*** *The biological productivity and the quality of coastal waters, streams, and wetlands, appropriate to maintain the optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible, restored through among other means minimizing adverse effects of wastewater discharges, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow, encouraging wastewater reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alteration of natural watercourses. Campus natural areas (i.e., areas outside of defined development zones) shall be protected, restored, enhanced, and managed as high-quality open space and natural habitat areas.*
>
> ***Implementation Measure 3.2.2 - Management of Terrace Wetlands.*** *The terrace wetlands shall be protected and enhanced by improving surface water flow, removing non-native and invasive plants, promoting the abundance and diversity of native plant species through small-scale plantings, creating buffers, implementing the Drainage Concept Plan (Appendix B), controlling access by humans and non-native animals, and implementing other enhancement measures in accordance with the provisions of this CLRDP, including its Resource Management Plan (Appendix A).*
>
> ***Implementation Measure 3.2.4 - Management of Special Status Species Habitat.*** *Special status animal species and their habitats shall be protected, and their habitats enhanced consistent with the Resource Management Plan (Appendix A), including through protection and enhancement of*

wetland habitats (including for California redlegged frog) and grassland/scrub-grassland habitats outside of development zones (including for special status bird species), through protection from non-native predators, and through implementation of other enhancement measures in accordance with the provisions of this CLRDP.

Implementation Measure 3.2.5 - Protect Habitat Areas From Human Intrusion. *Habitat areas on the Marine Science Campus shall be protected against degradation from human intrusion by developing trails and interpretive signs, managing trail use, and implementing other enhancement measures in accordance with the provisions of this CLRDP.*

Implementation Measure 3.2.6 - Natural Area Management. *The University shall restore, enhance, and manage all areas located outside of defined development zones (except for approved streets and trails) as high-quality open space and natural habitat area.*

Implementation Measure 3.2.8 - Maintenance and Monitoring of Terrace Habitats. *Long-term maintenance and monitoring programs for the terrace habitats shall be developed and implemented in accordance with the provisions of this CLRDP.*

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.*

Implementation Measure 3.2.14 - Non-Invasive Native Plant Species Required. *All*

landscaping and vegetation on the Campus (including restoration and enhancement plantings, screening vegetation, stormwater system plantings, ornamental plantings, and all other plant material) shall be limited to non-invasive native plant species that are appropriate to the habitat and region and that are grown from seeds or vegetative materials obtained from local natural habitats so as to protect the genetic makeup of natural populations. Horticultural varieties shall not be used. Except for the planting of Monterey cypress, only locally collected seed, cuttings, and/or other propagules shall be used for landscaping. If feasible, materials should be collected from coastal habitats that are located within approximately one mile of the Campus and seaward of Highway 1.

Policy 3.5 - Special Protection for Younger Lagoon Reserve. *The University recognizes the special biological significance of Younger Lagoon Reserve for habitat value and for research and education and therefore shall continue to provide special protection for the property by retaining it as part of the University's Natural Reserve System and protecting it consistent with this CLRDP.*

Implementation Measure 3.5.1 - Protection and Enhancement of YLR Habitats. *The native plant and animal habitats of Younger Lagoon Reserve shall be protected and enhanced by controlling and removing non-native and invasive plant species, promoting the abundance and diversity of native plant species through small-scale plantings and re-vegetation of areas where exotics and/or invasives have been removed, implementing the Drainage Concept Plan (Appendix B), maintaining and installing fencing/barriers consistent with this CLRDP to control trespass from the terrace portion of the site into YLR, limiting access by humans (except access otherwise allowed by this CLRDP), prohibiting domestic pets, and other appropriate means that may become available.*

Implementation Measure 3.5.2 - Protection of Special Status Species in YLR. *Habitats for special status animal species that use Younger Lagoon Reserve shall be protected and enhanced.*

Implementation Measure 3.5.3 - Protection of YLR Resources. *The biological productivity and quality of YLR shall be protected, including by minimizing the effects of stormwater discharges and entrainment, controlling runoff, preventing depletion of ground water supplies, maintaining natural vegetation buffers areas and minimizing alteration of natural features.*

Implementation Measure 3.5.4 - Development of Monitoring and Maintenance Program. *Long-term maintenance and monitoring programs for Younger Lagoon Reserve shall be developed and implemented to assist in long-term preservation of species and habitats in accordance with the provisions of this CLRDP.*

Planning Objectives 4.1.2 - Protecting Natural Resources on the Site.

- *Avoid or minimize adverse effects on the natural physical setting consistent with the resource protection provisions of the California Coastal Act and other environmental*

regulations, and consistent with achieving the planning objectives described above.

- *Rely on infill and clustering of facilities to provide for efficient use of the land while limiting development of undeveloped lands to the maximum extent feasible.*
- *Protect and enhance environmentally sensitive habitat areas and other coastal resources including vegetative and wildlife habitats.*
- *Site development in areas with similar uses to support pedestrian travel and to minimize vehicle use for circulation within the site.*

Resource Management Plan Goals for the Terrace.

Goal 1. *Maintain open space areas; protect and enhance the grassland, ruderal, and coyote brush scrub-grassland areas through eliminating highly invasive weeds, controlling lower priority weeds, promoting the abundance and diversity of native plant species through small-scale plantings, and preventing unauthorized trail development.*

Goal 2. *Protect and enhance the coastal bluff areas through eliminating highly invasive weeds, promoting the abundance and diversity of native plant species through small-scale plantings, preventing unauthorized trail development, and increasing the extent of coastal bluff vegetation.*

Goal 3. *Protect and enhance wetlands by improving surface water flow, controlling weeds, promoting the abundance and diversity of native plant species through small-scale plantings, creating buffers, implementing the CLRDP Drainage Concept Plan, and controlling access by humans and non-native animals.*

Goal 4. *Protect wetlands from adverse impacts due to weeds, noise, human and non-native animal intrusion, lighting, predation, and sedimentation.*

Goal 5. *Protect and enhance the wildlife corridor and wildlife corridor buffer areas by appropriately siting and designing development adjacent to them (and trails that may be adjacent and/or that may pass through them), eliminating highly invasive weeds, planting native species to provide better protective cover and visual screening for wildlife than existing vegetation, maintaining existing surface drainage patterns, controlling access by humans and non-native animals and providing a safe crossing for wildlife if Shaffer Road is improved.*

Goal 6. *Protect YLR from adverse impacts associated with terrace use by enhancing the YLR buffer area (including the berm in the lower portion of the terrace) through enhanced fencing and vegetative screening to block terrace noise, lights, and activities from YLR, controlling highly invasive weeds, and replanting with native species.*

Thus, the CLRDP contains strong goals, objectives, policies, and other implementing provisions that envision and require the restoration, enhancement, and management of the natural areas on the Marine Science Campus, including the terrace area now associated with Younger Lagoon Reserve.

B. Proposed Phase 1A Project

CLRDP Implementation Measures 3.2.5 and 3.2.6 provide protection parameters for habitat areas located on the UCSC Marine Science Campus. CLRDP Policy 3.5 and Implementation Measures 3.5.1-3.5.6 provide special protections for the habitats and the special status species found in the Younger Lagoon Reserve. Implementation Measures 3.2.2 and 3.2.8 specifically require protection, enhancement, long-term maintenance and monitoring of the terrace natural areas. Implementation Measure 3.2.10[4] states that restoration, enhancement, and management activities may be accomplished in up to three phases as guided by Specific Resource Plans (SRPs)[5] developed by the University in accordance with the CLRDP Scientific Advisory Committee (SAC) and the criteria contained in the CLRDP's Resource Management Plan and current professional standards for such plans.

The University proposes to implement Phase 1A[6] of the SRP for the restoration of natural habitat within the YLR terrace area. The goal of such restoration efforts is to create and enhance a mosaic of coastal habitats to preserve biodiversity, provide habitat for special status species, and buffer stormwater runoff. With about 47 acres outside of the development zone to be restored over the next 20 years, approximately 16 acres – or about one-third of the area overall – will be restored during each of the three SRP phases. SRP Phase 1A would focus on enhancement of coyote-brush scrub grassland, grassland, coastal bluff scrub, wetland willow, and wetland buffer areas (see Exhibit B for a map of the Phase 1A restoration areas by habitat type) and includes the following objectives:

- Increase native plant species richness and percent cover and decrease non-native plant cover in all terrace habitats.

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[4] Note that, as certified, this implementation measure exempts YLR from the requirements for natural areas habitat management. This is because at the time of certification, YLR consisted of approximately 25 acres that encompassed the lagoon itself and the upland habitat on the slopes surrounding the lagoon, and the CLRDP was premised on requiring natural area restoration and enhancement on the terrace above the lagoon area. Thus, this 25-acre area is not subject to the requirements of Policy 3.2.10. However, the terrace lands are subject to this requirement, even though they have since been incorporated into YLR. (The CLRDP by its own terms requires a CLRDP amendment to account for such textual anomalies in the CLRDP associated with the incorporation of the terrace areas into YLR, but such amendment has not yet been completed by the University.) In other words, the CLRDP does not require that Younger Lagoon and its upslope areas be restored/enhanced, but does require such restoration and enhancement of the terrace areas. This CLRDP distinction emanates from the determination that the lagoon environs was (and is) already high quality habitat. The CLRDP requires long-term protection and management for all non-development areas, including all of Younger Lagoon and the terrace areas.

[5] The SRP for Phase 1 addresses the first seven-year phase of RMP implementation. By the concluding year of the first 7-year phase of restoration, a second SRP will be written to direct Phase 2 of the restoration effort (years 7-14) and by year 14, the final SRP will be written for Phase 3 (years 14-21) of the restoration effort.

[6] Phase 1B of the SRP would include hydrologic modifications to wetlands on the Terrace Lands and will be the subject of a future NOID.

- Control Priority-1 weeds[7] (non-native invasive plant species) throughout the terrace.

All Priority-1 weeds would be controlled as they are detected throughout the Terrace lands. Removal of Priority-1 weeds may include hand pulling/mechanical control, winching, clipping/weed whacking, flaming, solarization (i.e., laying down black agricultural plastic), burning, grazing, and herbicide application. Larger Monterey pine and Monterey cypress would be controlled by cutting the above-ground material from the root, while seedlings would be controlled by hand pulling and/or digging. Any herbicide application would follow the standards of the California Department of Pesticide Regulation (CaDPR) and would be done by a CaDPR qualified applicator. Only registered aquatic herbicides would be used near wetland areas. Due to their potential to re-invade, all Priority-1 weeds with viable propagules would be solarized and composted onsite or bagged after removal and disposed of offsite.

Native plantings will be used throughout SRP Phase 1A to replace non-native plants that are removed, improve plant cover as appropriate, and enhance native habitats. As required by the CLRDP, the proposed planting palette is made up exclusively of native taxa that are appropriate to the individual habitats and the region. Seed and/or vegetative propagules would be obtained from local sources so as to protect the genetic makeup of natural populations and increase the probability of successful establishment. All planting would be done by hand. Ideally, plant installation will commence after the first winter rain and end well before the rains stop, ensuring that plants are naturally watered in and established before the summer dry period. However, if supplemental irrigation is needed, plants will be watered using one or all of the following methods: application by a water truck, by hose, by hand, or by overhead sprinkling. Supplemental irrigation is likely to be needed only in the summer and fall months in the first year after planting.

During Phase 1A, signage would be placed in the publicly-accessible areas of the terrace to interpret and explain the restoration work and related research. Additional signage or low fencing would also be installed along public trails that are adjacent to active restoration areas to protect new plantings from being trampled. All signage and fencing will comply with the CLRDP's sign and design standards (as described in Chapter 6 of the CLRDP) to avoid visual impacts while also providing maximal public access consistent with ongoing restoration activities.

The proposed project includes a monitoring program to evaluate whether the CLRDP's success criteria,

[7] The CLRDP assigns Priority-1 weed status to non-native plants that are large in stature, slow but steadily-spreading, and capable of invading and out-competing native plants in established plant communities. On the Marine Science Campus these include ice plant, Jubata (Pampas) grass, cape ivy, panic veldgrass, fennel, French broom, Harding grass, Himalayan blackberry, Monterey pine, and Monterey cypress. The Monterey pine and Monterey cypress on the site (fewer than 10 small trees) were either planted as landscape plants or grew from seeds transported to the site in wood chip mulch. Both species are fast growing, spread easily by seed, and once established shade out and invade native scrub, grassland and wetland habitats. As the University is actively trying to restore, enhance and protect these habitats, the Scientific Advisory Committee was unanimous in recommending that the University 1) remove the existing Monterey pine and Monterey cypress trees from the reserve, 2) refrain from planting any additional Monterey cypress or Monterey pine in the reserve, 3) remove any seedlings as they are detected in the reserve, and 4) encourage the campus to both seek alternatives for landscaping and remove any existing Monterey pine and Monterey cypress trees from the campus lands if possible. There are other native trees and shrubs that are not invasive and could be used for screening future development on the Marine Science Campus, such as California wax myrtle, Red flowering currant, Box elder, etc.

including for native plant cover and species richness, are being met. Monitoring will take place over a 7-year period. Results from the monitoring program will be included in reports that will be submitted by December 31st of each year to University planning staff, the Executive Director, and the Scientific Advisory Committee. A final monitoring report will be submitted to the Executive Director at the end of the final monitoring period of Phase 1. If the final report indicates that the project has been unsuccessful in achieving the required success criteria for habitat restoration and enhancement (in part or in whole), then the final report will identify remediation measures to be implemented to compensate for those portions of the original plan that do not meet the approved success criteria.

The University's proposed Phase 1A project meets the requirements of Policy 3.2, Implementation Measures 3.2.6 and 3.2.10, and the other habitat-protection and restoration requirements of the CLRDP because the Phase 1A project will implement the CLRDP's required long-term habitat restoration, enhancement, and monitoring and management activities for the natural terrace areas located outside of the development areas. The Phase 1A project is consistent with Implementation Measures 3.2.14 and 3.5.1 because it includes removal of non-native invasive plant species on the site and restoration with coastal native plant species that are appropriate to the individual habitats on the site. The Phase 1A Plan meets the requirements of Implementation Measures 3.2.5 and 3.5.1 because it includes appropriate fencing to protect restored areas from unauthorized public access, along with interpretive signage to inform the public of the sensitive nature of the habitat areas and to educate the public regarding the Campus and the restoration. Furthermore, the proposal includes implementation of a seven-year monitoring and maintenance program that will provide data on coverage and richness of native plant species to evaluate the success of the restoration efforts. Data compiled from monitoring and maintenance activities will be included in the CLRDP-required annual reports. In order to remedy any potential deficiencies in meeting the required success criteria, each report will discuss solutions and adaptive strategies to tackle unforeseen circumstances or new findings that require a change in restoration practices to better achieve the success criteria. These monitoring and maintenance activities meet the requirements of Implementation Measure 3.2.10 and will assist in long-term preservation of species and habitats on the Campus terrace, as required by Implementation Measure 3.5.4.

In summary, the CLRDP envisions restoration of the various habitats outside of Marine Science Campus development zones on the terrace, including the removal of non-native invasive plant species, the planting of appropriate coastal native plant species, the installation of appropriate fencing and signage to protect and interpret the ongoing restoration activities, and a long-term commitment to monitoring and maintenance of the restored areas to meet the success criteria developed by the Scientific Advisory Committee and the certified CLRDP. The University's submittal is consistent with the restoration and habitat management parameters certified by the Commission in 2009. Thus, as proposed by the University, implementation of Younger Lagoon Reserve Resource Plan Phase 1A is consistent with the certified CLRDP.

C. California Environmental Quality Act (CEQA)

Section 13096 of the California Code of Regulations requires the Commission to make a specific finding

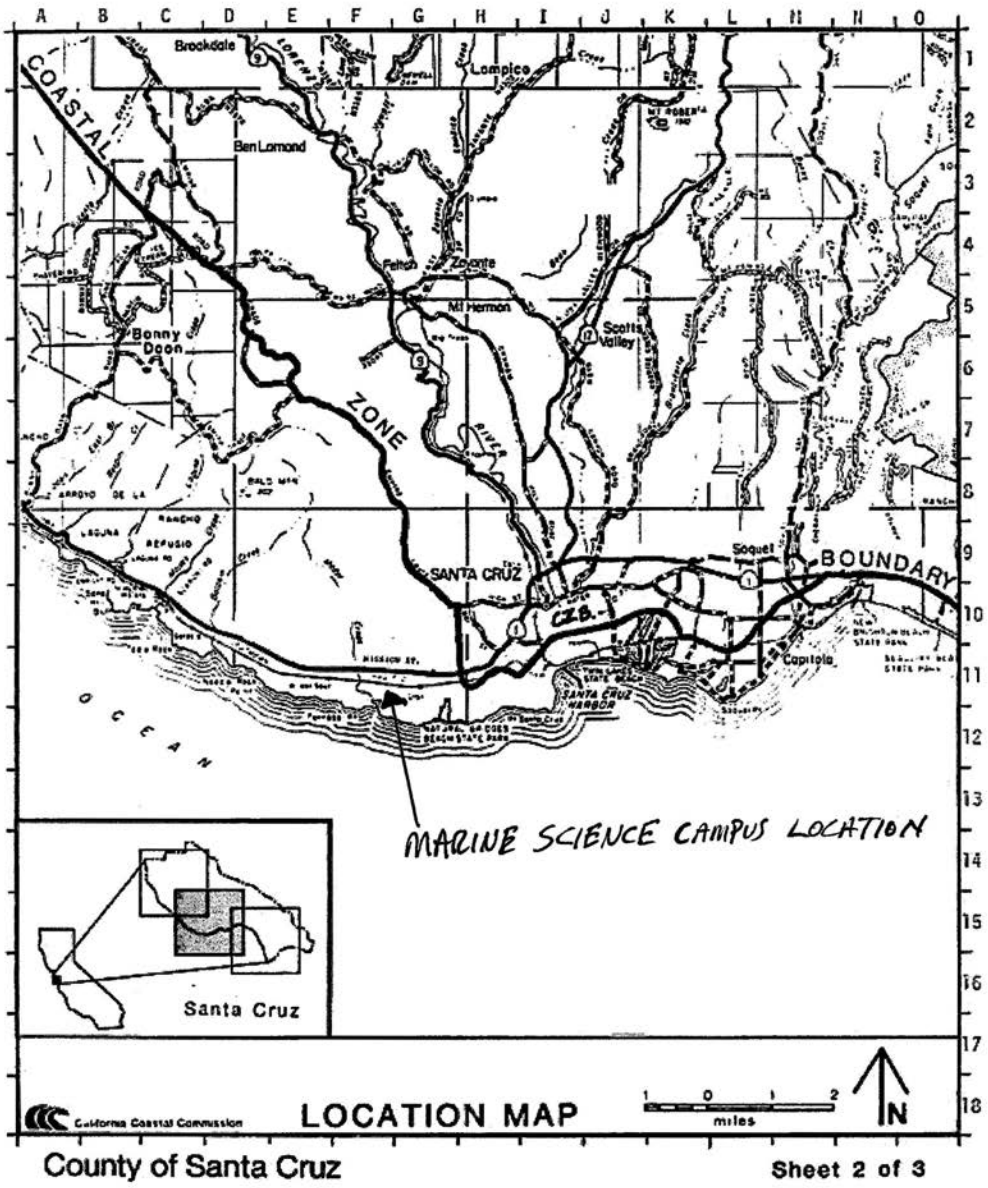
that a permit application is consistent with any applicable requirements of CEQA. This requirement also applies to the Commission's review of NOIDs, based on Regulation Section 13550(d). Section 21080.5(d)(2)(A) of CEQA prohibits a proposed development from being approved if there are feasible alternatives or feasible mitigation measures available which would substantially lessen any significant adverse effect which the activity may have on the environment.

The University, as the lead agency under CEQA, certified a Final EIR (FEIR) for the CLRDP in September 2004. In November 2006, the University certified an addendum to the FEIR to respond to changes in the CLRDP in the time since the original FEIR certification, including changes stemming from Coastal Commission review of the CLRDP prior to certification.[8] In July 2010, the University certified a second addendum to the FEIR, which describes and analyzes the potential environmental effects of the specific activities that would implement Phase 1A of the Specific Resource Plan, and found that Specific Resource Plan Phase 1A is in conformance with the requirements of CEQA.

The Coastal Commission's review and analysis of land use proposals has been certified by the Secretary of Natural Resources as being the functional equivalent of environmental review under CEQA. The Commission has reviewed the relevant coastal resource issues raised by the proposed project and has determined that the proposed project will not have adverse impacts on coastal resources. All public comments received to date have been addressed in the findings above. All above findings are incorporated herein in their entirety by reference.

The Commission finds that the proposed project will avoid significant adverse effects on the environment, within the meaning of CEQA. As such, there are no additional feasible alternatives or feasible mitigation measures available that would substantially lessen any significant adverse environmental effects that approval of the proposed project would have on the environment within the meaning of CEQA. The proposed project will not result in any significant environmental effects for which feasible mitigation measures have not been employed consistent with CEQA Section 21080.5(d)(2)(A).

[8] FEIR Addendum Number 1, dated certified November 29, 2006.



CCC Exhibit A
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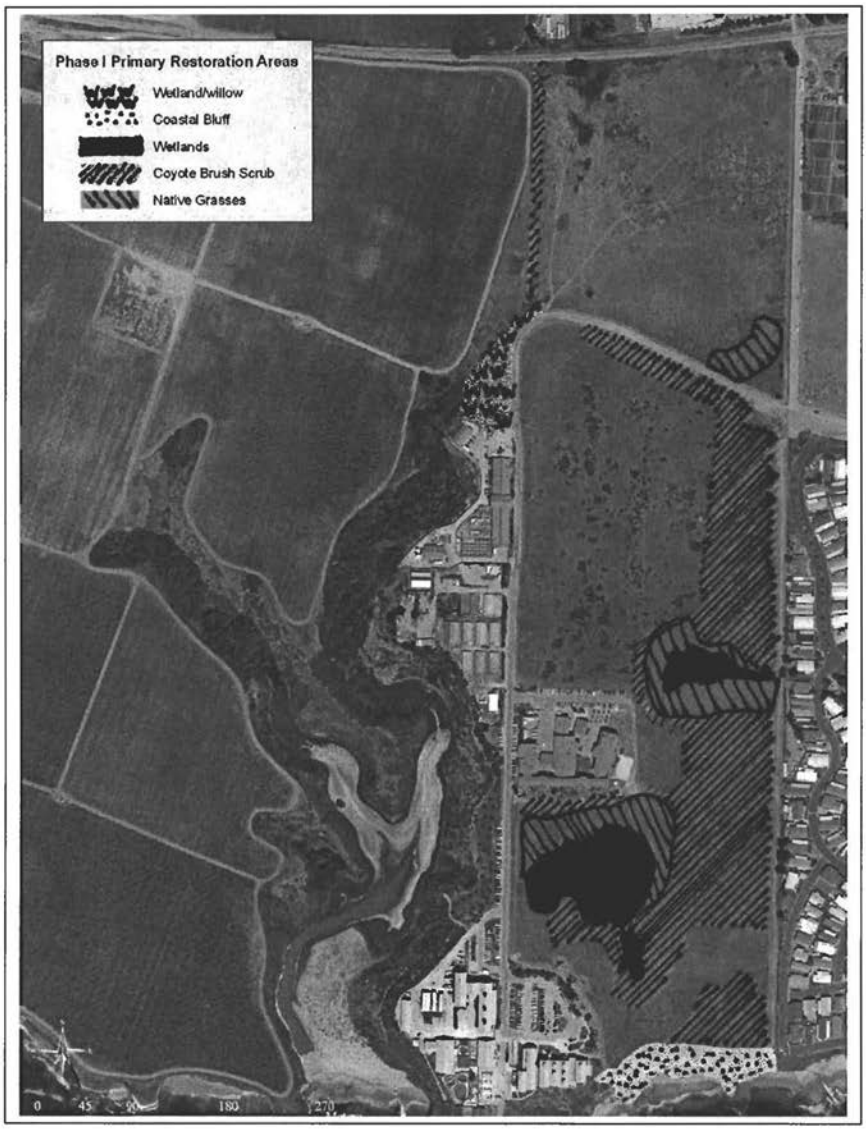

Figure 2. Phase 1A Primary Restoration Areas

CCC Exhibit B
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Appendix 2. Reference site characterization and restoration goals for northern coastal scrub and seasonal wetlands at Younger Lagoon Reserve

Reference site characterization and restoration goals for northern coastal scrub and seasonal wetlands at Younger Lagoon Reserve

Lewis Reed, Megan Hatch, Kira Valenta, and Karen Holl

Draft – August 2011

Introduction

Habitats of the immediate coastal terrace have been highly modified throughout central California. The biologically rich and unique mosaic of coastal scrub, coastal prairie, and seasonal wetlands that was once widespread along the central and northern coast has been severely reduced in extent and remaining stands are often compromised by exotic species and altered disturbance regimes (Ford & Hayes 2007). The effort to restore these communities at Younger Lagoon Reserve (YLR) provides a tremendous opportunity to better understand the ecology and management of these unique and poorly understood communities.

At Younger Lagoon Reserve coastal terrace communities have been degraded by historic cultivation and subsequent invasion by exotic species. The predicted potential vegetation for much of this site is a mosaic of mesic coastal prairie, coastal scrub, and freshwater wetlands but the site has been altered to the extent that there is currently little native representation of these communities on site. Moreover, this site has been subjected to decades of agricultural uses, including cattle grazing and cultivation of Brussels sprouts, activities which strongly negatively affect native cover and species richness (Stromberg and Griffin 1996).

The specific resource plan for the "Enhancement and Protection of Terrace Lands at Younger Lagoon Reserve" (UCNRS 2010) specifies a series of targets for the restoration of specific habitats at YLR. However, these criteria were originally drawn from the earlier Coastal Campus Long Range Development Plan for UCSC Long Marine Laboratory (Appendix A), and then revised based on expert opinion from a Scientific Advisory Committee, rather than determined from data collected at comparable sites. Therefore, an important first stage of the restoration is to collect data at reference sites in order to evaluate whether achieving these targets is a feasible and realistic goal.

Defining restoration targets for communities such as the northern coastal scrub and seasonal wetlands found at YLR is challenging. Little is known about historic composition and community structure on site and high quality local reference sites are scarce. The published literature on these specific habitats is also limited; in the case of seasonal wetlands, data are nearly nonexistent. Establishing a network of reference sites based on a range of qualifying criteria is a useful approach in this scenario. In our

previous work, we focused on reference sites for areas targeted for coastal prairie restoration (Holl & Reed 2010). In this report we seek to characterize a network of reference sites for northern coastal scrub and seasonal fresh water wetlands.

Background

Coastal Scrub

The northern coastal scrub ecosystem is located along the coast from central to northern California and contains a dynamic plant community, with vegetation ranging from herbs to woody shrubs. The most common species present in northern coastal scrub habitats are *Baccharis pilularis* (coyote brush), *Toxicodendron diversilobum* (poison oak), *Artemisia californica* (California sagebrush), and *Lupinus arboreus* (yellow bush lupine) (Ford & Hayes 2007). Variation in community composition in northern coastal scrub habitats is strongly influenced by distance from the coast, by slope, and by aspect. Exposure to salt spray, coastal winds, and fog are abiotic factors that influence the distribution of this habitat and composition within it (Ford & Hayes 2007, Pollock & Dolman 1991). Coastal scrub is becoming an increasingly threatened habitat due to anthropogenic land conversion, such as urban and agricultural development (Ford & Hayes 2007, Pollock & Dolman 1991). Several associations are represented within northern coastal scrub communities (California Natural Diversity Database 2003). In this report we focus on associations with *Baccharis pilularis* because this is the dominant canopy species in existing scrub patches at YLR.

Perhaps the most locally relevant literature on coastal scrub communities is a term paper written by UCSC students Jacob Pollock and Brook Dolman (1991). They sought to define coastal scrub communities from the Pajaro River to Waddell Creek, which almost entirely overlaps our study area. Their report includes 776 observations from nine sites on the first marine terrace and to some extent, in the south, along coastal plains within 400 meters of the ocean. The observations were taken along paced 2-meter point transects in which the plant nearest each point was recorded as well as its nearest neighbor. They also noted environmental factors such as wind, soil type, and slope at each site. Based on these surveys they classified four species as indicators of northern coastal scrub (*Baccharis pilularis*, *Eriophyllum staechadifolium*, *Artemisia californica*,

and *Erigeron glaucus*) and three (including one of the indicators) as pioneer species likely to colonize disturbed coastal scrub sites (*Baccharis pilularis*, *Toxicodendron diversilobum*, and *Achillea millefolium*). They noted in particular, high site to site variability in composition and diversity and a strong influence of wind on vegetation height. The report provides highly relevant localized information about this poorly understood habitat.

Seasonal Wetland

The wetlands at YLR are a particularly unique habitat of high conservation value. Wetlands in general are widely recognized for their habitat value and ecological services (Mitsch & Gosselink 2000). The conservation priority for these ecosystems is evidenced by the extensive regulatory framework in place to protect them (e.g. Coastal Zone Management Act and Clean Water Act) (Good 2010). Seasonal herbaceous wetlands, such as those represented and targeted for restoration at YLR, are among the more poorly understood and least protected of wetland habitats. Because these wetlands are completely dry during some parts of the year, they may be overlooked in wetland delineations or excluded from coarse classification schemes. Because they often exist in scattered patches within other habitats rather than consistently along major water ways, many of them may not warrant protection under section 404 of the Clean Water Act which designates protection of wetlands primarily when they are associated with "navigable water." Nonetheless, these seasonal wetlands provide critical habitat for numerous species and share many of the unique biogeochemical properties of other wetland types (Mitsch & Gosselink 2000).

Literature about the ecology and natural history of seasonal coastal freshwater wetlands is extremely limited. Subtle differences in edaphic conditions such as small scale topography and hydrology may have strong outcomes for potential vegetation as seen in other seasonally variable wetland habitats (Solomeshch et al. 2007, Mitsch & Gosselink 2000). Within our study area along the central coast of California, a variety of landscape attributes could lead to periodic and temporary hydric conditions sufficient to support the characteristic herbaceous wetland vegetation we seek to restore and enhance at YLR. The common use of tiling and other drainage features in farmlands of the central

coast marine terrace suggests that such wetlands may have been common prior to the advent of cultivated agriculture in the area. Our study of reference sites and restoration at YLR has strong potential to broaden our understanding of these unique and increasingly rare communities.

Methods

For each of the target habitats we compiled a list of potential reference sites by consulting local experts (Grey Hayes – Elkhorn Slough Coastal Training Program, Tim Hyland - California State Parks and YLR SAC member, Karen Holl – UCSC and YLR SAC chair). We sought to constrain our site selection to the first marine terrace between Point Lobos in the south and Half Moon Bay in the north. Some exceptions were made for high quality habitats that were geographically close or similar in physiognomy to YLR. After initial site visits were made some reference sites were excluded due to low native cover or limited spatial extent. Table 1 summarizes notes on site reference site histories and current management. At each reference site, vegetation was characterized by surveying along 50-m transects (see modification of transect layout for wetlands discussed below) explicitly placed through vegetation patches with high native cover. The data were collected from 15 April through 6 May 2011.

Northern Coastal Coyote Brush Scrub

Four sites within 100 km of YLR were selected to represent northern coastal scrub: Garrapata State Park and Point Lobos State Reserve at the south end of Monterey Bay, and Año Nuevo State Reserve and Whitehouse Creek north of Davenport. Within these sites we specifically searched for locations that were dominated by *Baccharis pilularis* and that had a topography and distance to the ocean similar to YLR; in particular we chose sites that were relatively flat and had scrub interspersed with grassland. We made this decision based on conversations with Grey Hayes and Tim Hyland who noted stark differences between scrub communities located on strongly sloped topography as compared with relatively flat sites such as YLR. Pollock and Dolman (1991) also noted an apparent influence of distance to the ocean on coastal scrub communities in our study area.

In addition to these reference sites, we surveyed one transect of restored coastal scrub along the bluff at Younger Lagoon. This transect was planted in 2007. It is important to note that the bluff site is sloped and more typical of a dense coastal scrub site (rather than scrub interspersed with grassland), but it does provide one example of the feasibility for coastal scrub restoration.

Fifty meter transects were positioned in the target communities so as to maximize interception of areas with high native cover. Along each transect, we visually estimated absolute herbaceous species composition within a 1 × 0.25 m quadrat laid at a 90° angle from the transect tape. We placed the quadrat every five meters, alternating left and right sides, unless the area was dominated by shrub canopy, in which case we did not measure herbaceous cover. The visual estimates of each researcher were averaged to minimize observer bias (Elzinga et al. 2001). We recorded the species composition in cover class increments of 5%. We used the midpoint of each cover class for data analysis. In order to measure absolute cover of species in the shrub canopy, we recorded the beginning and ending points (to nearest 0.10 m) where the transect intercepted each shrub species. Values for each species were summed by transect prior to analysis. We surveyed a 2-m belt transect along each side of the transect tape to account for any species on site that were not present in the quadrats or intercepted by the line transect.

We monitored three transects at the Año Nuevo, Point Lobos, and Whitehouse Creek sites, and four transects at the Garrapata site. We characterized each site based on the means and variability among transects. Absolute cover values for herbaceous species were converted to relative cover prior to analysis while canopy species were summarized based on absolute cover in each transect. We reported relative cover of herbaceous species and guilds in our 2010 report and here to account for: (1) differences in productivity across reference sites (i.e. total cover at different sites varies inherently due to abiotic conditions) and (2) natural variation in total cover within localized microsites (i.e. total cover may be lower in highly shaded or flooded sites). Species were identified as native or exotic according to Hickman (1993). Richness is reported here as the total native richness observed along a transect including canopy species intercepted by the line transect, herbaceous species observed in the quadrats, and any native species found within the belt transect.

Seasonal Wetland

Originally five sites along the central coast were chosen to be used as reference sites. These included Año Nuevo, Whitehouse Creek, Wilder Ranch (Scaroni unit), Point Lobos, and Light House field. After a preliminary survey, Light House field was removed from the list due to limited potential for running multiple transects through high quality habitat. At each of these locations, we selected sites in areas that appeared to be wetland habitat primarily based on the presence of typical native wetland species. Presence of standing water or evidence of hydric soils was also considered as the goal was to provide a baseline for the best freshwater wetland habitats along the central California coast.

Once again, 50-m transects were positioned within high quality patches so as to maximize interception of areas with high native cover. 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 place every 5 m on alternating sides of the transect. Cover of each species, bare ground, and litter were estimated in 5% intervals and the midpoint used for analyses. 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 (Holl & Reed 2010). After all cover estimates had been made, observers surveyed within 2 m of either side of the transect (a 4 × 50 m belt) for any species not encountered in the frames. Some transects had to be segmented because the wetland habitat did not always stretch 50 meters. In these cases we measured the whole length of the wetland area and then moved the transect 4-m away, parallel, in the same area to complete 50 meters.

Cover and richness analyses were completed in the same way as for coastal scrub habitat except that there was no shrub cover. In addition, we also categorized each species according to its wetland indicator status as listed for California on the USDA PLANTS database (plants.usda.gov). The wetland indicator status is an estimate of a plant species probability of occurrence in wetland habitats. Each plant species has been assigned one of five indicator status categories based on their frequency of occurrence by several federal agencies: obligate (OBL) > 99%, facultative wetland (FACW) = 67 - 99%, facultative (FAC) = 34 - 66%, facultative upland (FACU) = 1- 33%, and upland (UPL) < 1% (Wakeley 2002). This index can be useful for delineating wetlands based on

plant composition and may help us recognize similarities and differences in hydric conditions at our reference sites and YLR.

One of the quantitative methods for defining a wetland and delineating its boundaries based on vegetation criteria is to use the prevalence index. The prevalence index is a weighted average of wetland indicator status for all species in a sample from the plant community, not just a subset of dominants (Atkinson et al. 1993). To calculate the prevalence index, indicator status categories were assigned numerical ratings (i.e., OBL = 5, FACW = 4, FAC = 3, FACU = 2, and no wetland indicator status = 1) and weights were relative abundances of each species in the community. We used the formula:

$$WA = (c_1 * i_1 + c_2 * i_2 + ... + c_m * i_m)/100$$

where c_1, c_2..., c_m are the relative cover estimates for each species in the plot and i_1,i_2...i_m are the indicator status of each species (Atkinson et al. 1993).

Results

Northern Coastal Coyote Brush Scrub

Total shrub cover was fairly consistent within and between sites with the exception of Año Nuevo which had both higher mean cover and higher variance (Fig. 1). All sites had cover greater than the 40% cover requirement specified by the SRP. Canopy composition varied among sites (Fig. 2). *Baccharis pilularis* was common at all sites, which is not surprising since we selected sites with high *B. pilularis* cover, but secondary canopy dominants varied among sites and included species such as *Artemisia californica*, *Eriophyllum staechadifolium*, *Toxicodendron diversilobum,* and *Mimulus aurantiacus*. Average transect level richness across all sites was 10.5 ± 1.6 (SE) and varied greatly among sites (Fig. 3); herbaceous species accounting for an average of 55.2 ± 6.6% (SE) of the species present on a transect.

All sites had important native herbaceous components. The spaces between shrub patches often included native grassland species such as *Nassella pulchra*, *Danthonia californica*, and *Carex harfordii*. Openings within shrub patches were often occupied by

species such as *Scrophularia californica*, *Achillea millefolium*, and *Satureja douglasii*. These were mostly captured in the belt transects and their cover was not quantified since there were few frames that were left uncovered by shrub canopy. For a full species list see Appendix 1.

Seasonal Wetland

Wetland reference sites varied in their native cover and richness (Figs. 4 & 5). Native cover was highest at Point Lobos (94.4 ± 4.6%) and lowest at White House Creek (50.8 ± 10.4%). Transect-level richness ranged from 11.0 ± 1.2 species at Whitehouse Creek to 5.3 ± 1.2 species at Wilder Ranch (Fig. 5). Dominant species that were present at all sites included *Juncus phaeocephalus*, *J. patens*, *J. occidentalis*, *Carex harfordii*, and *Hordeum brachyantherum*. *Juncus balticus* and *Eleocharis macrostachea* were also important in some sites. For full species list see Appendix 1 and recommended species for restoration see Table 2. Transect level wetland indicator scores were consistent among the four reference sites ranging from 3.1±0.2 (SE) at Año Nuevo to 3.4± 0.1 (SE) at Whitehouse Creek (Fig. 6).

Discussion

Northern Coastal Coyote Brush Scrub

The goals detailed in the current restoration plan after three years, include eight appropriate native plant species for the habitat and 40% shrub cover where coyote brush scrub is the primary target. The goal for non-shrub cover is only applied to grassland areas, but we recommend creating a non-shrub cover goal for scrub areas too (described in recommendations below). In the baseline sampling at Younger Lagoon, there is substantial native shrub cover, primarily *Baccharis pilularis*, in many areas, but there is little to no native herbaceous cover in the spaces between the shrubs (Holl & Reed 2010). At reference sites, we found a diverse assemblage of herbaceous species existing in and around the shrubs that dominate these communities. The California Natural Diversity Database (2003) likewise recognizes several northern coastal scrub associations between *Bacharis pilularis* and various native herbaceous species. In surveys of northern coastal scrub communities of Santa Cruz County, Pollock and Dolmon (1991) frequently

encountered herbaceous species, particularly *Scrophularia californica* and *Achillea millefolium*. It is important to note that while the dominant species of northern coastal scrub are shrubs, much of the richness is comprised of herbaceous species and most of the special status species of these communities are herbs (Ford & Hayes 2007). Clearly, coastal scrub restoration efforts should include herbaceous components of these communities.

Cover of native shrub species at the reference sites was consistently higher than the 40% required by the SRP, so we consider this to be a reasonable target. The seven year old coastal scrub at YLR had 90.5% total shrub cover. While this was a slightly different system (located on steep slopes in immediate proximity to the ocean as opposed to extending inland along the more flat portions of the coastal terrace) the achievement of such high cover over within seven years provides some reference for what might be attainable at YLR. We suggest shifting the focus slightly in the direction of herbaceous richness which is likely to be a more difficult restoration goal than shrub cover. We point toward richness here rather than cover because these sites are ultimately intended to be dominated by native shrub cover. Having a richness target for herbaceous species will ensure that these important functional guilds are represented within the restored community. We also recommend working towards diversifying the shrubs, as the current shrub cover at YLR almost solely consists of *Baccharis pilularis* (Holl & Reed 2010).

The goal of eight native plant species also seems feasible at the reserve based on our monitoring at reference sites. Average transect level richness across all sites was 10.5 ± 1.6 species. The transect in the 7-yr old coastal scrub restoration at YLR had 11 native species. It is important to recognize the contribution of both shrubs and herbaceous species to overall richness in the scrub habitat. Herbaceous species comprised over half of the species across all sites at the transect level and shrub richness never exceeded six species per transect (Fig. 3). While we recognize the current richness target of eight species as desirable we further suggest that at least four of the eight species be herbaceous natives observed in our reference sites (Table 1 & Appendix 1)

Seasonal Wetland

The current restoration goals at YLR require that three native species are present and 30% native cover is achieved three years after planting, and 4 native species and 30% cover with signs of recruitment ten years after planting. All the reference sites had >50% cover suggesting that 30% cover is a reasonable target. Relative native cover in wetland 5 at YLR is currently >60% on average, although native cover in wetland 4 is ~10% (Appendix 2). We do not recommend increasing the cover value given the challenge of recreating wetland hydrology at a site that has been heavily used for agriculture. Additionally, YLR has been heavily tilled for much of the past 100 years, whereas there was no evidence or record of tilling at any of the reference sites.

Our observed transect level richness varied among reference sites; however, it was notably higher than the goal stated in the plan with >8 native species per transect in three of the four reference sites (Fig 5). The average five species per transect observed at wetland 5 (Appendix 2) represents the lower end of richness observed at our reference sites. Again, we recommend planting additional species in the existing wetlands to better match observed characteristics of reference sites, although we think that a higher richness criteria across all transects is unrealistic given the extensive past hydrologic alterations at YLR. It is important to note that hydrological alterations to some of the wetlands at YLR would be needed before they are likely to support facultative and obligate wetland species. If this management strategy is not implemented, a reduced success target would be appropriate. The current plan does not specify the scale at which richness should be assessed. We suggest that richness be considered in terms of means and variability at the transect level.

Recruitment (the establishment of new individuals) may not be a good parameter to monitor in this habitat since many of the species are asexually reproducing, rhizomatous species and, therefore, we recommend focusing on cover and transect-level species richness.

Calculating the wetland indicator status of reference sites, as well as wetlands 4 and 5 at YLR, provides an interesting insight into the degree to which each of these wetlands host obligate and facultative wetland species. We do not, however, recommend establishing criteria for overall wetland indicator status for two reasons. First, this index

is largely determined by abiotic factors that may be difficult and inappropriate to create at YLR. Second, there are many non-native species that are obligate or facultative wetland species, so restoration goals should focus on native cover and richness. However, selecting potential native species for planting at YLR that are obligate or facultative wetland plants can help guide selection of species to include as part of wetland planting efforts.

Recommendations

Modifications to and Notes on Sampling Protocol

Few changes were made to the previously established protocol. Two that were made include:

- In the shrub transects we measured absolute cover of canopy species meaning that an observer could report the same transect segment for two or more species if those species were overlapping.
- In wetland sites where suitable habitat patches were too small to fit a continuous 50-m transect, the entire length of habitat was surveyed and the remaining transect length was surveyed four meters from the transect parallel to the starting segment.

One other point worth reiterating is that we have reported herbaceous cover values in all habitat types as relative cover to correct for difference in total cover in different quadrats and sites.

Restoration Goals

We make the following recommendations regarding the restoration targets:

- The current cover targets for each habitat seem reasonable based on comparison with reference sites.
- Richness should be assessed at the transect level in all habitats at YLR to provide a spatial context for target numbers.
- In the coyote brush scrub areas, the current goal of eight species is appropriate but we note from our surveys the importance of herbaceous species within the scrub

habitat and further specify that at least four of the eight species be herbaceous natives.

- The current target for wetland richness is reasonable but we recommend planting additional species in areas with appropriate hydrological conditions to better meet levels observed in reference sites (5-7 species per transect).
- We recommend adding several species to the potential restoration pallet based on species lists from reference sites summarized in Tables 2 & 3 and Appendix 1.

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Figures

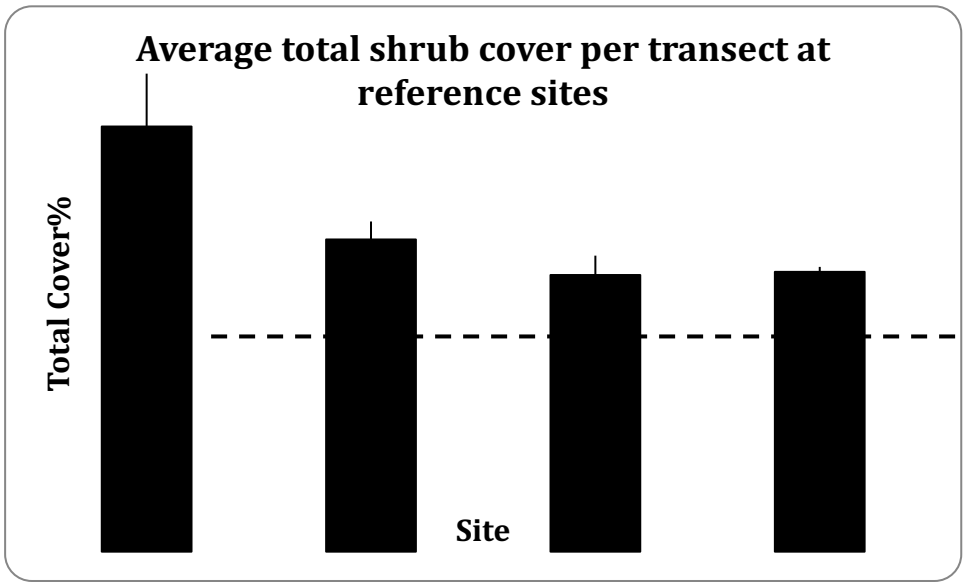


Figure 1. Mean absolute shrub cover at each coastal scrub reference site compared to the current target for YLR restoration. The dashed line indicates the current shrub cover target. Error bars represent one standard error.

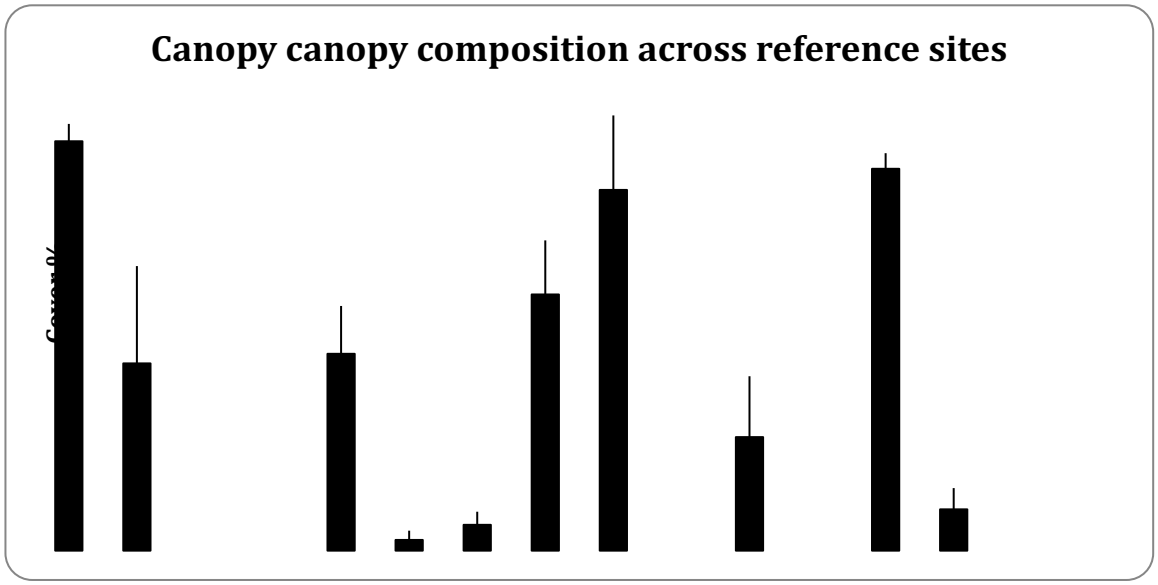


Figure 2. Comparison of canopy composition at each of the coastal scrub reference sites showing high site to site variability. BACPIL = *Baccharis pilularis*. TOXDIV = *Toxicodendron diversilobum*. MIMAUR = *Mimulus aurantiacus.* ARTCAL = *Artemisia californica*. Values are absolute cover. Error bars represent one standard error

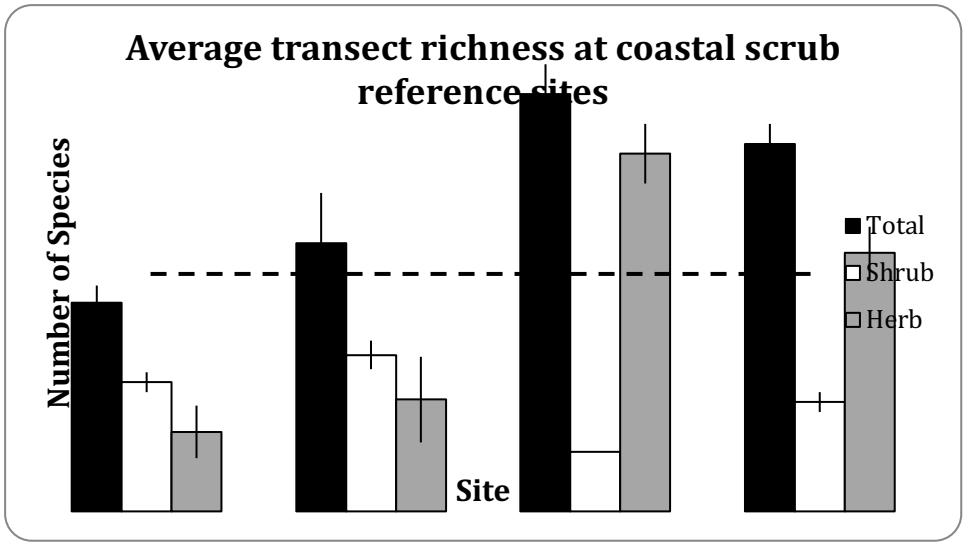


Figure 3. Transect level richness and contribution of shrubs and herbs to richness at each coastal scrub reference site. The line indicates the current stated richness target for coastal scrub. Error bars represent one standard error.

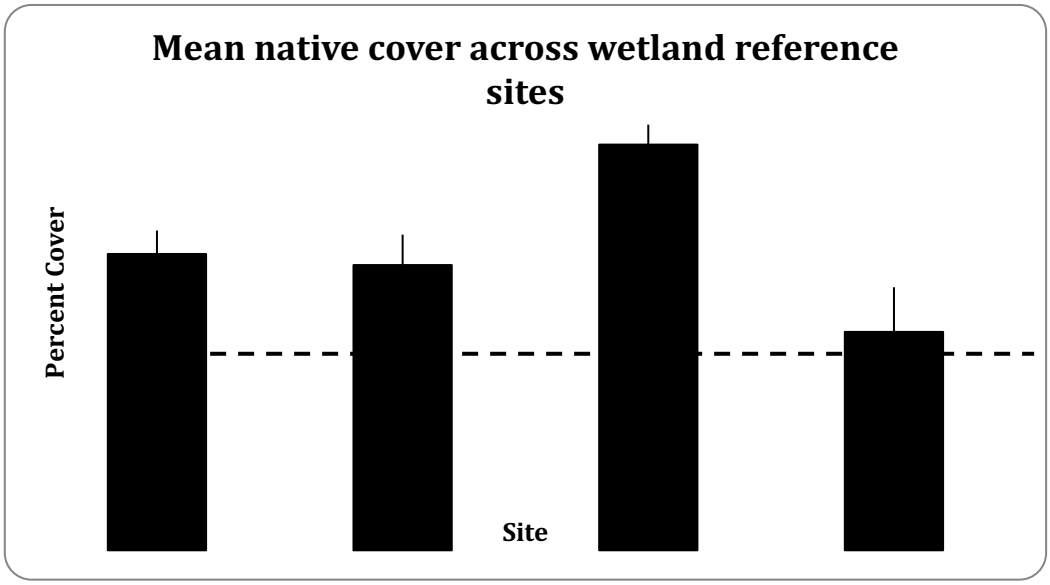


Figure 4. Relative native cover at seasonal wetland reference sites. The line indicates current target native cover in wetlands at YLR. Error bars represent one standard error.

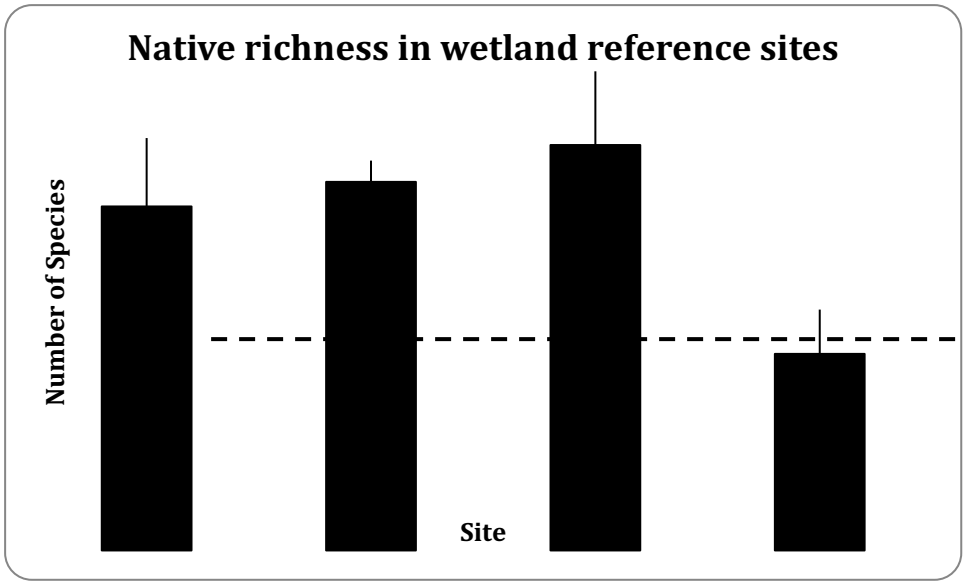


Figure 5. Native richness at seasonal wetland reference sites. The line indicates current target native richness in wetlands at YLR. Error bars represent one standard error.

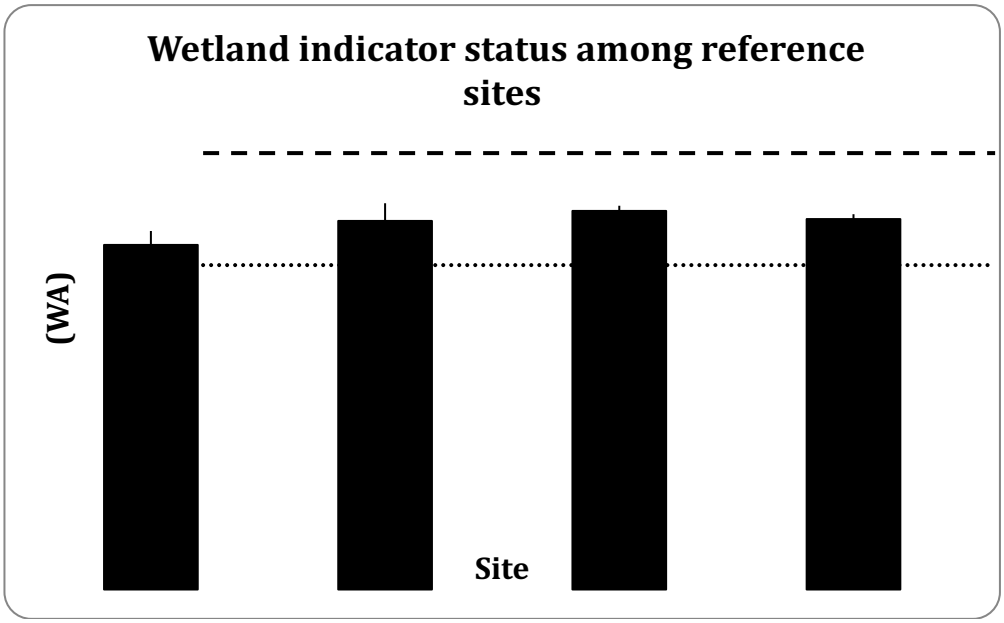


Figure 6. Wetland indicator status (WA) for each wetland reference site. The flat upper dotted line indicates current WA in wetland five at YLR while the fine lower dotted line indicates current WA for wetland 4. Error bars represent one standard error.

Table 1. Reference site history and management notes based on communications with Jeff Frey and Portia Halbert of California State Parks.

Site	History Notes	Current Management	Native Cover	Native Richness
Garrapata Scrub	Grazed until 1984. No evidence or record of tilling.	None.	72.6±4.2 %	9.0± 1.7
Point Lobos Scrub	State Park land since 1933. No known history of cultivation. Middens and other artifacts in the area indicate heavy past use by Native Americans.	Monterey pine removal in 2010. Burned a few times in the last 15 years.	64.3±4.5 %	14.0±1.0
Año Nuevo Scrub	State Park land since 1950's. Site is believed to have been historically cultivated. There are mature Monterey pine groves nearby and Monterey pine stumps and coast live oak seedlings in the survey area. This site may be in the early seral stages of a woodland succession.	None.	98.9±12.3 %	7.0±0.6
Whitehouse Creek Scrub	No evidence or record of tilling.	Gorse removal, pine removal, eucalyptus removal.	65.1±1.2 %	12.3±0.7
Point Lobos Wetland	State Park land since 1933. No known history of cultivation. Middens and other artifacts in the area indicate heavy past use by Native Americans.	Burned a few times in the last 15 years.	94.4±8.0 %	10.0±0.6
Wilder Ranch Wetland (Scaroni Unit)	No evidence or record of tillage, no evidence of modified hydrology, grazed until ~1988.	Spot treatment for Harding grass by herbicide or hand pulling.	68.9±9.4 %	5.3±1.2
Año Nuevo Wetland	State Park land since 1950's. No evidence or record of tillage but trenching around	None.	66.3±12.3 %	9.3±1.9

	the site indicates past manipulation of hydrology.			
Whitehouse Creek Wetland	No evidence or record of tilling. Evidence of trenching and other drainage modifications nearby but not in surveyed areas.	Spot treatment for Harding grass and gorse by herbicide or hand pulling.	50.8±18.0 %	11.0±1.2

Table 2. Recommended species for coyote brush scrub restoration pallet. The asterisks indicate species that are considered particularly appropriate for restoration at YLR based on their commonness among reference sites or presence at sites with environmental conditions particularly similar to YLR. GEO=Geophyte, GRM=Graminoid, PF=Perennial Forb, PG=Perennial Grass, S=Shrub.

Species	**Functional Group**
*Chlorogalum pomeridianum**	GEO
Calochortus uniflora	GEO
Triteleia hyacinthina	GEO
Carex harfordii	GRM
Juncus occidentalis	GRM
Juncus patens	GRM
Juncus phaeocephalus	GRM
*Achillea millefolium**	PF
Aster chilensis	PF
*Camissonia ovata**	PF
Cirsium brevistylum	PF
*Satureja douglasii**	PF
*Scrophularia californica**	PF
Sidalcia malviflora	PF
Sisyrinchium bellum	PF
*Bromus carinatus**	PG
Deschampsia cespitosa	PG
*Elymus glaucus**	PG
Hordeum brachyantherum	PG
*Nassella pulchra**	PG
*Artemisia californica**	S
Baccharis douglasii	S
*Baccharis pilularis**	S
Eriophyllum staechadifolium	S
Heteromeles arbutifolia	S
Lotus scoparius	S
*Mimulus aurantiacus**	S
*Rubus ursinus**	S
*Rhamnus californica**	S

Table 3. Recommended species for seasonal wetland restoration pallet. The asterisks indicate species that are considered particularly appropriate for restoration at YLR based on their commonness among reference sites or presence at sites with environmental conditions particularly similar to YLR. AF=Annual Forb, AG= Annual Grass, PF=Perennial Forb, PG=Perennial Grass, PGRM=Perennial Graminoid, AG=Annual Gramminoid.

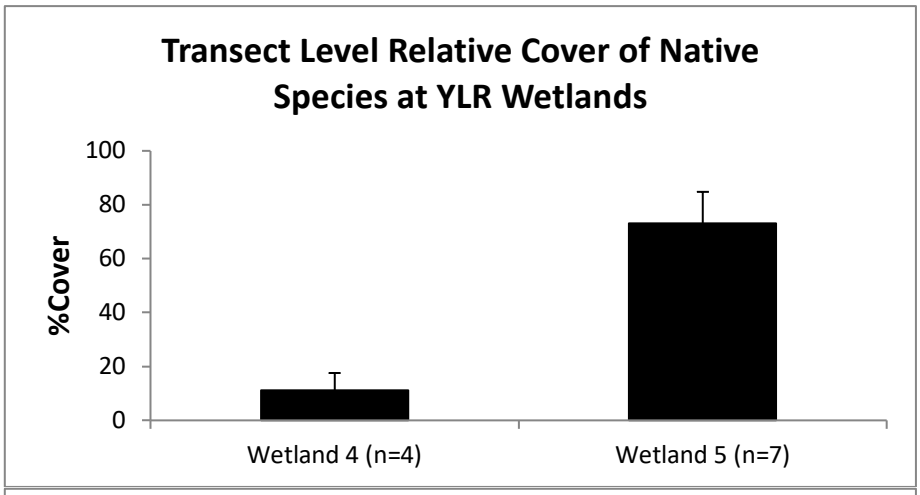
Species	**Wetland Indicator Status**	**Growth Form**
*Aster chilensis**	FAC	PF
*Juncus patens**	FAC	PGRM
*Juncus bufonius**	FACW	AGRM
*Distichlis spicata**	FACW	PG
*Hordeum brachyantherum**	FACW	PG
Carex subbracteata	FACW	PGRM
Juncus mexicanus	FACW	PGRM
*Juncus phaeocephalus**	FACW	PGRM
Eryngium sp.	NL	AF
*Rumex salicifolia**	NL	PF
*Deschampsia cespitosa**	NL	PG
Carex dudleyi	NL	PGRM
*Juncus occidentalis**	NL	PGRM
*Scirpus cernuus**	OBL	AGRM
*Scirpus koilolepis**	OBL	AGRM
*Baccharis douglassii**	OBL	PF
*Euthamia occidentalis**	OBL	PF
*Carex harfordii**	OBL	PGRM
*Eleocharis macrostachya**	OBL	PGRM
*Juncus balticus**	OBL	PGRM
*Lilaea scilloides**	OBL	AGRM

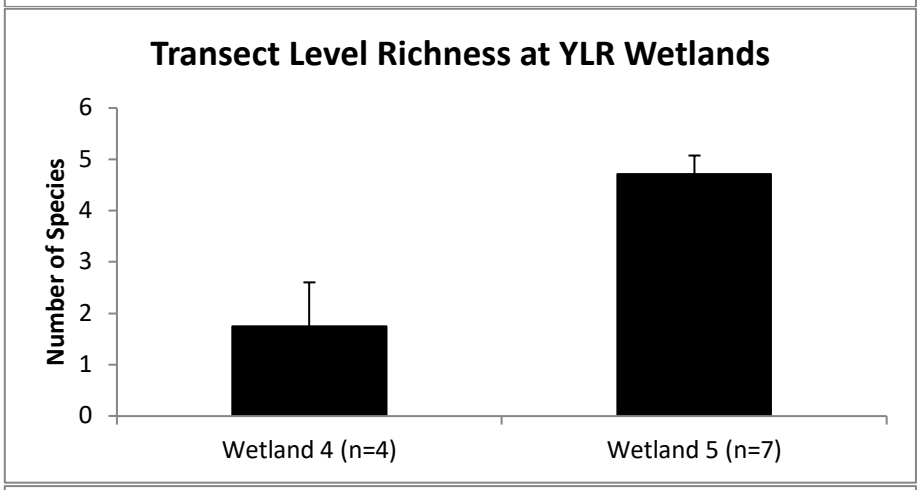
Appendix 1. Complete list of species identified during spring 2011 surveys.

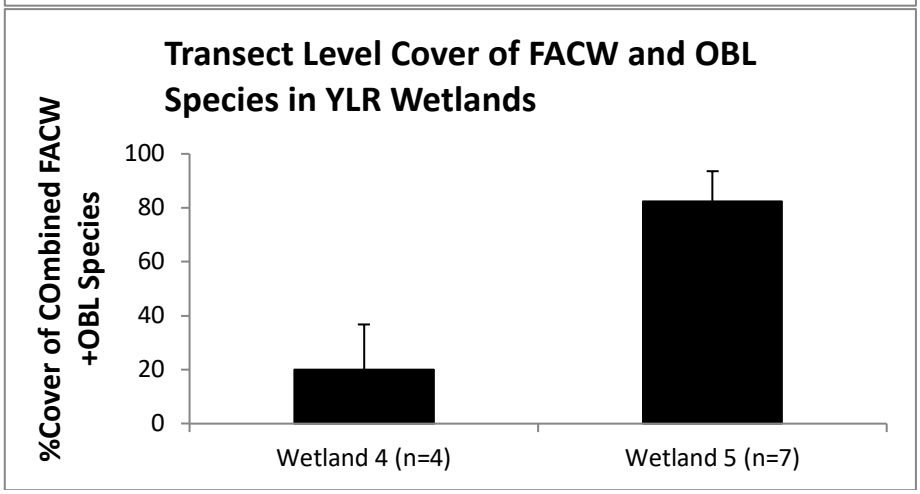
Species	Functional Group	Origin
Epilobium ciliatum	AF	N
Sanicula maritima	AF	N
Stachys adjugoides	AF	N
Anagalis arvensis	AF	E
Cirsium vulgare	AF	E
Erodium cicutarium	AF	E
Geranium dissectum	AF	E
Lythrum hyssopifolium	AF	E
Picris echioides	AF	E
Sonchus asper	AF	E
Stellaria media	AF	E
Vicia sp.	AF	E
Galium sp.	AF	?
Aira caryophyllea	AG	E
Briza minor	AG	E
Bromus diandrus	AG	E
Bromus hordeaceus	AG	E
Bromus madritensis	AG	E
Hordeum murinum ssp. *leporinum*	AG	E
Lolium multiforum	AG	E
Polypogon monspeliensis	AG	E
Vulpia myuros	AG	E
Chlorogalum pomeridianum	GEO	N
Calochortus uniflora	GEO	N
Triteleia hyacinthine	GEO	N
Carex dudleyi	GRM	N
Carex harfordii	GRM	N
Carex subbracteata	GRM	N
Eleocharis macrostachya	GRM	N
Juncus balticus	GRM	N
Juncus bufonius	GRM	N
Juncus capitatus	GRM	N
Juncus mexicanus	GRM	N
Juncus occidentalis	GRM	N
Juncus patens	GRM	N
Juncus phaeocephalus	GRM	N
Scirpus cernuus	GRM	N

Scirpus koilolepus	GRM	N
Achillea millefolium	PF	N
Aster chilensis	PF	N
Camissonia ovata	PF	N
Cirsium brevistylum	PF	N
Eryngium sp.	PF	N
Euthamia occidentalis	PF	N
Gnaphalium sp.	PF	N
Rumex salicifolia	PF	N
Satureja douglasii	PF	N
Scrophularia californica	PF	N
Sidalcia malviflora	PF	N
Sisyrinchium bellum	PF	N
Plantago lanceolata	PF	E
Rumex acetosella	PF	E
Rumex crispus	PF	E
Convolvulus sp.	PF	?
Bromus carinatus	PG	N
Deschampsia cespitosa	PG	N
Distichlis spicata	PG	N
Elymus glaucus	PG	N
Hordeum brachyantherum	PG	N
Nassella pulchra	PG	N
Holcus lanatus	PG	E
Phalaris aquatica	PG	E
Artemisia californica	S	N
Baccharis douglasii	S	N
Baccharis pilularis	S	N
Eriophyllum staechadifolium	S	N
Heteromeles arbutifolia	S	N
Lotus scoparius	S	N
Mimulus aurantiacus	S	N
Rhamnus californica	S	N
Rhus ovata	S	N
Rubus ursinus	S	N
Salvia melifera	S	N
Toxicodendron diversilobum	S	N
Pinus radiata	T	N
Quercus agrifolia	T	N

Appendix 2. Results from vegetation mapping at wetlands 4 and 5 for comparison. Values are means ± 1 SE for relative cover, species richness, and wetland indicator status. Note that differences in cover values between Yiangou paper and here are due to reporting absolute cover (Yiangou paper) and relative cover (here) in order to make values comparable to reference sites.







Appendix 3. Monitoring Photos

YLR Terrace Photopoint #1. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 200°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

YLR Terrace Photopoint #1. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 240°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide

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YLR Terrace Photopoint #1. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 290°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

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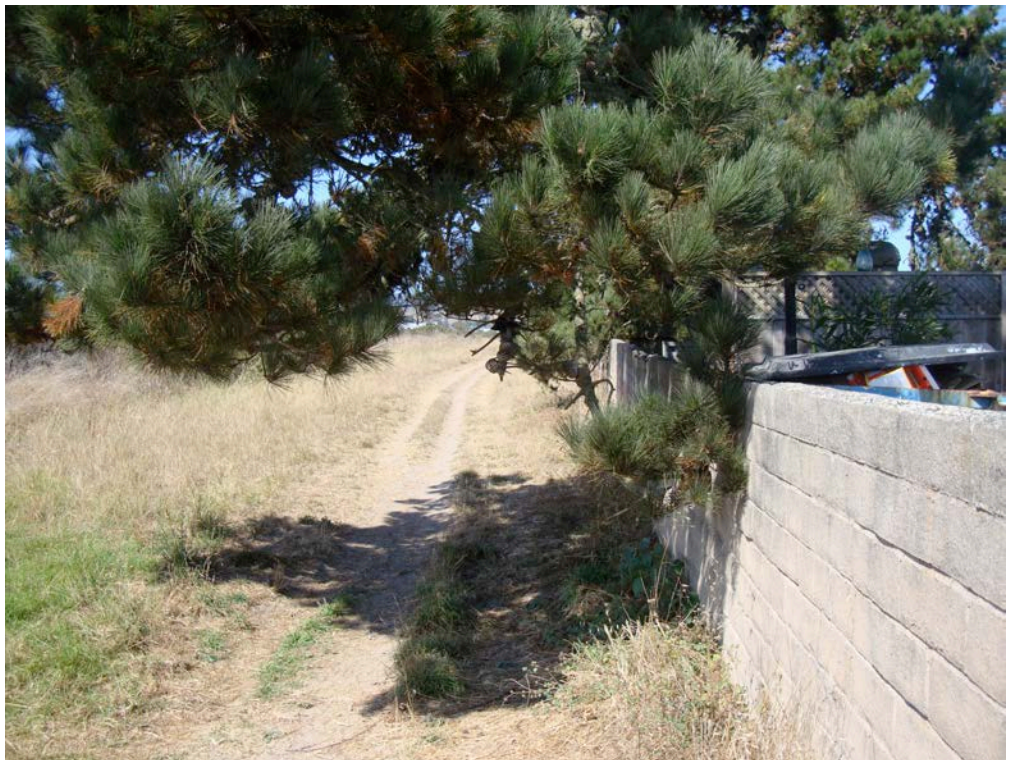

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YLR Terrace Photopoint #3. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 60°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

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YLR Beach Photopoint #3. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 345°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

YLR Beach Photopoint #3. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 15°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

YLR Beach Photopoint #4. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 335°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

YLR Beach Photopoint #4. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 25°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

YLR Beach Photopoint #4. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 45°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.

YLR Beach Photopoint #4. July 28, 2011. Photographer: Elizabeth Howard. Bearing: 110°. Camera: Sony Cyber-shot Carl Zeiss Vario-Tessar 13.6 Megapixels, lens fully extended wide.