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North Campus Open Space Restoration Project

Monitoring Report: Year 6, December 2023

UC SANTA BARBARA
Cheadle Center for Biodiversity
& Ecological Restoration

Restoration and associated monitoring for the North Campus Open Space Restoration Project are made possible with funding from the following agencies: USFWS, State Coastal Conservancy, Wildlife Conservation Board, California Department of Fish and Wildlife, Ocean Protection Council, Department of Water Resources Urban Streams Program, California Natural Resources Agency Urban Greening program, CalTrans, California State Parks, State Coastal Conservancy Wetlands Recovery project community grant program, Environmental Mitigation Program through CalTrans and California Department of Natural Resources with funding through California Climate Initiative, Proposition 1, Proposition 84. Additional funding has come from smaller contributions from SoCalGas, the UC Santa Barbara Associated Students' Coastal Fund, California Native Plant Society, local foundations, and individual donors as well as funding from the County of Santa Barbara and the City of Santa Barbara which supported the planning and design process. (Cover photo from December 2023)

EXECUTIVE SUMMARY

Born out of a vision shared by the local community, students, faculty, researchers, and state and federal agencies, the North Campus Open Space (NCOS) restoration project has created more than 40 acres of estuarine and palustrine wetlands that historically comprised the upper portion of Devereux Slough that was filled in the mid-1960s to create the Ocean Meadows golf course. The project is also restoring more than 60 acres of upland habitats that include native grassland, coastal sage scrub, riparian, oak chaparral woodland, vernal pools and patches of annual wildflowers in clay and sandy soils. Led by UC Santa Barbara's Cheadle Center for Biodiversity and Ecological Restoration (Cheadle Center), the NCOS project involves collaboration with other UCSB departments, faculty, student, and local community groups as well as contractors and government agencies. In addition to wetland and upland habitat restoration, the project has successfully reduced flood levels, supports threatened and endangered species, incorporates public access, and provides educational opportunities. Ancillary benefits of the project include carbon sequestration, preservation of local genotypes, and protection of adjacent ecological values and infrastructure through a design that integrates sea level rise considerations.

Currently in its sixth year of implementation and with planting of the project site essentially complete, project efforts are now focused primarily on research projects, and supporting special status species such as the federally endangered Ventura marsh milk-vetch (*Astragalus pycnostachys* var*. lanosissimus*) and the newly established salt marsh bird's beak (*Chloropyron maritimum var maritimum*). This report describes the methods and results of monitoring for the six years of the project, with a primary focus on the sixth year (2022-23). This work documents the progress of the project and supports longer-term research and monitoring programs. Results from the sixth year of monitoring show this project to have been successful and exceeded our expectations thanks to the dedication of staff, students and contracted organizations. Here follows a brief summary of the topics covered in this report.

Photo-Documentation

Comprehensive photographic documentation of the transition and development of the entire NCOS project site has been carried out on a quarterly basis since December of 2016. This report describes the methods for capturing photos and includes a map of the photo point locations on the project site, a link to a full set of photos linked to the map, along with a set of representative photos in Appendix 1. These photographs provide a visual record of the transformation of the site from a bare landscape at the end of 2017 to a completely established salt marsh and well-developed perennial grassland on the Mesa by the summer and fall of 2020. 2022 photos show the addition of the outdoor classroom and 2022 photos represent the opening of the mesa trail and further plant establishment. In the 2023 photos we can see evidence of the cultural burn in the mesa area.

Vegetation

All habitats/plant communities have 0% cover of high-risk invasive species in the sampled quadrats as determined by the California Invasive Plant Council (Cal IPC). All habitats met the year 6 success criteria for total vegetation cover, relative percent native cover, and native biodiversity when interpreted within the context of the site except the Fresh/ Brackish Marsh which was 78/80 percent cover. The

ponds were inundated for much longer than other years due to the higher than average rainfall causing low vegetation cover in the center of the pond. The high rainfall made vegetation cover the easiest criteria to meet, however the high rainfall also causes a huge growth of all vegetation including non-natives.

Overall, the results from year 6 monitoring show consistent improvement over time. There have been 89 native species identified in the quadrat transect monitoring over the past six years. One species of interest is the Ventura marsh milk-vetch (*Astragalus pycnostachys* var *lanosissimus*). NCOS is home to the largest population of the federally endangered Ventura marsh milk-vetch growing with no irrigation or protection from herbivory. In the 2023 monitoring year, the Ventura marsh milk-vetch habitat continued to reproduce prolifically at the primary site and at several additional locations at NCOS where seeds were distributed. It has come to the point in the VMMV maturity where the first seedlings planted at the beginning of restoration are slowing down and getting affected by insects and disease, but the new seedlings from the last year are thriving and reaching reproductive age.

Multiple other species recognized by the California Native Plant Society as special status species are establishing robust populations, including southern tarplant (*Centromadia parryi* var. *australis*) and Parish's glasswort (*Anthrocemum subterminale)*. This year also marked the beginning of a salt marsh birds beak experiment. Seed was acquired from Carpinteria Salt Marsh through our partners at Tidal Influence and USFWS and planted across 8 experimental sites. Results show that birds beak thrives in sandy soil on site.

Wildlife

In the sixth year of wildlife monitoring at the NCOS project we documented tidewater goby throughout the NCOS portion of Devereux Slough as well as at the mouth. Monitoring was conducted in June while there was still significant water in the system. No burrowing owls overwintered at NCOS. The western snowy plover had a successful breeding season on the beach at Coal Oil Point, which is their preferred habitat, so we do not expect a large population of these shorebirds to choose to nest in the estuary where resources are not as abundant as on the beach. Belding's savannah sparrows have been spotted on site for the last 6 years with evidence of breeding that includes nests with eggs and mating songs in 2022-23.

Waterfowl, aerial insectivores and shorebirds had a significant increase from year 5 to year 6. Other species stayed the same or slightly decreased. This is likely because the rainfall across the whole county created many other ideal wetland habitats for birds to use.

Hydrology and Water Quality

Several components of our monitoring program are focused on the hydrology and water quality of Devereux Slough and the tributaries that feed into the restored estuary. Monitoring data collected in year six indicate that the estuary continues to perform as expected in terms of an increased water-holding capacity, reduced flood levels and an increased tidal prism. The 2023 water year was especially wet given the many atmospheric rivers that passed through Santa Barbara. The effect that the estuary has on surrounding lands was recognized by FEMA in September 2021. FEMA officially issued a LOMR (Letter of Map Revision), which formally documents a change to the flood hazard zone of an area. The flood hazard zone is the extent of a particular landscape subject to a 1% chance of

flooding in a year. This was exciting news, as reducing flood impact as a mitigation to climate change was one of the major goals of this project. Water nutrient concentration monitoring was paused in 2023, though water nutrient concentration from previous years can be found in the earlier reports. All other water quality and quantity monitoring continued.

There were 38 days with more than 0.1 inches of precipitation in the 2023 water year and 8 days with more than an inch of precipitation. The largest single storm was on January 8th producing 3.9 inches of rain in a single day. Due to the many heavy storms and continual rain the slough opened 4 times in the 2023 water year. It opened for the first time on January 1st at 12:30 am and closed for the season on approximately March 30th. The 2023 water year was the wettest year since 2010 with a total of 32.18 inches of rain.

Table 1. Total rainfall of 2023 and average distribution of rainfall throughout the year in Santa Barbara County. Average values are retrieved from Santa Barbara County Water Resources. (n.d.). Historical Monthly Rainfall Trends – Countywide. https://www.countyofsb.org/2322/Monthly-Yearly-Rainfall.

Month	% of 2023 rainfall	Santa Barbara County average % of rainfall by month	2023 rainfall (Inches)
October	0 %	4 %	0.0
November	3 %	10 %	1.0
December	18 %	15 %	5.4
January	36 %	20 %	11.4
February	9 %	21 %	3.1
March	31 %	18 %	9.73
April	0 %	7 %	0.0
May	2 %	2 %	0.7
June	1 %	0 %	0.3
July	0 %	0 %	0.0
August	0 %	0 %	0.7
September	0 %	1 %	0.0

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1. INTRODUCTION AND PLANTING SUMMARY

The University of California, Santa Barbara (UCSB) North Campus Open Space (NCOS) is a 136-acre site located northwest of the main university campus. Bordered by the UC's Coal Oil Point Nature Reserve to the south and the City of Goleta's Ellwood Mesa/Sperling Preserve to the west, the NCOS site expands upon a contiguous block of open space and wildlife habitat, with residential neighborhoods to the north and east. Funded by federal, state and local agencies, the NCOS project's goals include flood reduction, wetland and upland habitat restoration, support for threatened and endangered species, public access and the provision of educational opportunities. Ancillary benefits of the project include carbon sequestration, denitrification, preservation of local genotypes, and protection of adjacent ecological values and infrastructure through a design that integrates sea level rise considerations. The focal point of the project is the restoration of more than 40 acres of estuarine and palustrine wetlands that were historically part of Devereux Slough and were filled in the mid-1960s to create the Ocean Meadows golf course. The project is also restoring more than 60 acres of upland habitats that include native grassland, coastal sage scrub, riparian, oak chaparral woodland, vernal pools and patches of annual wildflowers in clay and sandy soils. Led by UC Santa Barbara's Cheadle Center for Biodiversity and Ecological Restoration (Cheadle Center), the NCOS project involves collaboration with other UCSB departments, faculty, student, and local community groups as well as contractors and government agencies.

The formal, "on the ground" restoration of NCOS began in February 2017 with the removal of most of the exotic trees on the former Ocean Meadows golf course. The grading and movement of soil on the site occurred from April to October 2017. This project aims to restore local genotypes, rare plant communities and hydrologic function to the site. To do so, over 350,000 cubic yards of soil were removed from the upper arms of Devereux Slough to restore historic wetland functions. Excavated soils removed from the wetland were recycled and placed on the adjacent land to restore the historic mesa. This was followed by the construction of a multi-use trail, two bridges, and a boardwalk and culvert crossing that were completed in June 2018. Descriptions of the target habitats to be restored and/or enhanced are provided in Section 3 of the Restoration Plan. The plan recognizes that changes or modifications in the locations and extents of habitats could occur depending on the post-grading conditions of the site. Minor changes made in some of the vegetation communities are described in the year 4 monitoring report (https://escholarship.org/uc/item/7bq618m8). A map of the NCOS project in Figure 1 reflects the current extent of habitats being restored and enhanced along with the as-built elevation contour lines (one-foot interval), constructed trails, bridges and crossings.

Year 1 Planting Summary

During the first year of restoration (September 2017 – October 2018), more than 185,000 locally sourced native plants comprised of 45 species were installed across 40 acres, covering 75 percent of the Peripheral Upland Mosaic and Salt Marsh habitats. In December 2017, an inoculum containing seeds and dormant invertebrates from existing and adjacent vernal pools was spread in the eight vernal pools created on the Mesa area of NCOS. In addition, throughout the winter and spring of 2018, grasses such as *Hordeum brachyantherum* ssp. *brachyantherum* and *Stipa pulchra* were planted along the margins and between the vernal pools. Approximately 25 percent (3.9 acres) of the Native Perennial Grassland habitat (the eastern portion) was drill seeded with 4 lbs. per acre of *Stipa pulchra*

seed in October 2017, and the remaining area (9.1 acres) was drill seeded with 6 lbs. per acre of seed in October 2018. More than 100 tree saplings comprised of six species were installed in the new riparian habitat along the Whittier Channel in the northeastern area of NCOS, and while no planting occurred in the other target habitats, a small number of native plants sprouted voluntarily in many areas of the project site.

Year 2 Planting Summary

The second year of restoration had an addition of more than 100,000 plants and added 15 more species to the project site, bringing the overall total to nearly 290,000 individual seedlings of 60 species planted. The primary planting of the Salt Marsh and Transitional habitats as well as the Peripheral Uplands was completed. An additional 33 trees and more than 2,100 understory plants (20 species) were installed in the riparian habitats along Phelps Creek and Whittier Channel. 95 coast live oak (*Quercus agrifolia*) trees were planted in pockets along the north facing slopes of the Mesa (identified as Oak Woodland/Chaparral in the map in Figure 1) as well as in a few locations in the Peripheral Uplands near Phelps Creek. Planting of the Coastal Sage Scrub habitat along the Mesa slopes occurred in the summer and fall.

Year 3 Planting Summary

Planting efforts in the third year of the project (2020) focused on continuing the development of Coastal Sage Scrub (CSS) communities around the site. Nearly 7,000 plants comprised of 13 CSS-associated species were planted in this area. Other areas of focus included the Peripheral Uplands in the northwestern arm (5,300 plants from 14 species) and additions to sections of the transitional/high salt marsh (4,100 plants from 5 species). We also enhanced the grassland habitat on the Mesa by seeding and planting nearly 7,000 seedlings of five wildflower species, and we established the Discovery Trail and Visitor Plaza pollinator garden with more than 4,000 plants from 51 species. In total, we added more than 30,000 plants and 21 species in year three, bringing the overall total for the project so far to more than 320,000 plants comprised of 81 species.

The successful establishment of the largest population (more than 400 individuals) of the federally endangered Ventura marsh milk-vetch (*Astragalus pycnostachys* var*. lanosissimus*) is an exciting achievement in third year of the NCOS project. Eighty-five percent (404 of 495) of the originally planted seedlings survived to reproductive age and 75 seedlings from the 2020 cohort of offspring that successfully germinated in the spring were thriving in the fall. A detailed report on the establishment and monitoring of Ventura marsh milk-vetch at NCOS is available on the Cheadle Center eScholarship webpage (escholarship.org/uc/item/91f243kg).

Year 4 Planting Summary

There were over 20,000 plants and 29 species planted in year 4 bringing the overall total to over 342,000 seedlings planted. Of all the seedlings planted, 80% were planted in the Mesa area focusing on the vernal pool habitat and 17% were on the salt marsh transition. The federally endangered Ventura marsh milk-vetch (*Astragalus pycnostachys* var*. lanosissimus*) continues to thrive and has expanded its boundaries through natural seeding.

Construction of the donor funded NCOS Field Lab has been completed and now serves as a location for faculty and students to complete research focused on NCOS. The lab has been used as a location for sorting and identifying aquatic macroinvertebrate and phytoplankton.

Year 5 Planting Summary

The Duttenhaver outdoor classroom and refurbished parking lot project construction concluded in March 2022 and supports environmental education at all levels. There were an estimated 15,000 plants from 25 different species planted in 2022 bringing the total to over 365,000 plants and 71 species. Of all the seedlings planted 70% were on the mesa with a continued concentration on the vernal pool habitat and 20% were planted at Whittier in association with the outdoor classroom planting. Throughout the whole project about 30% of all seedlings were planted on the mesa.

Year 6 Activities Summary

The 2022-2023 year work focused on weed management, environmental education, research, monitoring and implementation of our first prescribed cultural burn of the 14 acres of native grassland. The burn incorporated members of the Chumash tribes and integrated values associated with traditional burns to enhance native wildflowers and geophytes as one of the primary goals. Seeds have been spread and many bulbs planted pre and post burn to support this vision. The feldspar plots that were established in the wetland after the grading to mark elevation were re-monitored by Jennifer King's lab to assess sediment accretion over 5 years and to study the nature of the carbon sequestered in the sediment. This information will help inform us about the ability of the newly restored system to keep up with sea level rise through natural sediment accretion.

Report Structure and Content

This report describes the NCOS monitoring program, methods and protocols, and includes data primarily from the sixth year of monitoring (October 2022 to October 2023).

Monitoring and research efforts as well as data presented in previous reports that are not included in this year 6 report include the development of the bathymetry of the wetland, carbon sequestration, trail use surveys, tick presence, bird recording, bat species surveys, water nutrient concentrations and greenhouse gas fluxes of the wetland. Past reports and independent research projects completed by students and staff can be found at our escholarship website. If funding is secured, we plan to re-measure the elevation cross-sections of the wetland again in 2024.

The monitoring efforts described herein include:

- Photo-documentation
- Vegetation, including trees
- Wildlife, including bird surveys, special status species, aquatic arthropods, small rodents, and reptiles
- Hydrology, water quality and nutrient flux of Devereux Slough. The restored vernal pools on the Mesa, and groundwater at NCOS

Key data and related information about the project are posted on the EcoAtlas website (www.ecoatlas.org/regions/ecoregion/statewide/projects/9462) and dryad (https://doi.org/10.25349/D9RP7X). Monitoring reports and associated data are also available through eScholarship (escholarship.org/uc/ccber) and Cheadle Center's website (www.ccber.ucsb.edu/ecosystem/management-areas/north-campus-open-space).

Figure 1. Map of the habitats/vegetation communities at the North Campus Open Space restoration project.

2. PHOTO-DOCUMENTATION

Photo-documentation was established in the NCOS Restoration Plan as one of the methods for monitoring the progress of the project, including the development of the wetland and changes in the size and cover of vegetation being restored across the different habitats. The locations of photo points were initially established, and the first set of photos were taken in December 2016, prior to the start of the project. Subsequent photo-documentation monitoring has been conducted on a quarterly basis.

At up to 46 points distributed across the site, one to seven photographs are taken depending on what is required to capture all aspects of the site that are visible from each point (see Figure 2 for a map of the photo monitoring points). Each photo is labeled with the photo point number, direction (N, SE, W, etc.), and the date the photo was taken (*e.g*. NCOS_08_N_20190417). Photo point numbers ending with the letters ‘a’ and ‘b’ are where photos are taken of the same general area but from different views or angles (*e.g*. 09a and 09b, 28a and 28b).

Through the early stages of the restoration project, we made a few minor revisions in the number and location of photo points and the frequency of photos at some points. In year 3 of the NCOS monitoring, we added a point (number 44) and additional photos at points 36 and 38 to include better coverage of the development of the Visitor Plaza and Discovery Garden as well as forthcoming changes to the parking lot and area west of the ROOST maintenance building.

Comparative photos from four points from year one and year six are included in Appendix 1 of this report. The complete set of photos can be accessed from an interactive web map here, and full details of the data set, including methodology, revisions, and urls for the web map and complete set of photos are available in a data description document on the Cheadle Center eScholarship webpage (escholarship.org/uc/item/5zf6d6q3).

Figure 2. Map of photo monitoring points at the North Campus Open Space restoration project.

3. VEGETATION

Vegetation Monitoring Methods

The establishment of native vegetation is usually the foundation and the most visible and commonly measured component of a restoration project. The modified monitoring plan and schedule is outlined in Table 2. The goal of this monitoring is to record changes in the absolute cover of native and non-native vegetation in each habitat by species as well as the percent cover of thatch, bare ground, and other cover such as mulch/woodchips or algae, all of which can provide habitat in one form or another for different organisms and potentially increase the level of biodiversity across the site. Habitats comprised primarily of low growing vegetation, such as grasslands and wetlands, are monitored with quadrat transects (QT), and habitats with taller vegetation such as riparian woodland are monitored with point-intercept transects (PIT). Trees planted by NCOS staff and volunteer groups such as *My Children's Trees* are monitored individually. The vegetation success criteria for the project are assessed at the end of this report section.

Quadrat Transects (QT)

In the eight habitats dominated by short or low-growing vegetation permanent transects are monitored with a one-square-meter quadrat, alternating between the left and right side of the transect line every 3 meters. Quadrats are spaced 3 meters apart and the transects are 30-meters long. The first quadrat is centered to the left of the starting point at each transect, which results in 11 quadrats for each 30-meter transect. For the vernal pools, given their small extent relative to other habitats and plant communities, the quadrats are placed every two meters. The length of transects and number of quadrats across vernal pools and the seasonal pond depend on the overall extent of these habitats. The quadrats are subdivided into 100 ten-centimeter squares and Daubenmire cover classes are used to estimate the cover of each species in the quadrat. We also record the percent of the quadrat that contains thatch (dead vegetation from the previous year's growth), and other cover types such as algae, moss, biocrust, mulch, erosion control netting, and black plastic for weed control.

Point-Intercept Transects (PIT)

This method is used for vegetation communities with larger growth forms, such as Coastal Sage Scrub (CSS) and Riparian. It records the presence of species in the canopy (above two meters) and sub-canopy (below two meters) at every (1) meter along the permanent, 30-meter transect. Including the starting point, this results in a total of 31 points per transect. The vertical "point" at each meter along the transect is represented by a two-meter tall, half-inch diameter wood dowel with a laser attached to the top for extending the point through the canopy. Each species that touches or intersects the dowel in the sub-canopy is recorded once and each species that intersects the laser in the canopy is recorded once. Therefore, if an individual tree intersects the point in both the canopy and subcanopy it is recorded present for both strata. When no vegetation crosses the point in the sub-canopy, other cover such as thatch or mulch or bare ground is recorded.

For analysis of point intercept data (pg 23) absolute cover of native and non-native plants in the point-intercept transect plots is measured by tallying the proportion of sample points (31) that natives or non-natives, respectively, were encountered at least once in each transect; the mean of all transects is presented. Total plant cover is also presented as the total tally because each sample point along the

transect may have several different plant species intercepts at a single point; thus total tally is the sum of all intercepts by native and/or non-native species; the mean across all transects is presented. Relative plant cover is the sum of all plant intercepts (hits) and the proportion of native and non-native out of the total number of plant hits. Relative cover is also presented as the proportion of all intercept data including both plants and substrate (e.g. bare dirt, litter, etc).

Table 2. Vegetation monitoring plan for the habitats/vegetation communities at the North Campus Open Space restoration project. Figure 3 contains a map of the habitats and monitoring transects. Methods include PIT (point intercept transect) and QT (quadrat transect).

Habitat / Vegetation Community	Acres	Method	Survey Month	Number of Transects / Quadrats and Trees
Grassland and Mosaic Habitats				
Perennial Grassland (Mesa)	16.8	QT	July	8 / 88
Peripheral Upland Mosaic (Grassland/Scrubland/Bioswale)	8.8	QT	June	7 / 77
Sandy Annuals	1.2	QT	June	1 /11
Wetlands				
Fresh-Brackish Wetlands: Remnant Brackish Marsh & New Seasonal Pond	1.5	QT	July/August	1 / 11 1 / 15
Vernal Pools (8 pools)	1.3	QT	June	8/ lengthwise transects- minimum 5 quadrats per pool.
Salt Marsh – Restored low (6-8 ft.) and mid (8-12 ft.) elevations, and Transitional/High Salt Marsh at 10-15 and 15-18 feet in elevation	38.7	QT	August	6-8 ft. 7 / 77 8–12 ft. 7 / 77 10-15 ft. 5 / 55 15-18 ft. 3 / 33
Salt Marsh – Pre-existing Remnant	0.9	QT	August	2 / 22
Shrublands and Woodlands				
Coastal Sage Scrub (CSS) Mosaic (incl. Chaparral / Oak Woodland)	10.7	PIT, Individual Trees	June/July	7/217 points, ~ 105 trees
Riparian Woodland – Pre-existing	1.5	PIT	June/July	2/62 points, 9 trees
Riparian Woodland – New (Phelps Creek and Whittier Channel)	1.7	PIT, Individual Trees	June/July	2/62 points, ~ 130 trees
Open Ground / Sparsely Vegetated				
Sand Flat/Snowy Plover Habitat	3.2	QT	September	2 / 22

Transect Locations & Orientations

Figure 3 contains a map of monitoring transects and habitats/vegetation communities. Transect locations were established by generating a randomly placed starting point using GIS. Points were kept a minimum of 60 meters apart and 10 meters from the edge of the habitat/plant community. A 90-square-meter grid was used to divide the larger habitats (CSS Mosaic, Perennial Grassland, Peripheral Upland Mosaic, Salt Marsh, Transition/High Salt Marsh, and the Sand Flat) into similarly sized sections, each separated by a 10-meter buffer, and the randomly placed transect starting points were generated within these sections. This helped provide a more spatially balanced distribution of monitoring transects in these larger habitats/plant communities.

The direction or bearing of transects was determined by a combination of factors: the distance of the starting point from the edge or boundary with adjacent habitats; the width of the habitat area around the point (if 30 meters or less, then the transect direction would be limited to run approximately parallel to the edges of the area); and if the transect would cross any features where disturbance should be avoided (*e.g*. sediment accretion or carbon sequestration monitoring plots).

Trees

All trees planted at NCOS are monitored annually by measuring the height and diameter at breast height (DBH), and assessing tree vigor using a rating scale of 1 to 4, where 1 = high vigor with new growth; 2= medium vigor with some stunting, yellowing, or less vigorous growth; 3= poor, appearing nearly dead or dying; and 4 = dead. We estimate the height of tall trees by reading a six-foot long pole marked with inches and feet that is held upright above a height of seven feet.

Data Collection & Management Methods

At the start of each monitoring season, all surveyors are trained on cover estimation and species identification. Transect and quadrat data are recorded using the ESRI Survey123 app on tablets, while the individual tree monitoring data is recorded in Google Sheets. The data are reviewed as soon as possible after collection and any issues such as data entry errors, missing or duplicate quadrats are corrected through consultation with field staff. All data are collated, reviewed, managed, summarized, and plotted using Microsoft Excel and R Studio.

Figure 3. Map of the vegetation monitoring transects at the North Campus Open Space restoration project.

Vegetation Monitoring Data

Native Vegetation Summary

The extreme precipitation events experienced in the 2023 water year presented a uniquely difficult environment to control non-native species. Many non-native species thrive in moist environments and while overall native cover stayed the same or increased in most habitats, the relative cover decreased due to the increase in non-native cover caused primarily by the annual grass, Italian wild rye (*Festuca perennis*), and bristly ox-tongue (*Helminthotheca echioides*). Annual precipitation (32.2 in) was nearly double the average rainfall and was distributed fairly evenly throughout the winter which diluted the salinity in the salt marsh which typically excludes most invasive species. While we strive to eliminate all non-native species, many permitting agencies now consider annual Mediterranean grasses to be naturalized components of California ecosystems. Thus, as we set priorities with our limited resources under these wet conditions, we focused on habitat-altering weeds more than annual grasses. In addition, because we knew we were going to do the cultural burn of the perennial grassland, we did not mow the grassland to reduce annual grass cover because we wanted to fully burn the thatch to open the site for the germination of geophytes and other native forbs.

The overall vegetation cover increased in every habitat except the freshwater pond- due to inundation. Native species cover was 50% or more of every habitat except sandy annual habitat and perennial grasslands where absolute native cover was 48% and where interstitial open spaces are important for germination of annual wildflowers.

Overall, there were 69 native species identified site wide in quadrat monitoring in 2023. The native presence of the new and pre-existing riparian area increased in 2023. All salt marsh habitats were similar to the year 5 results with only slight fluctuations of native and non-native distribution. Salt grass, *Distichlis spicata,* was recorded the most frequently in 2023. This species appeared in 204 of 528 quadrats or 39%. Pickleweed, *Salicornia pacifica*, was the second most common.

Non-Native Vegetation Summary

Non-native vegetation cover increased in year six due to the heavy rainfall. Total non-native diversity has decreased from 78 species to 65 species in 2023 site wide.

Seasonal brackish marsh had the largest increase in non-native abundance followed by the sandy annual site. The seasonal brackish marsh non-native cover was mainly *Atriplex prostrata* which has been, considered a naturalized species, and is native to other parts of the US. It is not ranked by CalIPC as a species of concern. Most of the other habitats had similar non-native species cover compared to past years.

Cortaderia selloana, ranked as “High” on the Cal-IPC inventory was successful eradicated from all habitats with no instances in 2023 vegetation monitoring.

Italian rye grass, *Festuca perennis* (ranked “Moderate” by Cal-IPC), continues to be the most frequently recorded invasive species found in 54% of quadrats. *Festuca perennis* has always been prevalent at NCOS, however it has increased greatly over the years. It appeared in 136 quadrats the first year, 174 the second year 185 the third year, 233 quadrats in the fourth year, 251 in year 5 and 284 in year 6. Two other non-natives recorded frequently include *Polypogon monspeliensis* and *Bromus hordeaceus*.

Table A2.2 in Appendix 2 contains a figure of all non-native species recorded in each habitat in each year

Bare Ground, Thatch, and Other Cover

With the significant increase in vegetation cover recorded in all monitoring years, the relative cover of bare ground decreased to below 25% percent in all restored habitats, except the Sand Flat (70%). The sand flat habitat is expected to retain bare ground in the form of mud flats or salt flats

The relative cover of thatch, which we define as dead vegetation from the previous year's growth (some of which was mowed or trimmed), fluctuates from year to year in most habitats. Thatch relative cover decreased or stayed the same in all habitats in 2023.

Other cover, which primarily consists of mulch, erosion control wattles, and/or dried algae decreased in most habitats. As with bare ground, this decrease is expected as vegetation continues to develop and increase in cover. In habitats such as the Seasonal Fresh/Brackish Pond, Remnant Brackish Marsh, and Restored Salt Marsh, we may see the amount of dried algae cover fluctuate each year, depending on the amount of rainfall and/or the rate that water in the ponds and wetlands evaporates.

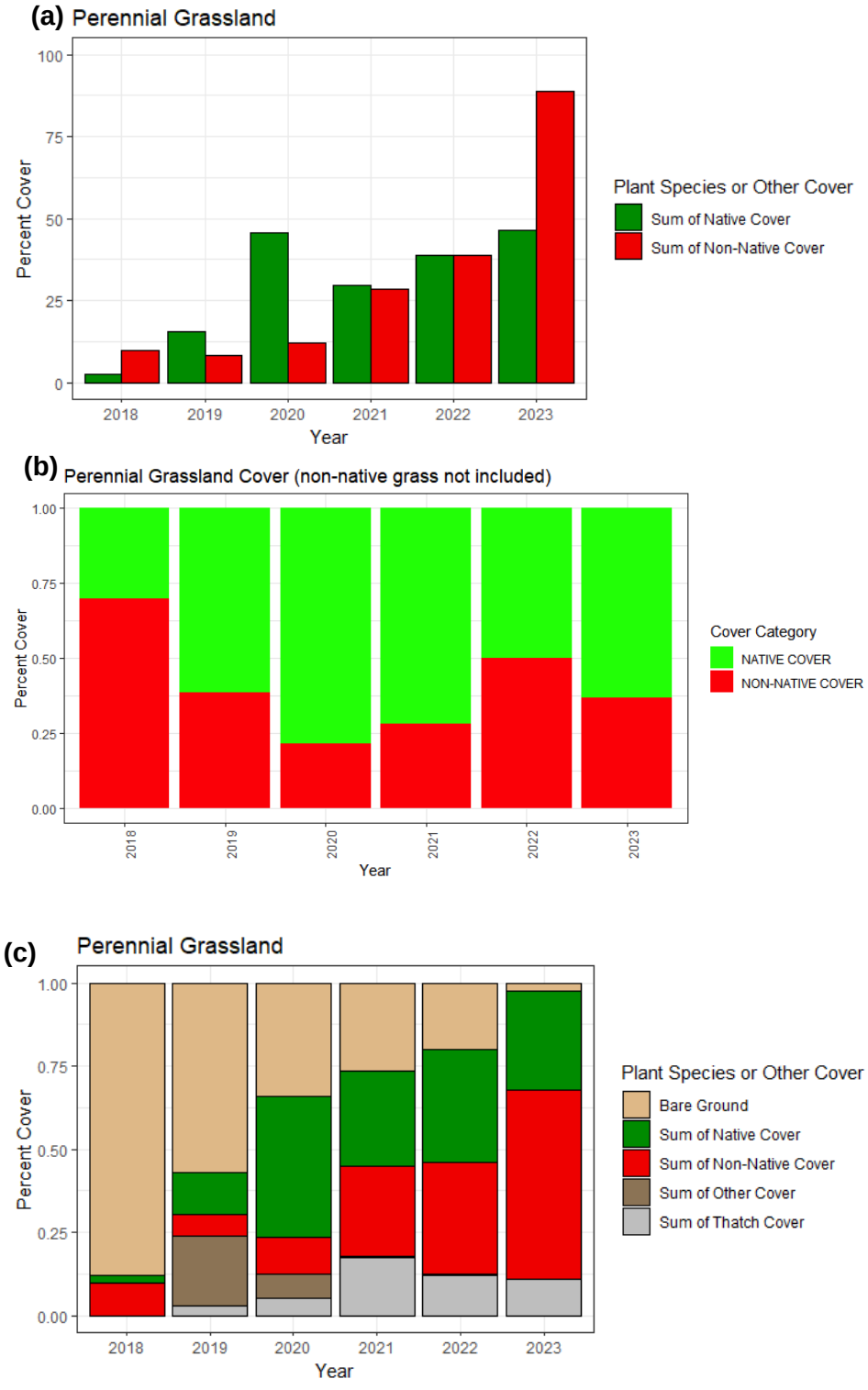


Figure 4. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation (annual non-native grass species are not included in graph b), and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Native Perennial Grassland habitat at the North Campus Open Space restoration project.

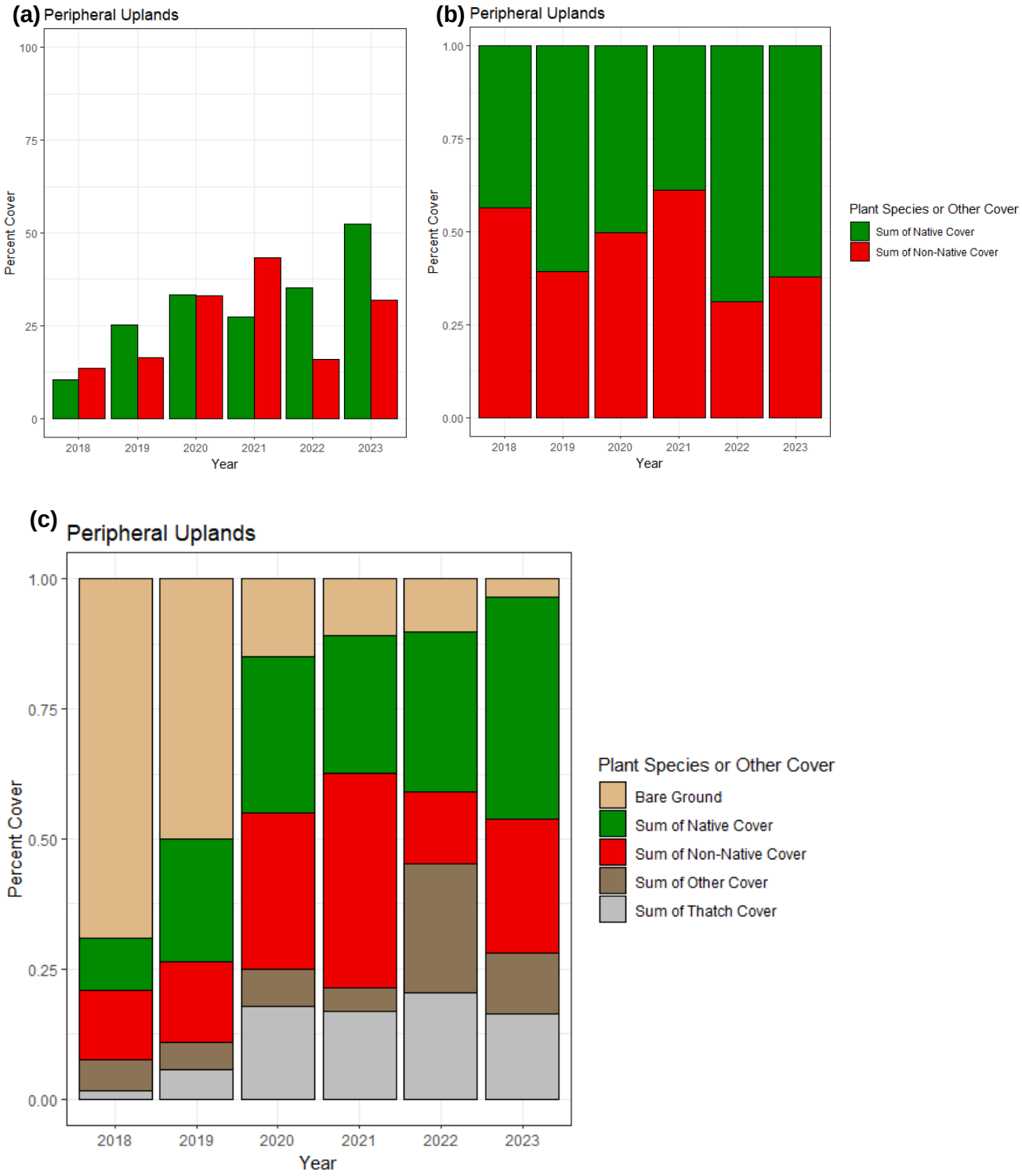


Figure 5. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Peripheral Upland Mosaic habitat at the North Campus Open Space restoration project.

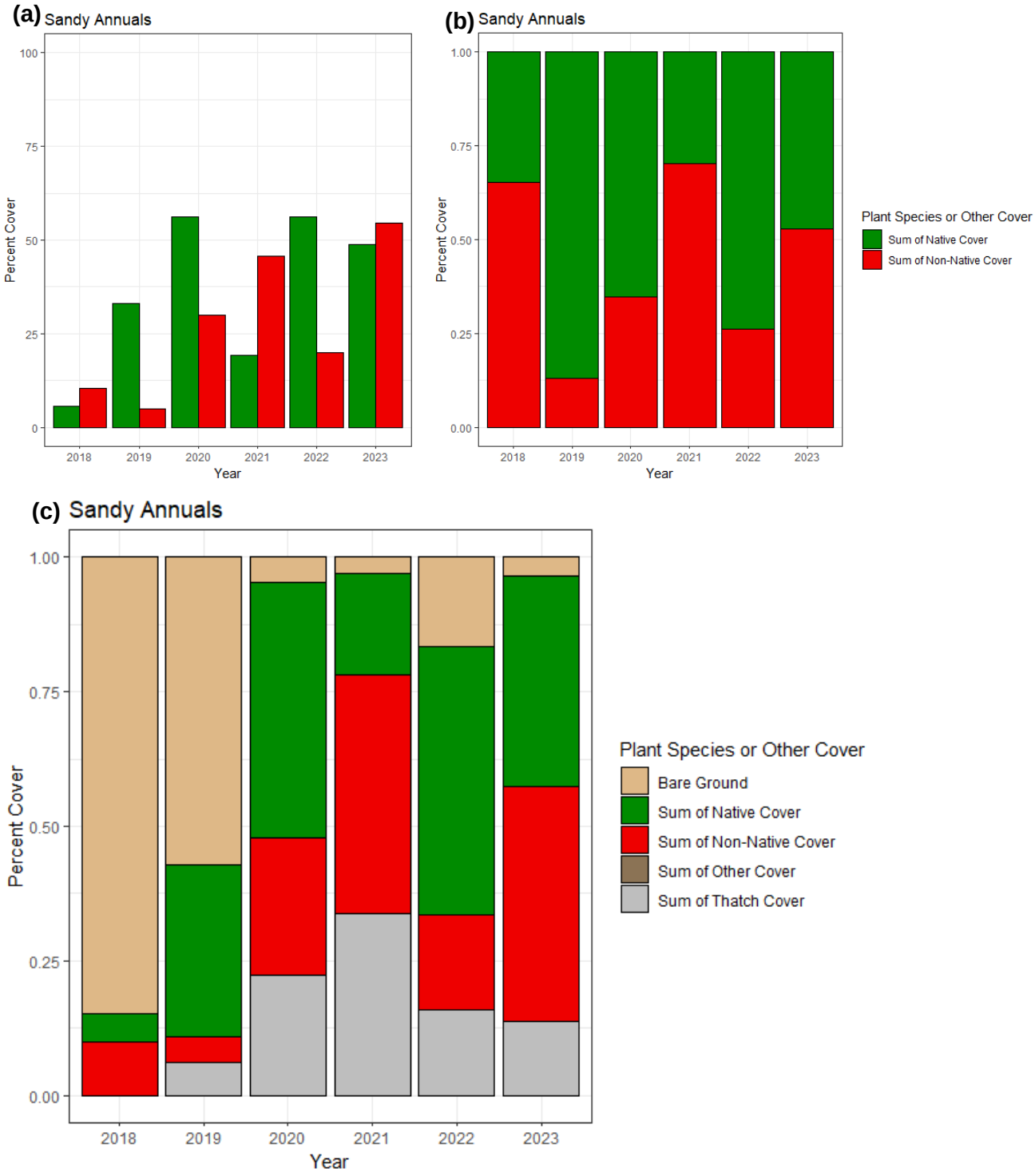


Figure 6. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Sandy Dune Annuals habitat at the North Campus Open Space restoration project.

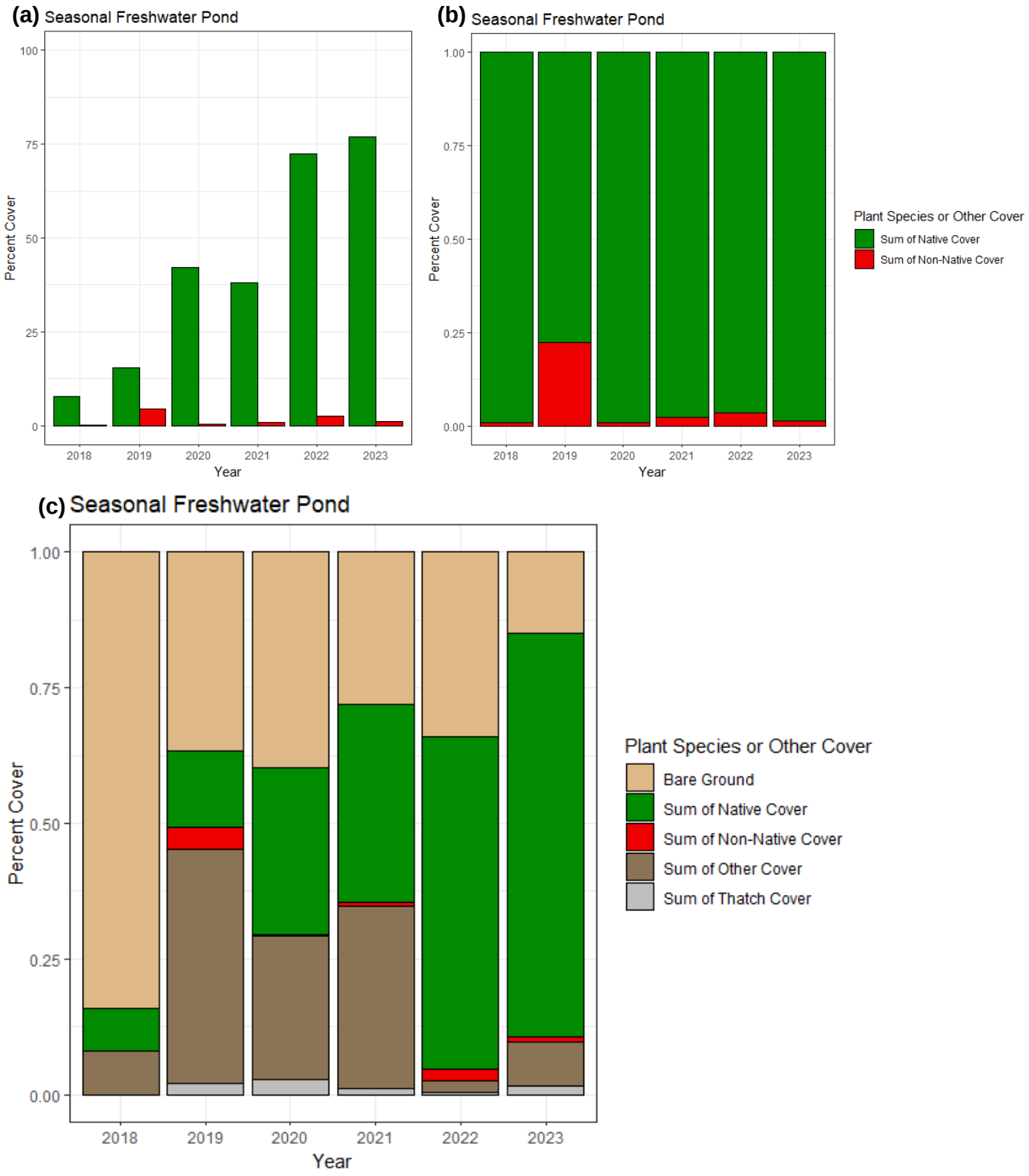


Figure 7. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Seasonal Fresh/Brackish Pond habitat at the North Campus Open Space restoration project.

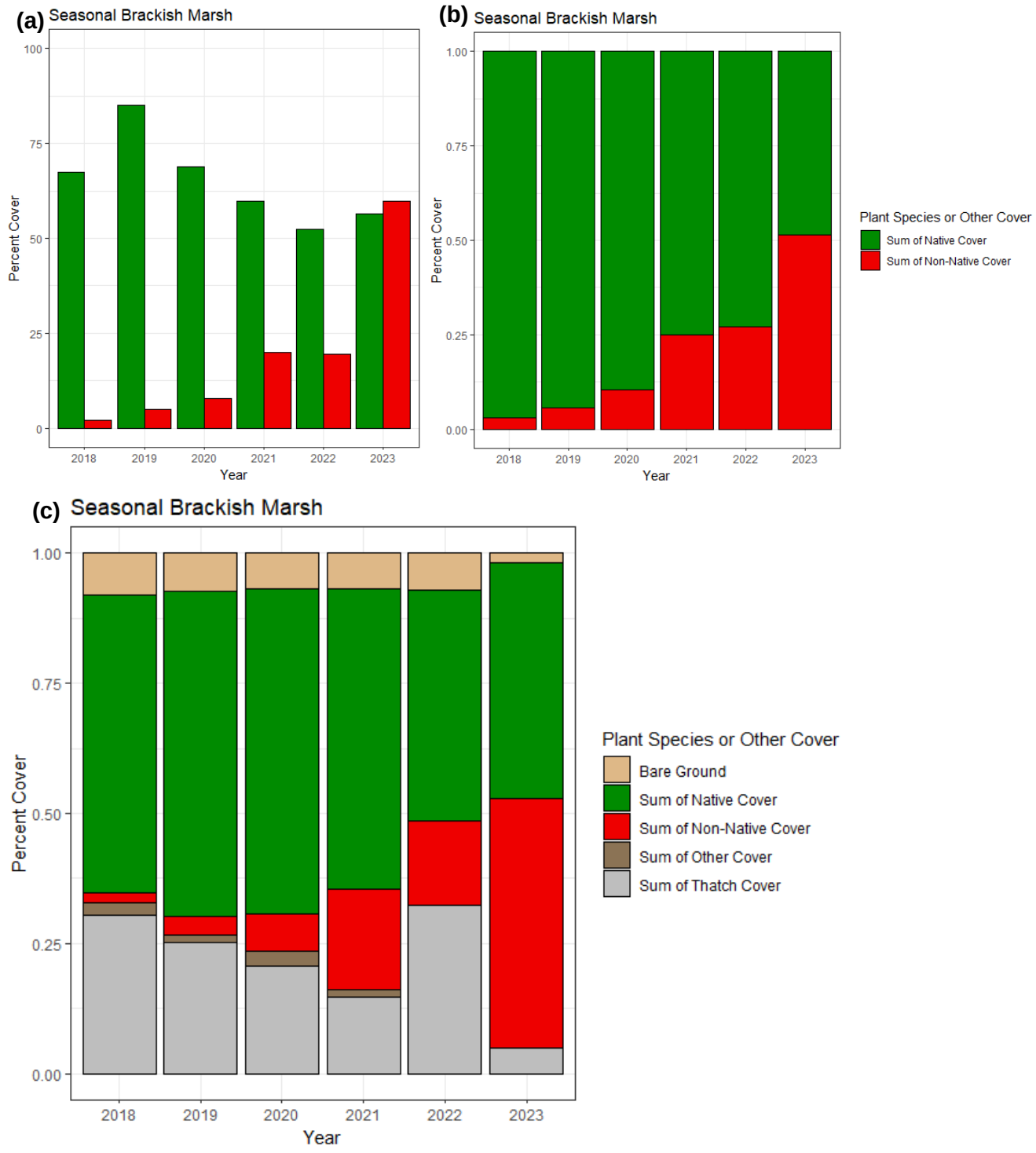


Figure 8. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Seasonal Brackish Marsh habitat at the North Campus Open Space restoration project.

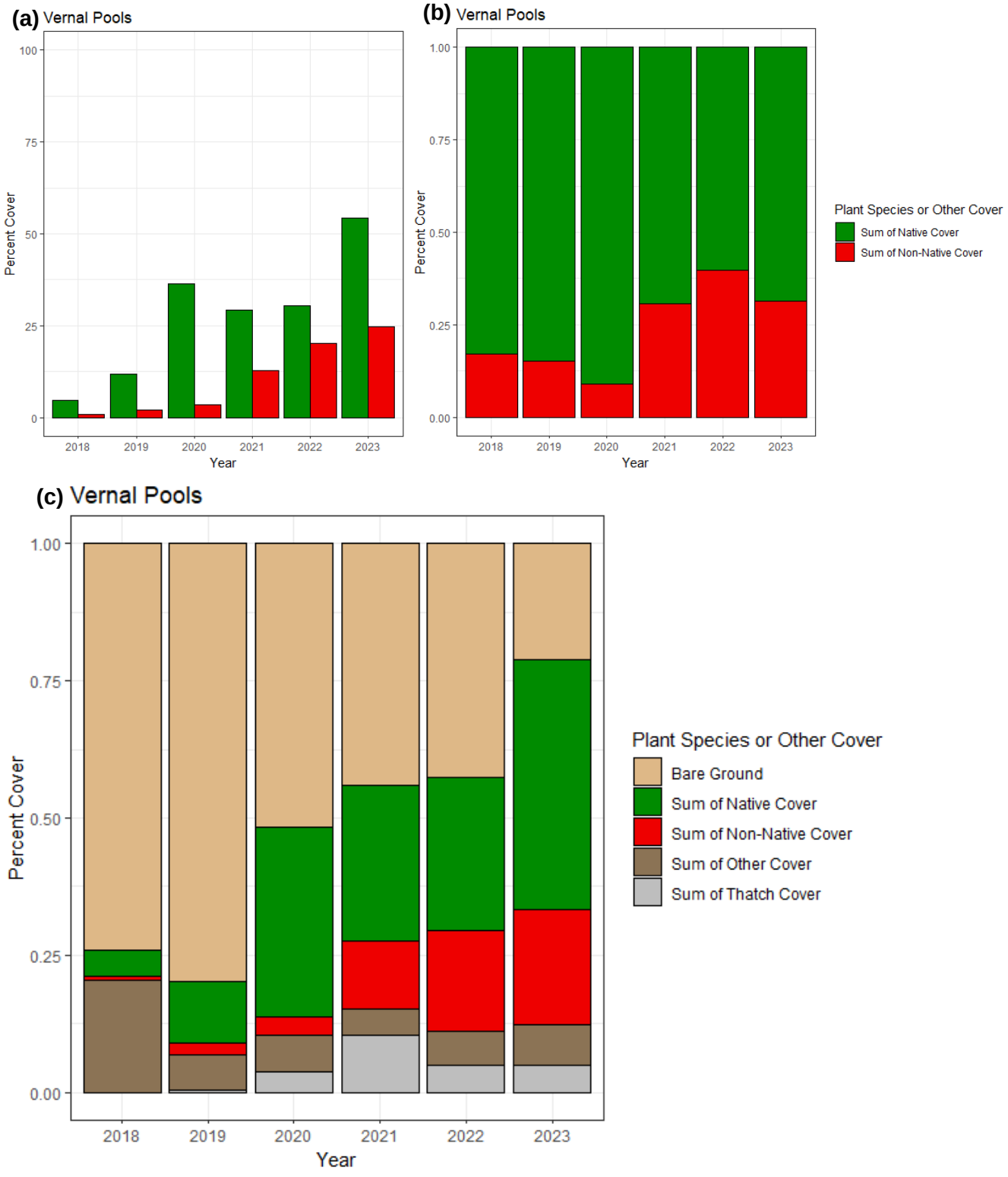


Figure 9. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the eight vernal pools on the mesa of the North Campus Open Space restoration project.

Figure 10. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Low and Mid Elevation Restored Salt Marsh habitats at the North Campus Open Space restoration project.

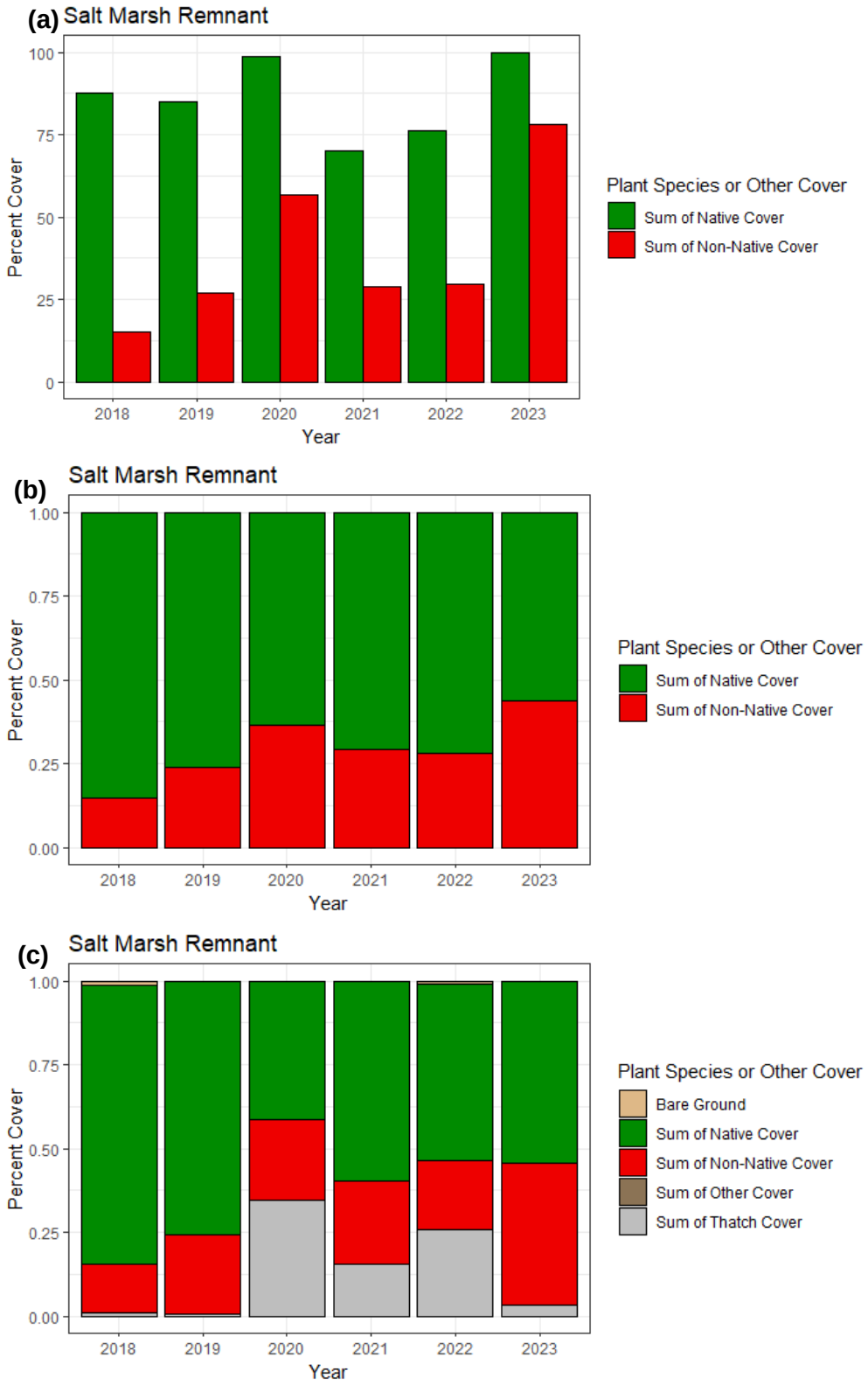


Figure 11. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Remnant Salt Marsh at the North Campus Open Space restoration project.

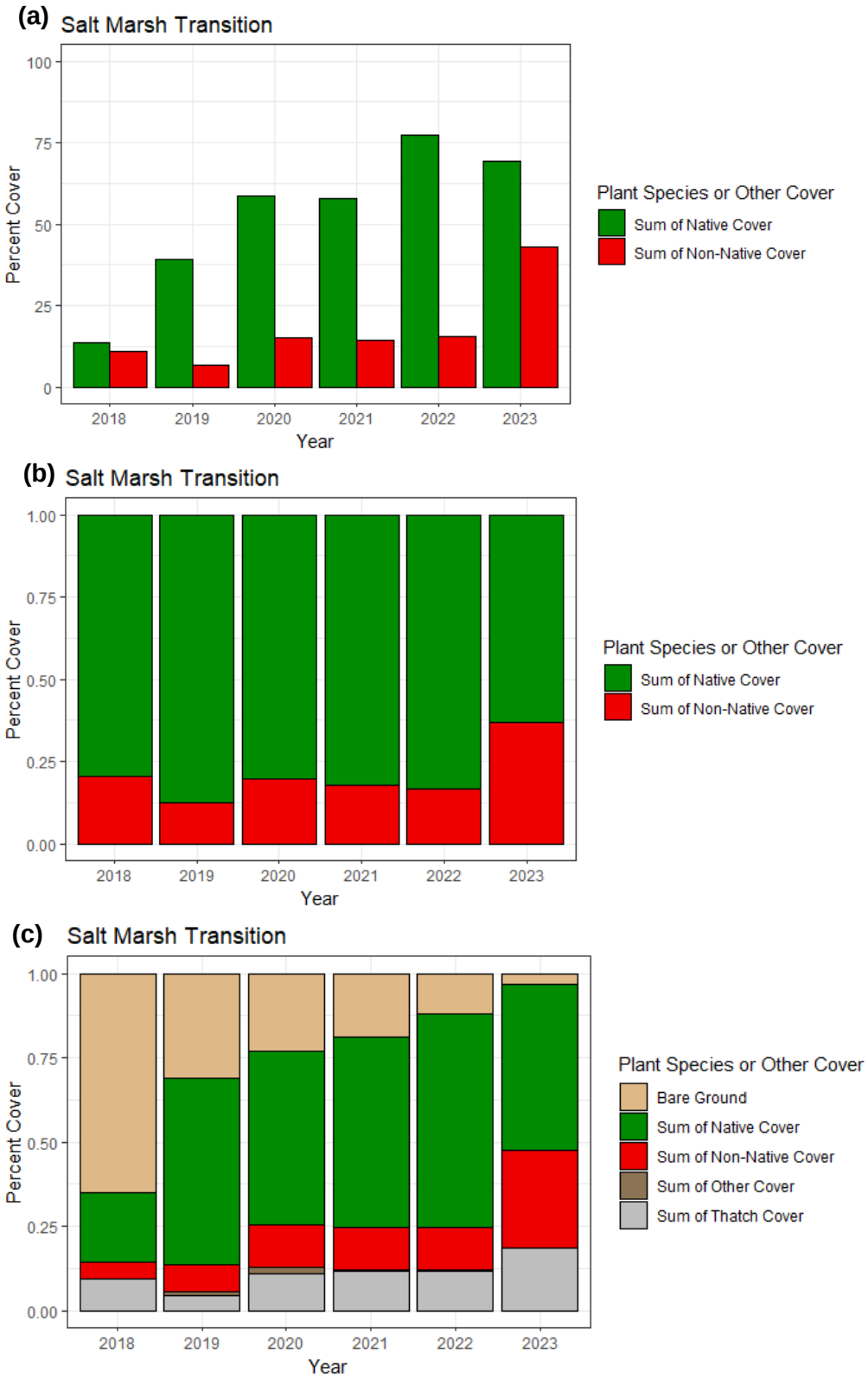


Figure 12. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Transition/ High Salt Marsh habitat at the North Campus Open Space restoration project.

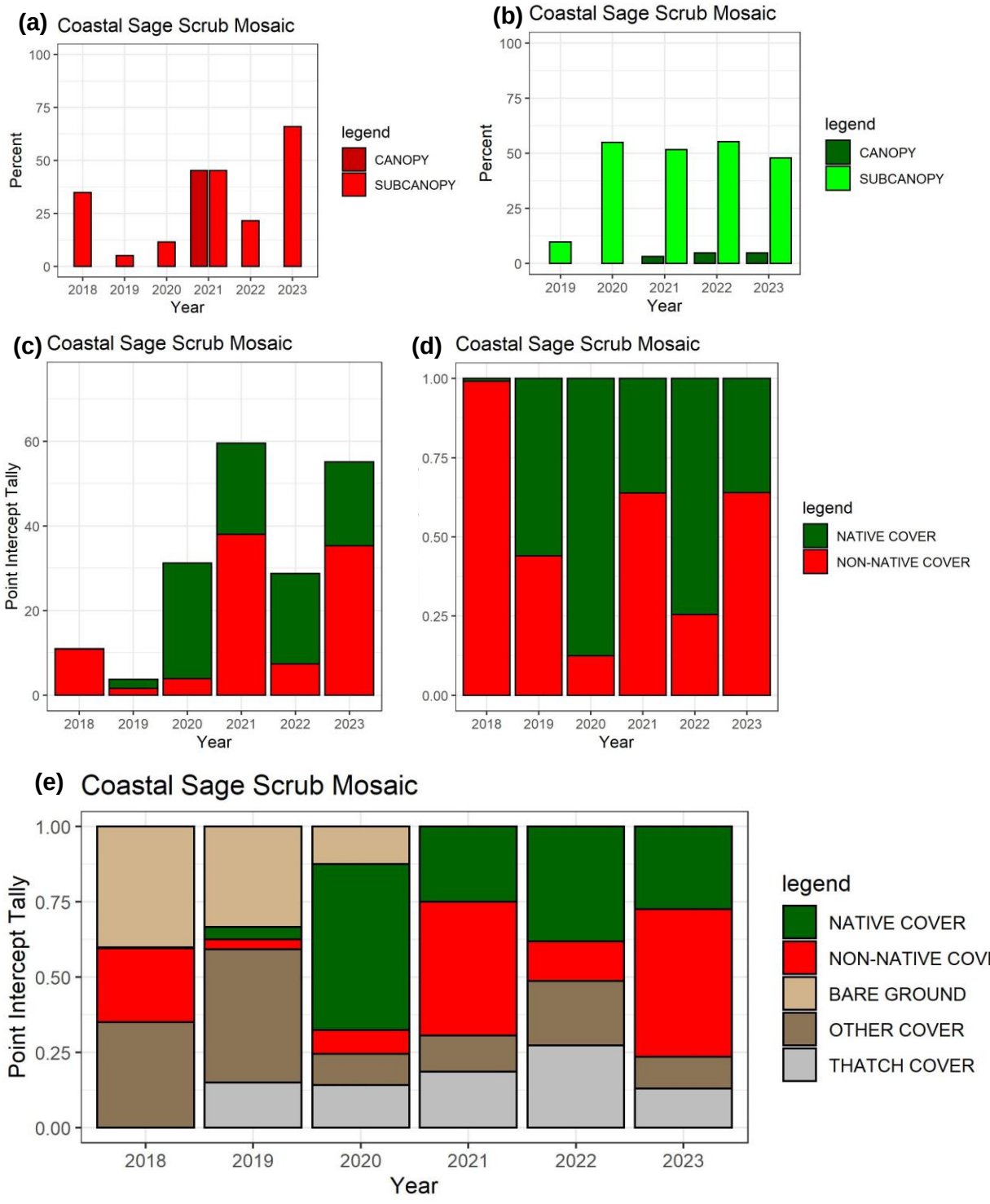


Figure 13. Mean percent of point intercept points per transect of (a) non-native, (b) native (Elzinga et al., *Chapter 8. Field Techniques for Measuring Vegetation* 1998) **(c) mean of all intercepts per transect of native and non-native vegetation (d) relative cover: total native hits & total non-native hits each divided by total hits of native and non-native combined and (e) relative cover of vegetation, thatch, other cover types, and bare ground in the Coastal Sage Scrub (sampled using point of intercept transect) at the North Campus Open Space restoration project.**

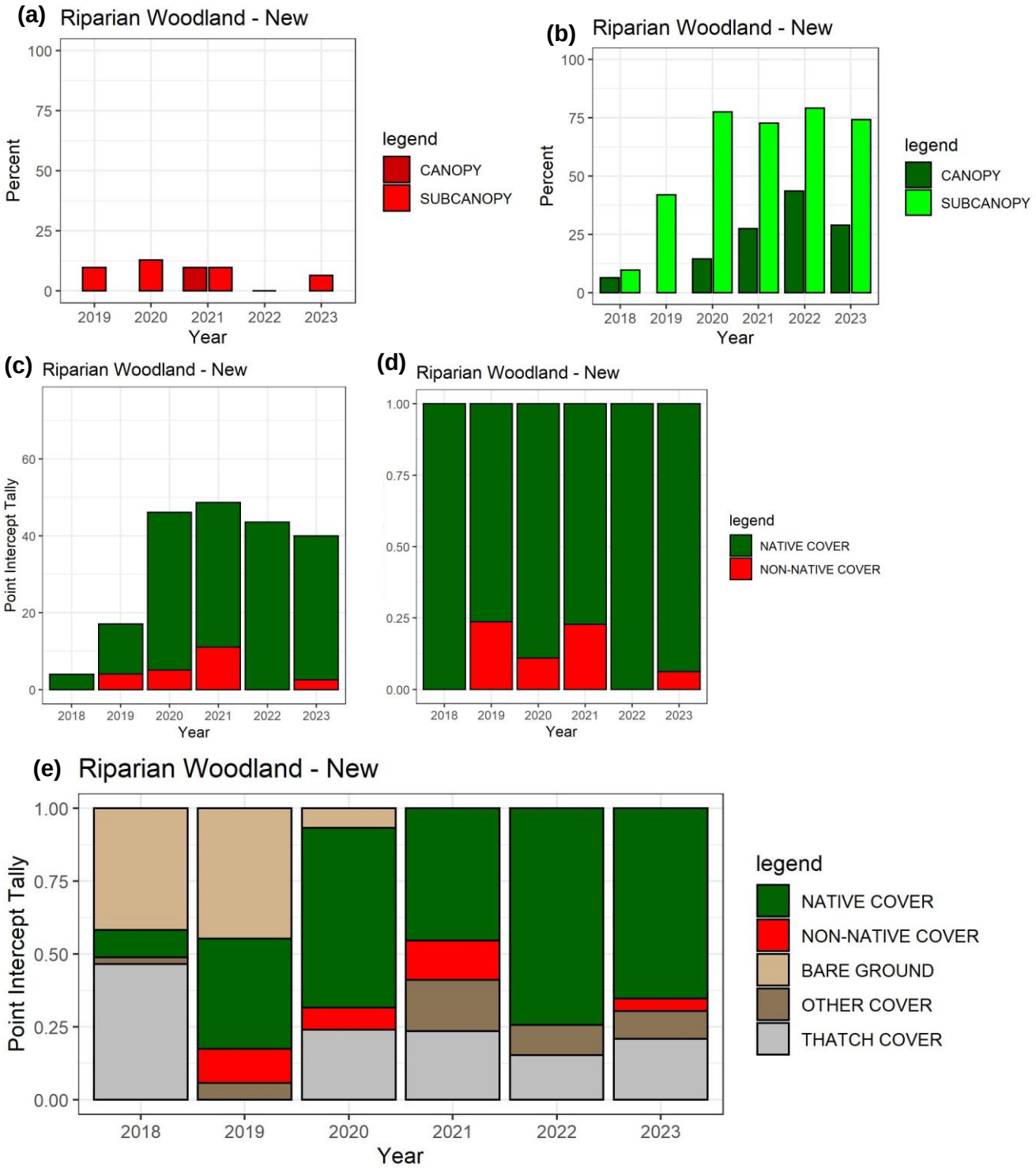


Figure 14. Mean percent of point intercept points per transect of (a) non-native, (b) native (Elzinga et al., *Chapter 8. Field Techniques for Measuring Vegetation* 1998) (c) mean intercepts per transect of native and non-native vegetation (d) relative cover: total native hits & total non-native hits divided by the sum of native and non-native plant hits and (e) relative cover of vegetation, thatch, other cover types, and bare ground in the New riparian woodland (sampled using point of intercept transect) at NCOS.

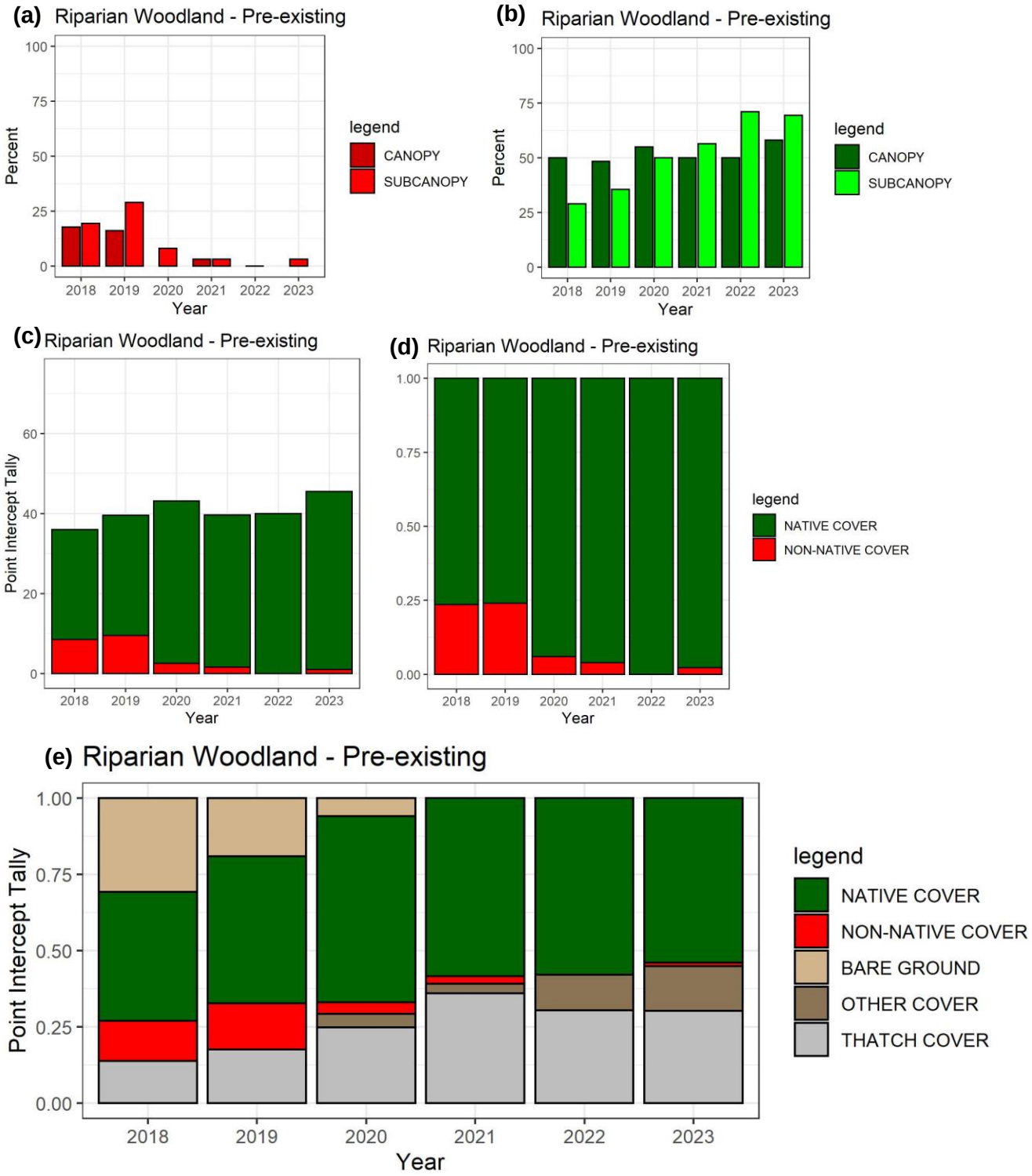


Figure 15. Mean percent of point intercept points per transect of (a) non-native, (b) native (Elzinga et al., *Chapter 8. Field Techniques for Measuring Vegetation* 1998) **(c) mean intercepts per transect of native and non-native vegetation (d) relative cover: total native hits & total non-native hits divided by the sum of native and non-native hits and (e) relative cover of vegetation, thatch, other cover types, and bare ground in the pre-existing riparian woodland habitat (sampled using point of intercept transect) at the North Campus Open Space restoration project.**

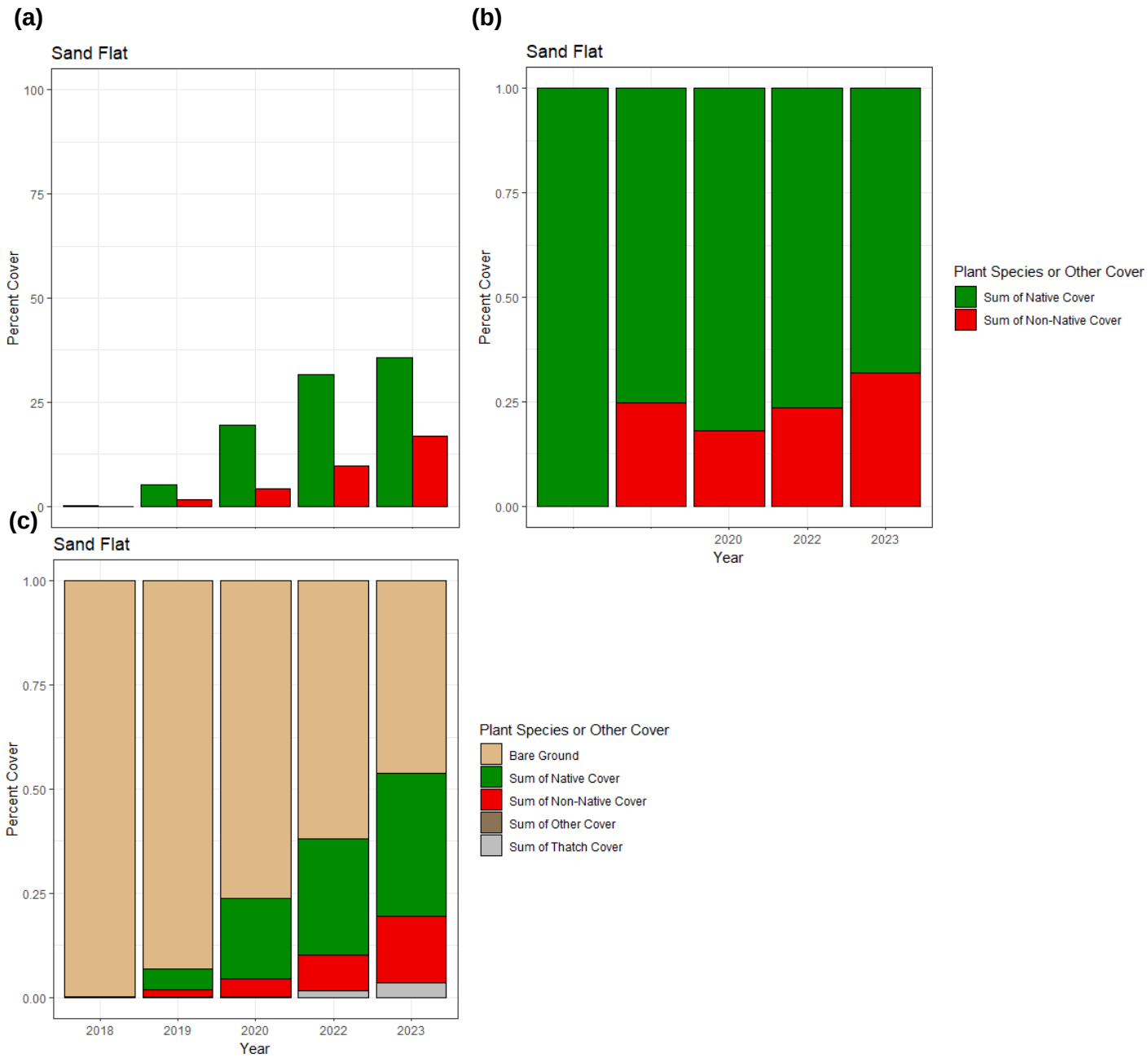


Figure 16. Mean percent of (a) absolute and (b) relative cover of native and non-native vegetation, and (c) relative cover of vegetation, thatch, other cover types, and bare ground in the Sand Flat habitat at the North Campus Open Space restoration project.

Vegetation Success Criteria

The NCOS Restoration Plan identifies four vegetation success criteria, or objectives, for each of the first five years of restoration planting in the primary target habitats/plant communities:

- the percent of total vegetation cover,
- the relative percent of total vegetation cover by native species,
- the relative percent of total vegetation cover by invasive species rated as “High” by the California Invasive Plant Council (Cal-IPC), and
- the diversity of native species.

Vegetation Success Results

The monitoring data collected in 2023 shows that most habitats met three out of four success criteria. Data shows that all criteria other than the absolute percent native cover were met in all habitats except the fresh brackish marsh which met the total native relative criteria, but did not meet the total cover criteria. This is likely due to the extreme water year experienced in 2023- causing an increase in overall vegetation in all habitats except the freshwater pond which was inundated for most of the year inhibiting vegetation from growing. If annual grasses were not included in the total non-native plant cover or the native cover (e.g. considered naturalized) then all criteria would be met. In a site as large as NCOS that contains so many acres of low growing grassland and salt marsh transitional habitats, it is likely unrealistic to expect to eliminate annual grasses, particularly in wet years.

Fall 2023 marked the first prescribed burn using traditional Chumash techniques. This was a collaborative effort to reinstate Chumash tradition and hopefully reduce the non-native seed bank for the grassland area in 2024. This burn occurred after the grassland monitoring. We will be closely managing the grassland this winter and spring to support the expression of seeded and planted native wildflowers and geophytes, in addition to the regrowth of the perennial bunch grass, and to reduce non-native cover.

The vegetation monitoring as well as visual assessment reflects success in the goal of eradicating all species rated as “High” by Cal-IPC at NCOS. One seedling of *Tamarix ramosissima was found in 2019 and* one small cluster of pampas grass (*Cortaderia selloana*) was found in 2019 and 2021, however both have been eliminated and not observed since 2021

Table 3. Comparison of vegetation monitoring data with proposed minimum success criteria for target habitats/plant communities from the Restoration Plan for the North Campus Open Space project. The proposed minimum criteria are italicized for the first 5 years and the monitoring data is in the columns on the right-hand side of the table. We used year 5 monitoring criteria for year 6 of data collection. Table cells that are bold and green indicate monitoring data that meets or exceeds the corresponding criteria.

	Proposed Minimum Criteria					Monitoring Data					
	Year 1	***Year 2***	***Year 3***	***Year 4***	***Year 5***	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Native Perennial Grassland											
% Total cover	*35*	*45*	*60*	*70*	*80*	12	24	58	58	**77**	**100**
% Native Relative	*50*	***60***	***70***	*70*	*70*	19	**65**	**79**	51	51	68
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	***<5***	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	***3***	***4***	***6***	***7***	***7***	**8**	**18**	**21**	**25**	**23**	**19**
Peripheral Upland (Mixed Grassland/Shrubland)											
% Total cover	*35*	*45*	***60***	***70***	*80*	24	42	**66**	**71**	50	**86**
% Native Relative	*50*	***60***	*70*	*70*	***70***	43	**61**	50	39	**70**	62
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	*<5*	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	***3***	***4***	***6***	***7***	***7***	**15**	**40**	**36**	**35**	**31**	**24**
Salt Marsh											
% Total cover	*30*	***40***	***60***	*70*	***70***	15	**50**	**62**	68	**73**	**100**
% Native Relative	***70***	***80***	***80***	***80***	*90*	**94**	**88**	**87**	**91**	88	68
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	***<5***	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	***4***	***6***	***7***	***7***	***8***	**11**	**15**	**30**	**14**	**17**	**29**
Transitional/High Salt Marsh											
% Total cover	*30*	***40***	***50***	***60***	***65***	24	**46**	**74**	**72**	**92**	**100**
% Native Relative	***50***	***60***	***65***	***70***	***80***	**55**	**86**	**79**	**80**	77	61
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	***<5***	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	***8***	***8***	***10***	***12***	***15***	**20**	**22**	**28**	**20**	**25**	**25**
Fresh/Brackish Marsh (Seasonal Pond)											
% Total cover	*50*	*50*	*60*	*70*	***80***	8	20	43	39	**96**	78
% Native Relative	***70***	***70***	***70***	***80***	***80***	**99**	**78**	**99**	**98**	**91**	**97**
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	***<5***	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	*7*	***7***	***10***	***12***	***14***	6	**7**	**17**	**16**	**16**	**16**

	Proposed Minimum Criteria					Monitoring Data					
	Year 1	***Year 2***	***Year 3***	***Year 4***	***Year 5***	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Vernal Pools											
% Total cover	*30*	*40*	***40***	*45*	***50***	6	13	**40**	42	**50**	**95**
% Native Relative	***70***	***70***	***70***	*80*	*80*	**83**	**84**	**91**	69	60	68
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	*<5*	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	***7***	***7***	***10***	***12***	***15***	**17**	**28**	**33**	**37**	**43**	**46**
Sandy Dune Annuals											
% Total cover (variable by season)	*20*	***25***	***30***	***35***	***40***	16	**38**	**86**	**56**	**44**	**100**
% Native Relative	*50*	***60***	*70*	*70*	*80*	35	**87**	65	17	75	47
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	***<5***	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	*3*	***3***	***4***	*5*	***5***	2	**7**	**5**	3	**6**	**4**
Coastal Sage Scrub/Chaparral Mosaic											
% Total cover	*30*	*40*	***50***	*60*	***65***	30	7	**66**	**79**	**77**	**100**
% Native Relative	*50*	*60*	***65***	*70*	***80***	0	43	**83**	59	**74**	48
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	***<5***	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	*8*	*8*	***10***	***12***	***15***	0	3	**16**	**16**	**24**	**23**
Riparian											
% Total cover	*50*	***50***	***60***	***70***	***80***	13	**53**	**90**	**88**	**81**	**100**
% Native Relative	***70***	***70***	***70***	***80***	***80***	**100**	**81**	**88**	**85**	**100**	78
% Invasive Relative	***<5***	***<5***	***<5***	***<5***	***<5***	**0**	**0**	**0**	**0**	**0**	**0**
Diversity (Native Species)	*7*	*7*	***10***	***12***	***14***	4	6	**12**	**12**	12	11

Characterizing short-term sediment accumulation within coastal wetland systems

After wetland grading, feldspar plots were created in collaboration with Dr. Jenifer Kings lab at UCSB. PhD student Jesse Landesman is sampling and analysing the soil data and plans to publish the findings in the next year. The following contains more details about the project:

In the face of intensifying global climate change and its undeniable impacts on our planet, the significance of Earth's natural ecosystems as powerful allies in mitigating these effects has become increasingly significant. One example of these important natural ecosystems are coastal wetlands. Coastal wetland systems are able to provide resilience to climate change by accumulating sediment in order to keep pace with sea level rise (Weston et al., 2023). However, most of the research that has been done looks at sediment accumulation between wetland sites, rather than observing patterns in sediment accumulation within wetland systems, based on spatial heterogeneity.

During July to September of 2023, we measured sediment accumulation at 44 feldspar plots that were placed in North Campus Open Space (NCOS) and Coal Oil Point Reserve (COPR) after restoration of NCOS in 2018. In addition to measuring sediment accumulation above the feldspar layer, we measured other parameters that vary within this wetland system, including elevation, plot flooding frequency, and aboveground biomass at each plot, as well as soil bulk density and other soil characteristics. These measurements will allow us to estimate sediment accretion rates and examine patterns within this wetland system.

Tree Monitoring Data

No trees were planted in 2023. Monitoring the height, diameter at breast height (DBH), and vigor of the 243 trees that were planted in years 1-5 of the restoration project continued.

Two trees were found to be dead in year 6 monitoring (vigor rating of 4). The overall success rate of tree survival for the 6 years of monitoring is 97.5%.

Overall, every year of monitoring reflected healthy growth for all six species. A comparison of the year five and year six data shows an increase in overall mean height by 11 inches-from an average of 82 to 92 inches. Height measurements stop at 24 feet so height measurements are less meaningful in year six monitoring. We will use a tree measuring laser in the future to increase our accuracy in measuring tree height moving forward. DBH increased from 1.1 to 1.5 inches. The mean overall vigor rating stayed the same. The greatest average tree diameter increase was seen in white alder which increased to an average of 5.79-inch diameter. Similar growth patterns were observed in every year of monitoring.

White alder at Whittier grows at an astonishing rate compared to other species and locations with an average height of over 20 feet. The white alders are significantly taller than other species and also have one of the largest diameters compared to other tree species (Figure 19). White alder seemed to thrive even more this year compared to other years due to the wet conditions.

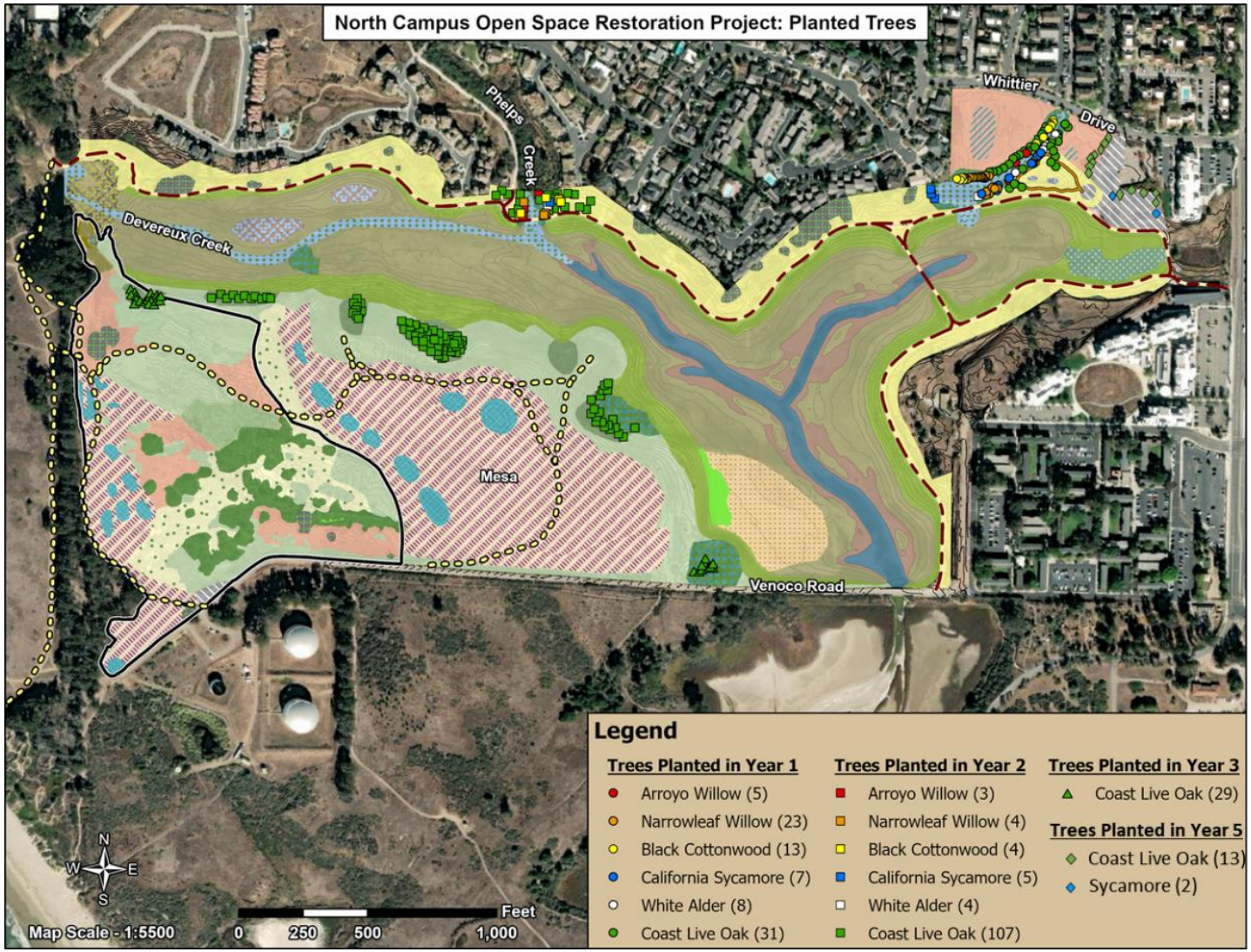


Figure 17. Map of trees planted during the first three years of the North Campus Open Space restoration project. See Figure 1 for a legend of the habitats/plant communities and trails.

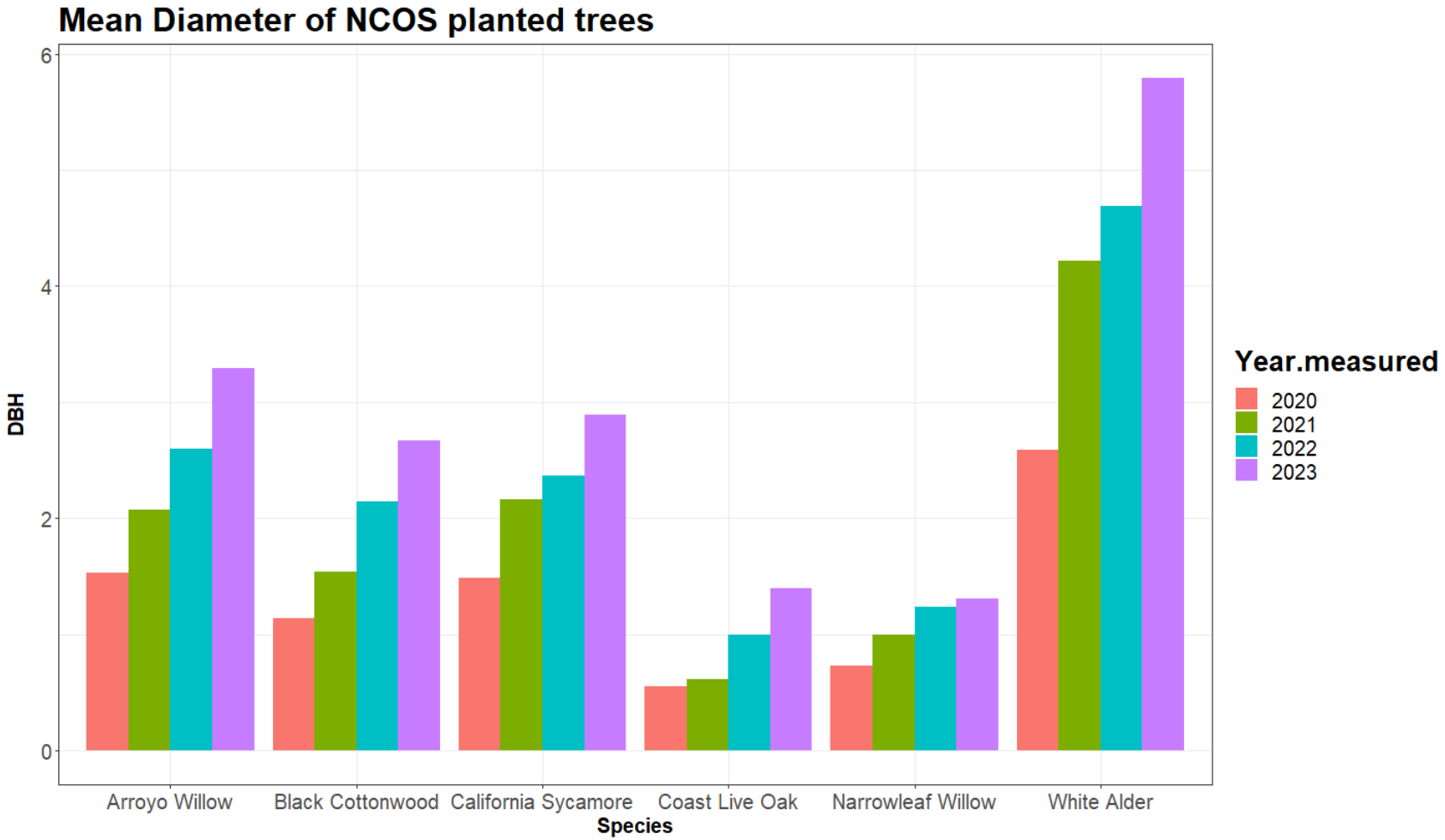


Figure 18. Bar charts of mean diameter at breast height (inches) of six tree species planted during the first and second years of the North Campus Open Space restoration project.

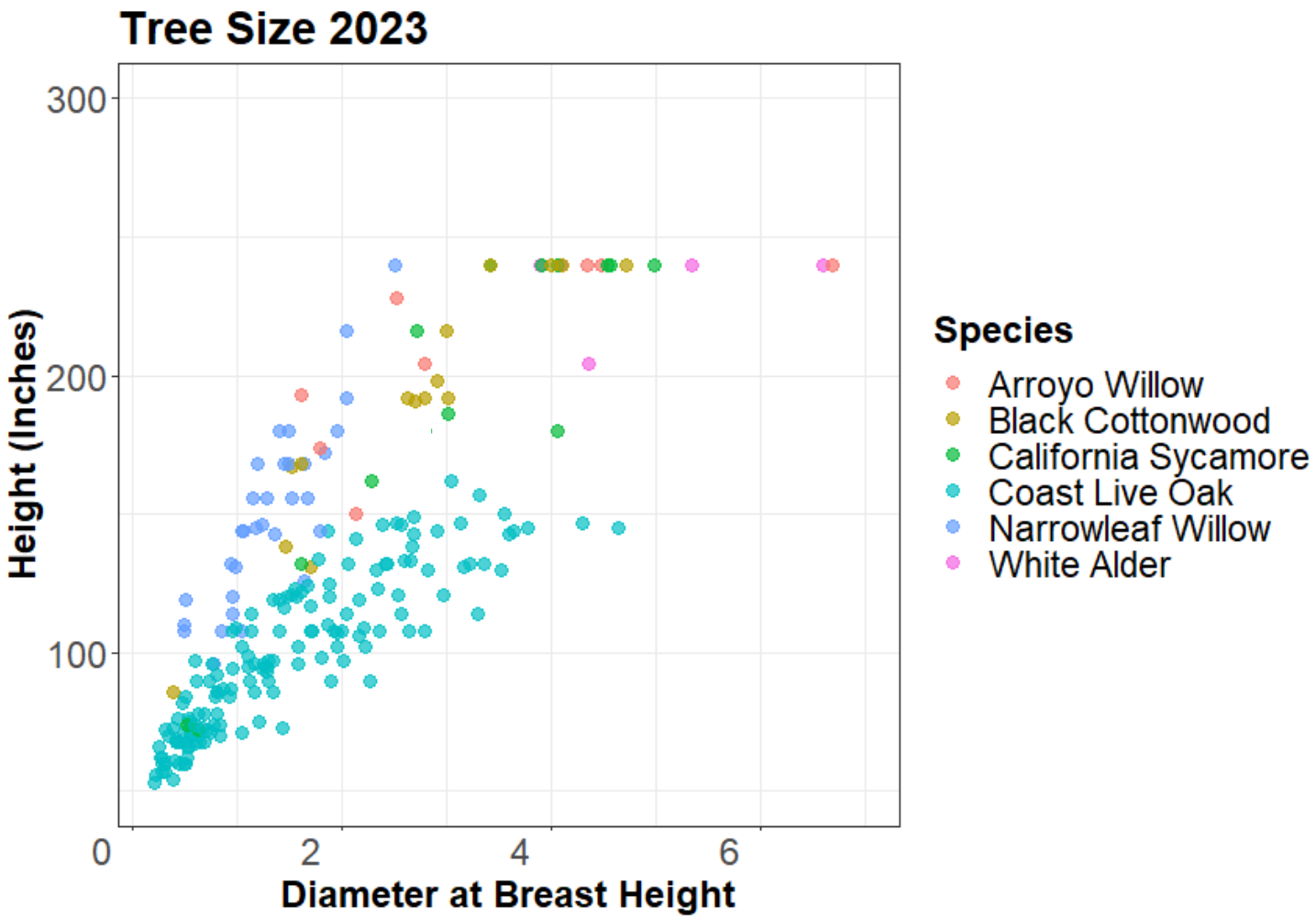


Figure 19. Scatter plot of tree height and diameter. This figure represents all living planted trees that are part of the study at NCOS in year 6. Trees could not be measured over 240 inches, therefore anything over 240 inches was recorded as 240.

4. WILDLIFE

Wildlife monitoring efforts at NCOS are focused primarily on monthly bird surveys and targeted surveys for sensitive and special status species such as the federally endangered Tidewater Goby, the threatened Western Snowy Plover, and the California state endangered Belding's Savannah Sparrow. Certain aspects of NCOS are designed and managed specifically to support these and other special status species such as the Burrowing Owl. The status of these species at NCOS are described later in this section.

Additional studies and surveys that examine and document the development of the greater food web at NCOS are focused on wildlife such as arthropods, small rodents, and reptiles. These projects are briefly described at the end of this section.

Bird Survey Methods

The Cheadle Center has conducted monthly bird surveys at the project site since September 2017. The surveys are conducted in the morning, beginning within one hour of sunrise, and typically taking two to 2.5 hours to complete. Beginning at the Venoco access road bridge near the southeast corner of NCOS, two teams of observers walk eastern and western routes around the site, typically meeting at the end of the survey near the trail bridge over Phelps Creek along the northern side of the site. At least one expert birder takes part in each survey, helping to verify species identification and counts.

Using binoculars, spotting scopes and the GIS app ESRI Collector on a tablet, each team records every species of bird seen or heard on site, including birds flying between habitats or structures on or adjacent to the site. The ESRI Collector app records the route walked by each of the two teams. Each observation recorded in the app includes a minimum of the following information: the location and substrate/habitat of the observation, bird species (common name), and count (number of individuals of the species for the observation). Observations of birds seen previously during the survey in a different habitat, or that may have been observed by both teams are recorded as "Repeat Observations". Additional information that may be recorded includes sex (male, female, or juvenile), evidence of breeding activity, and any other notes about the observation such as unusual or notable behavior and descriptions to help with uncertain identification of birds. The elevation of the water in the slough (read from a staff gauge at Venoco Bridge) and the weather conditions (temperature, wind speed and direction, cloud cover and precipitation) are recorded at the beginning and end of the survey.

After the survey is completed, the total count of each species observed is reviewed and revised if needed by the expert birder and each team leader. Lastly, the final, reviewed list and count of species observed for each survey, excluding repeat observations, is uploaded to the Cornell Lab of Ornithology's eBird repository.

Bird Survey Data & Trends

Guilds and Data Metrics

To facilitate an efficient means of summarizing, analyzing, and interpreting the bird survey data, we categorized the species observed into 13 guilds based on their primary habitat and/or food source, or ecological niche. We have split the large and diverse insectivore guild into two groups starting in monitoring year 3, separating species that are predominately aerial insectivores (*e.g*. swallows and flycatchers), and all others into an insectivores – terrestrial guild (e.g. blackbirds, sparrows, woodpeckers, and wrens).

Comparison of Survey Years

Bar charts comparing the mean count per quarter are presented in Figure 20. Appendix 3 contains a list of all species observed in each survey year grouped by our guilds and sub-classified into eBird Species Groups as defined by the "eBird Clements v2018 integrated checklist (August 2018)".

The overall mean number of birds observed per survey increased, from 431 in year one to 570 in year two, 731 in year three (September 2019 – August 2020), 470 in year 4 and 563 in year 5 and was 498 in year 6.

The total number of species observed increased from 104 in year one to 129 in year two, 128 species in year three, 115 species in year four, 122 in year 5 and 116 in year 6. We did not observe any new species in year 6. Collectively, 169 species have been recorded over the six years of surveys. This covers 71 percent of the 239 species reported to the eBird repository for this site since 2018 (ebird.org/hotspot/L820867?yr=all&m=). E-bird data reflects unique species that are often on the site for short periods of time and may not be captured in the monthly bird surveys such as Bobolinks. Trends in the total number of species and the percent of total observations per guild are similar to the mean monthly counts, though they show a smaller degree of change between years (Figures 21 and 22). In 2023 we observed breeding behavior from the scaly-breasted Munia for the first time.

Discussion of Slough Water Level Influence on Bird Trends

The year 6 estuary water level was higher than average in most months. The birds survey water elevation is representative of a single day; however the slough water level changed a lot in the 2023 water year due to the heavy rainfall and frequent breaching of the slough. Figure 22 shows the relationship between waterfowl and friends, season, and water elevation (for all years of data). There is both the highest diversity and the highest bird count in winter months when water elevation is high. The extremely high number of birds observed in March 2020 (figure 22) that results in a steep negative trend line for the spring data is largely due to the observation of 189 American Coots and 115 Northern Shovelers at the cusp (March) between data assigned to "winter" and "spring" for this graph.

Comparison with Reference Site

To the south of NCOS, and encompassing the majority of Devereux Slough, Coal Oil Point Reserve (COPR) is an important reference site for most of the bird species that we expect to see at NCOS as the restoration progresses. We compared bird species abundance and diversity at the two sites for the first two years of surveys at NCOS. Excluding the beach habitat at COPR, the two years of survey data

showed that the sites are generally similar in overall diversity and abundance. In the second year of surveys, COPR had a greater abundance of Shorebirds, Herons/Egrets, and Cormorants, while NCOS had more Insectivores and Seed/Fruit eaters. This comparison of bird survey data from the two sites is described further in a short article on the Cheadle Center website (www.ccber.ucsb.edu/news-events/2nd-annual-ncos-vs-copr-bird-survey-roundup).

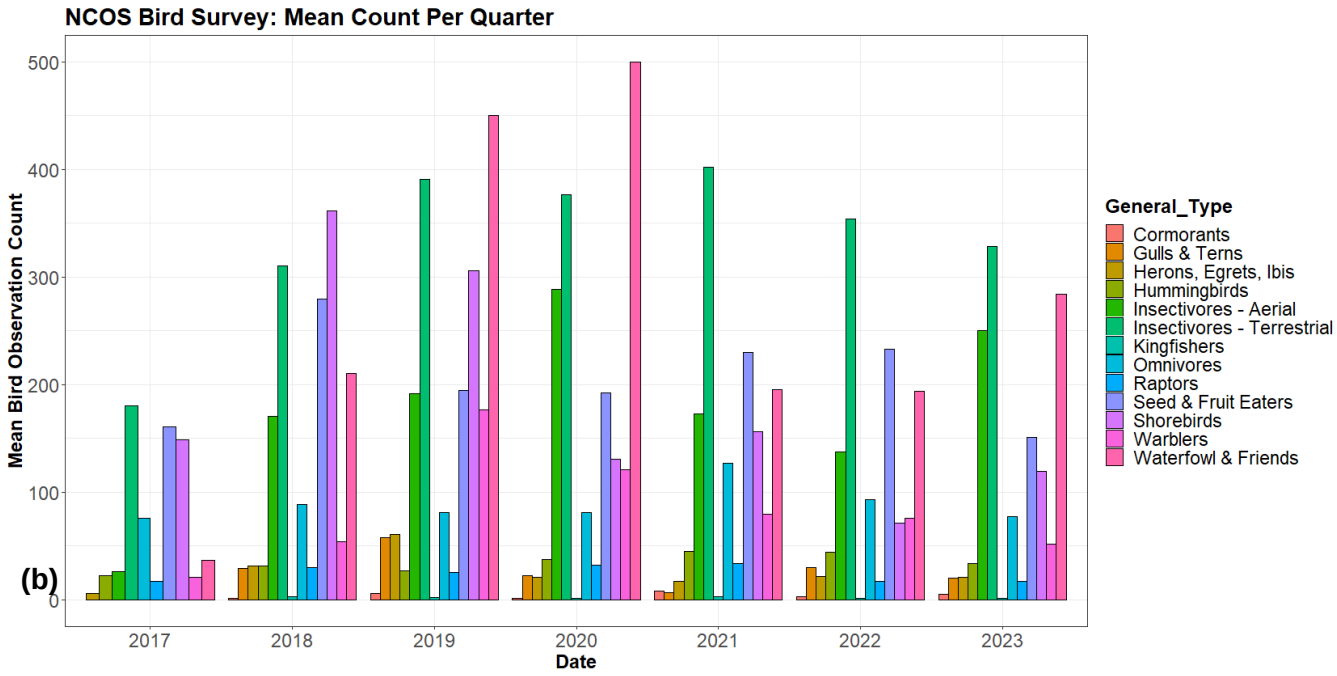


Figure 20. Mean of counts per quarter of birds in 13 guilds observed in each year (September through August) of monthly surveys at NCOS (2017 – 2023).

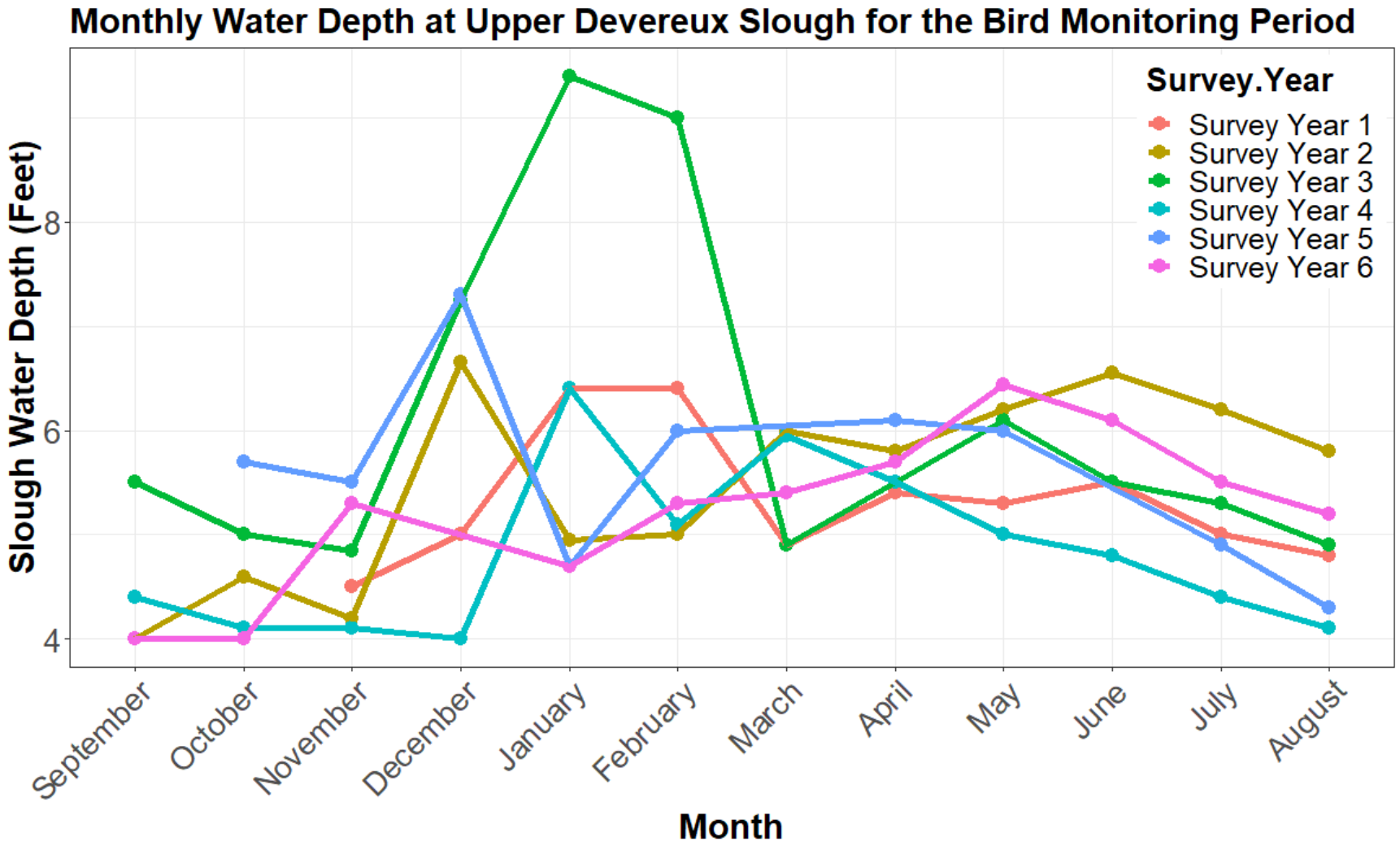


Figure 21. Line graph comparing the water surface elevation (in feet) of Venoco Bridge for each year (September through August) of monthly bird surveys at NCOS. Year 1 (2017-18), Year 2 (2018-19), Year 3 (2019-20), Year 4 (2020-21), Year 5 (2021-22), and Year 6 (2022-23)

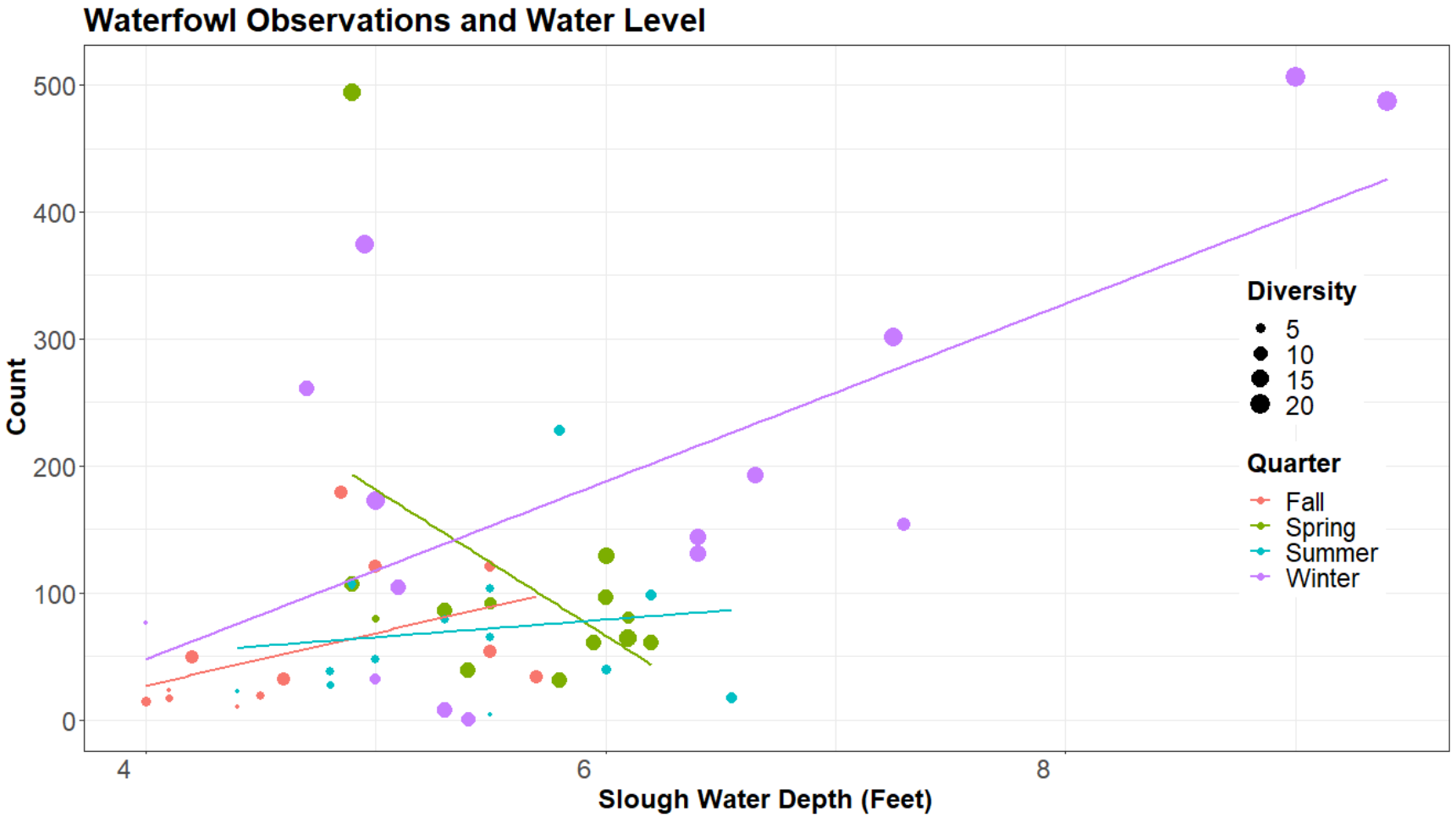


Figure 22. Number of waterfowl observed in monthly surveys from 2017-2023 and a linear trend line for each season. The size of each point represents the number of species seen in that survey. Season has a strong effect on observations because of migration patterns.

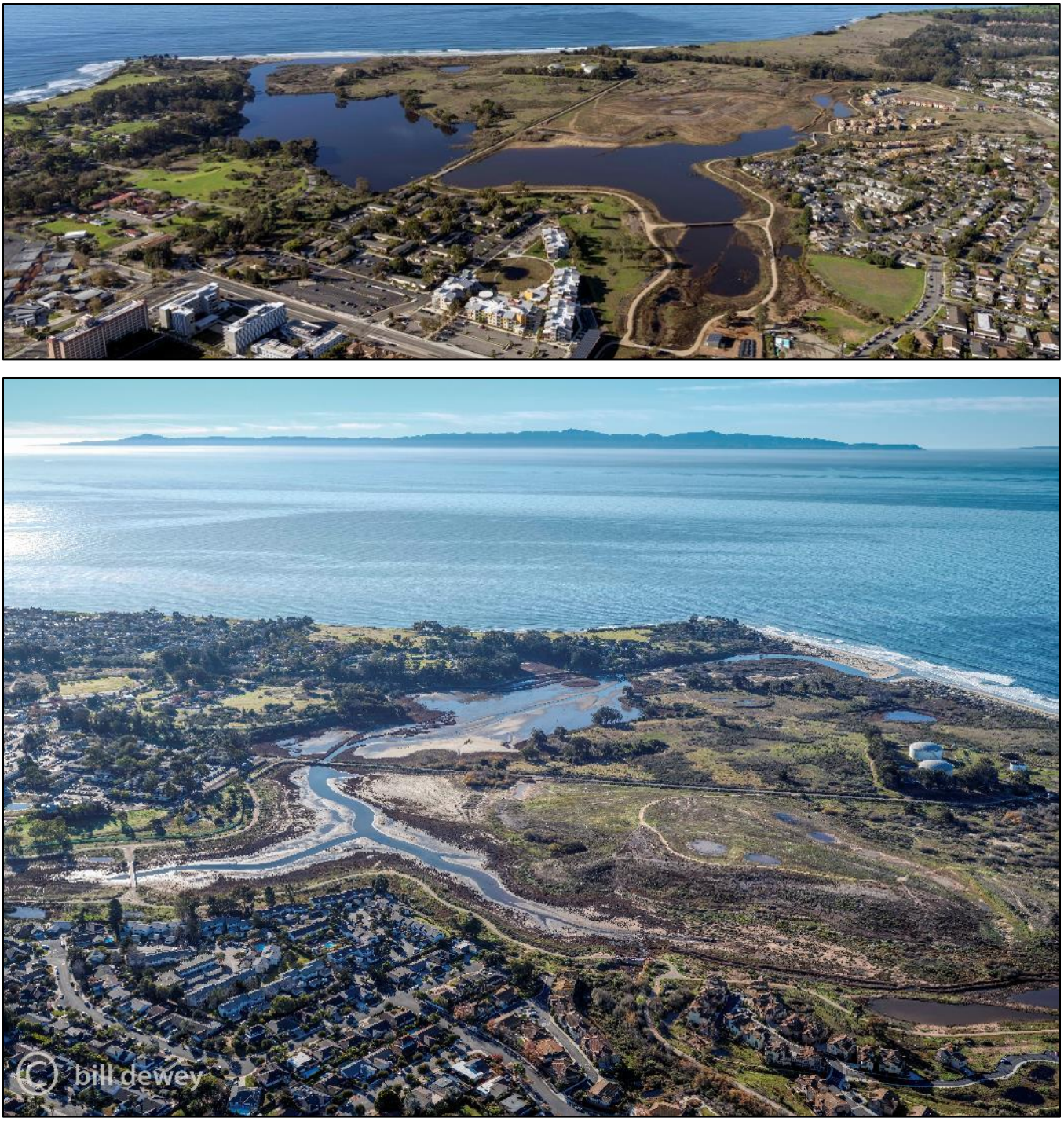


Figure 23. Aerial photos of North Campus Open Space by Bill Dewey. Top: December 2019 showing the high-water level when the Slough is full; Bottom: January 2022 showing the low water level after the slough has opened, Credit: Bill Dewey

Special Status Birds

Three bird species of particular interest at NCOS include the threatened Western Snowy Plover, the California state endangered Belding's Savannah Sparrow, and the Burrowing Owl, a species of conservation concern nationally and in California. Certain areas of NCOS are designed and managed with a focus on providing suitable and secure habitat for these species, such as the sand flat and intertidal mudflats for supporting breeding by the Western Snowy Plover, the large areas of undisturbed salt marsh for the Belding's Savannah Sparrow, and multiple hibernaculum and burrows for the Burrowing Owl in the perennial grassland.

Western Snowy Plovers were recorded on site in the first five years of the survey. Breeding attempts have occurred in each of the first three years, with one unsuccessful nest in 2018, two in 2019 and one in 2020 that produced at least one fledgling. No Western Snowy Plovers attempted nesting on site in 2021. In 2022 North Campus open space had its first observed successful breeding by two pairs with 2 chicks each that fledged. No nesting attempts were recorded in 2023. One likely explanation for the absence of Western Snowy Plover nesting at NCOS in 2021 is the simultaneous optimization of snowy plover habitat at Coal Oil Point at the beach. Coal Oil Point Reserve management began crow control in early 2021, reducing the potential for snowy plover chick predation at the beach. The beach gets regular energy and food supplements from deposited kelp wrack and when predation is reduced, is a more ideal plover habitat. The full news article on snowy plover presence in 2022 can be found here.

Belding's Savannah Sparrow have been recorded in each year either in surveys or noted by confident birders, particularly in the spring and summer breeding seasons. There have been multiple observations with counts of more than one individual, with five being the highest count recorded to date. In the May 2020 survey, we recorded three separate observations of males singing and in fall 2021 we found a nest demonstrating breeding activity on site. In 2023 there was one recorded pair nesting.

Fifty habitat features called 'hibernaculum' were installed at the start of the project with burrowing owl in mind as well as to provide refuge for other species while vegetation became established. Burrowing owls were observed on site for most of the overwintering period (October – March) in the first four years, however in year five, 2021-22, the newly arrived burrowing owl was harassed by a peregrine falcon and disappeared soon after that. In October of 2020, six artificial burrows were installed specifically for burrowing owl on the mesa, and two owls were documented regularly using these features in the year three survey and three owls in the fourth year of surveying. No burrowing owls have been documented in the 2022-23 year.

A UCSB undergraduate student dissected owl pellets, and documented that burrowing owl at NCOS mainly consume insects such as earwigs, ground beetles, woodlice, and wasps as well as field and harvest mice while literature shows that burrowing owls at other locations consume a higher ratio of small vertebrates such as mice. Our small mammal study shows that there is not a large population of mice at NCOS.

Figure 24. Top Left image: Western snowy plover chick on the slough shore at NCOS in July 2022 (photograph by Mark Bright). Top Right image: A Belding's savannah sparrow seen during a monthly bird survey at NCOS in November 2018. Bottom Left image: Belding's savannah sparrow nest with 3 eggs found at NCOS in 2021. Bottom Right image: Burrowing owl spotted at NCOS in October 2021

Figure 25. Top image: One of three pairs of artificial burrows constructed on the mesa of NCOS in the summer of 2020. Bottom image: A burrowing owl at an artificial burrow entrance in November 2020.

Breeding Bird Observations

During the monthly surveys, an effort is made to record observations of breeding behavior such as gathering or carrying nest material, courtship/territorial displays or singing, copulation, and actual nests with eggs or chicks, or dependent fledglings with adults. With six years of data, we now have observations of breeding behavior recorded for 32 species, including observations of breeding behavior of the common yellow throat in 2023 for the first time. There is an average of 12 species and 22 breeding behavior observations per year with a total of 130 breeding behavior observation during surveys (Table A3.2 in Appendix 3).

Another source for records of breeding behavior at NCOS is the Santa Barbara Audubon Society's Breeding Bird Study database. The data extracted from this database for NCOS is similar to the monthly bird survey data, with a total of 40 species exhibiting breeding behavior at the site since 2017 at an average of 15 species and 30 observations per year. 2023 observations show 7 species and 10 observations of breeding at NCOS. This database does include some of the records from our monthly bird surveys (Table A3.2 in Appendix 3). Overall, 173 observations of bird breeding have been recorded at North Campus open space since 2017

Special Status Aquatic Species

To fulfill project grant and permit monitoring requirements, and for general interest, the Cheadle Center has conducted pre- and post-construction surveys for three sensitive and special status aquatic species: California Red-legged Frog, Tidewater Goby, and Southwestern Pond Turtle. Surveys were led by a permitted biologist, with the assistance of Cheadle Center staff.

In the 2023 survey, 63 tidewater goby were found in total and they were found as far up the estuary as the bridge over Phelps Creek. The survey conducted in October 2019 recorded the presence of 5 Tidewater Goby in the lower slough. All other surveys (2017, 2018, 2020-22) did not find any Tidewater Gobies present.

None of the surveys conducted found presence of the California Red-legged Frog or Southwestern Pond Turtle. The survey conducted in July 2020, unlike prior surveys, did not include the lower portion of Devereux Slough that lies within Coal Oil Point Reserve due to restrictions associated with the COVID-19 pandemic. A Technical Memorandum about the results of the June 2023 survey is provided in Appendix 4 of this report. The 2023 survey was completed earlier in the year than previous surveys.

Outside of the surveys described above, Cheadle Center staff have observed a Southwestern Pond Turtle prior to construction in the area where Phelps Creek flows into NCOS, and periodically in the same area since the first post-construction sighting in November 2018. The last documented sighting of the species was in March of 2019.

Invertebrate Surveys & Studies

Aquatic Macroinvertebrate and Zooplankton Study

A study comparing the aquatic macroinvertebrate species diversity and abundance of the newly restored wetlands at NCOS with long established wetlands in the adjoining Coal Oil Point Natural Reserve (COPR) began in the spring of 2018 through a collaboration with the Santa Barbara Audubon Society and the COPR Nature Center. Several undergraduate interns, volunteers and student leaders collect aquatic macro invertebrate samples using the filtered bucket method and occasionally soil core samples at 6 sites once per academic quarter (four times per year). The samples are preserved, sorted and identified by students and analysis is done for each location. Water samples were collected for E-DNA analysis in 2022 to compare with hand sorted samples. All E-DNA is processed by Jonah Ventures. We found that macroinvertebrates shed much less DNA than other organisms so few replicates of invertebrate eDNA came back from the lab to compare to hand sorted samples. We did get interesting results from algae and fish DNA that can be seen here.

Scrutiny of the EDNA data revealed that the invasive New Zealand mudsnail was present in Phelps Creek. The species was physically observed in follow-up field studies and appropriate protections and notifications are now in place regarding this species.

The hand sampling conducted in 2018 found up to 13 taxa at NCOS dominated by four types overall (Copepoda, Corixidae, Ostracoda, and Cladocera); these species have the ability to adapt to changes in salinity and dissolved oxygen. In addition, four taxa have relatively high abundance in benthic samples (Chironomidae, Ceratopogonidae, Ephydridae, and Nematoda). In comparison with COPR, the study has found that NCOS appears to have equivalent, if not slightly greater species richness and evenness. Students found that salinity has a greater impact on species than site does (Figure 28.). These findings continue to be true for the sampling results of 2019-2023. A detailed report on the analysis of aquatic invertebrates collected in 2018/2019 is available on eScholarship (escholarship.org/uc/item/59c872mm). A poster presentation on the findings can be found at https://escholarship.org/uc/item/64f0w6hx. In 2023 we are transitioning to a dip netting methodology focused on the benthic layer. We have also expanded to include submerged aquatic vegetation and algae into our sampling protocol. NCOS is part of the Southern California Coastal Water Research Project (SCCWRP) Bight 2023 estuarine study.

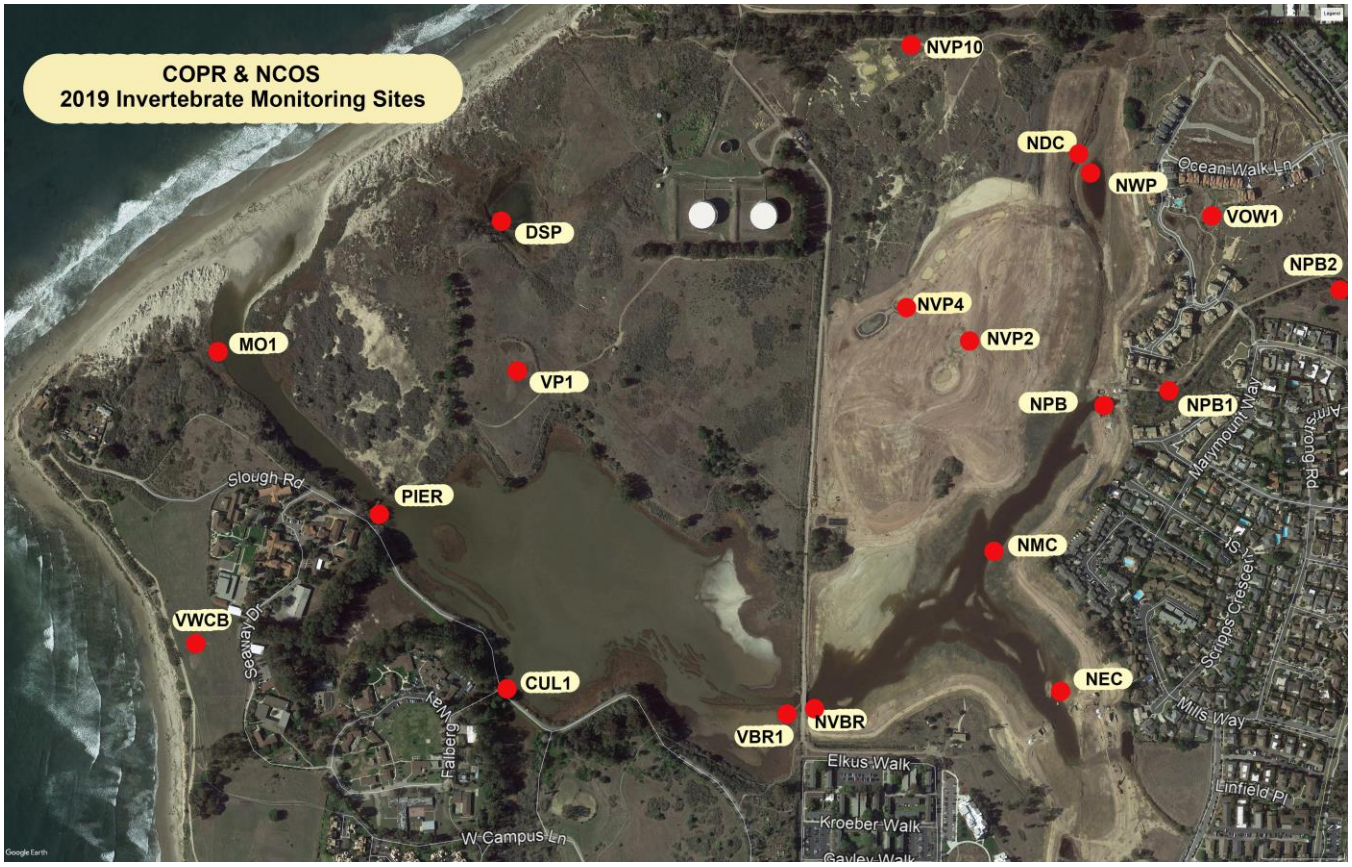


Figure 26. Map of Aquatic Invertebrate Sampling Locations

Small Rodents, and Reptiles

Beginning in November 2019, the Cheadle Center initiated an education-focused program to assess and monitor the presence and abundance of small rodents and reptiles in the Salt Marsh and Native Grassland habitats on and adjacent to the NCOS mesa. One of these projects is a collaboration with the lab of UCSB Ecology, Evolution and Marine Biology Associate Professor Hillary Young and conducted under approval of Institutional Animal Care and Use Committee (IACUC) protocol 908.1. The objective is to provide an educational experience in ecology for students while monitoring changes in the abundance and diversity of small rodents as the restoration progresses. The surveys are conducted by setting out three grids of 20 Sherman Live traps for four nights in a row in each habitat. The traps are baited and cotton balls are added to offer additional shelter and protection for captured animals through the night. All traps are checked early in the morning to avoid heat stress, and any animals captured are quickly identified, measured (length and weight) and marked with an ear tag or sharpie marker on the foot before they are released. Starting in fall 2019 we conducted a spring and fall survey each year. Two common mouse species, Deer mice (*Peromyscus maniculatus)* and Harvest mice *(Reithrodontomys megalotis),* were captured, with greater numbers of individuals captured in the Salt Marsh than in the grassland.

In 2023 fall trapping we caught a total of 18 animals in the salt marsh. 14 Harvest Mice, 2 Deer mice and 2 house mice. The grassland was not sampled in the fall due to cold temperatures.

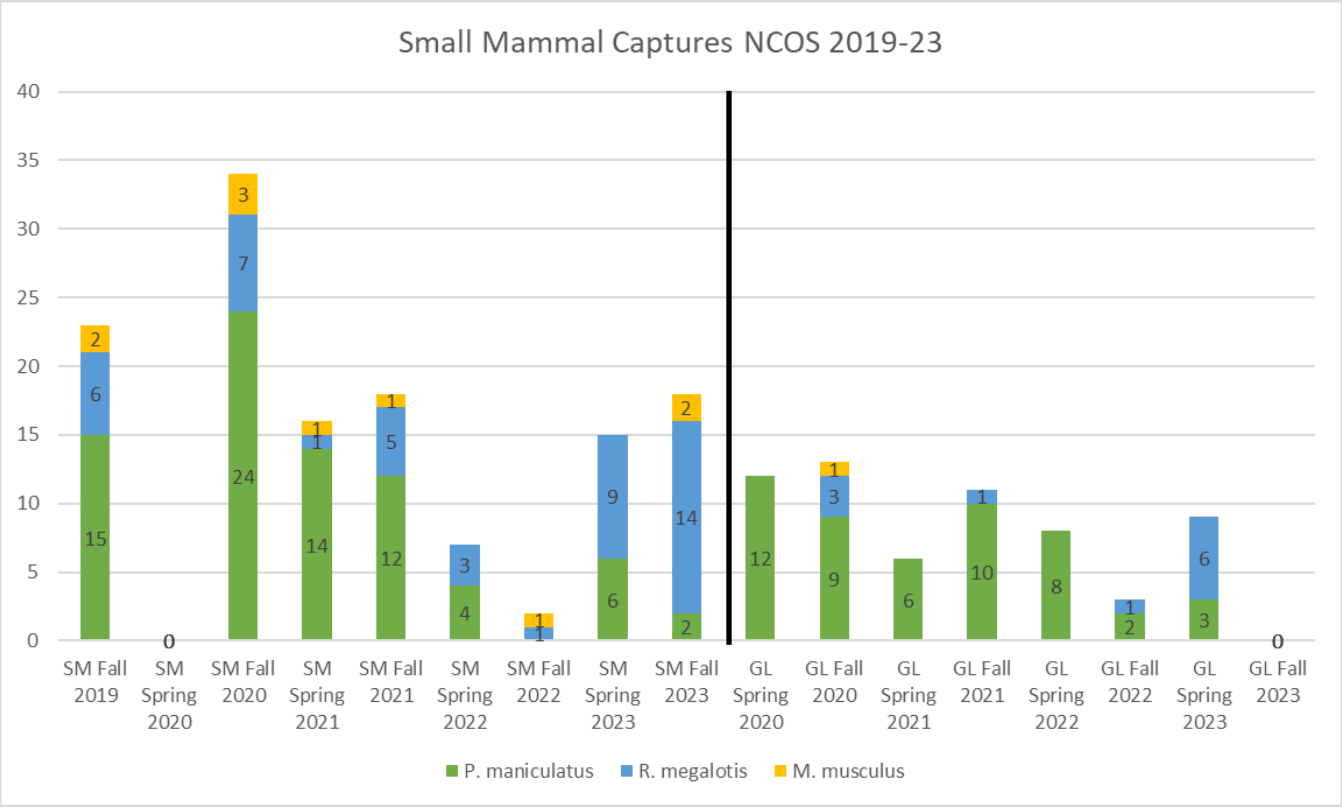


Figure 27. Small Rodent captures in three grids of 20 Sherman Live traps for four nights in a row in each habitat

In October 2020, we established and have continued a student-led, long-term monitoring project that involves counting and identifying vertebrates and invertebrates under 44 coverboards distributed across the mesa and transition/high salt marsh zone along the southwestern half of NCOS on a weekly basis. While this monitoring project is focused primarily on reptiles such as lizards and snakes, all other vertebrates and invertebrates encountered are being recorded and compared with data from pre-project coverboard surveys. The main purpose of this project is to compare small animal presence in a variety of habitats with different histories of disturbance and restoration. The student leader of this project presented the results at the Joint Meeting of Ichthyologists and Herpetologists in July 2022. The poster can be found here. Results, (figure 31) show that the western fence lizard is by far the most frequent vertebrate found under the coverboards followed by the western skink.

In addition, a camera trap observational study on the use of hibernaculum features was conducted in the later winter and spring of 2021 by a student who presented his results at the Ecological Society of America Conference in August 2021. This study identified 23 species of vertebrates using these rock features with 5 common species. Fence lizards and ground squirrels used the features during the day and mice and rabbits were more frequently observed at night. Burrowing owls used the sites in the day and night.

Figure 28. Coverboard plot locations

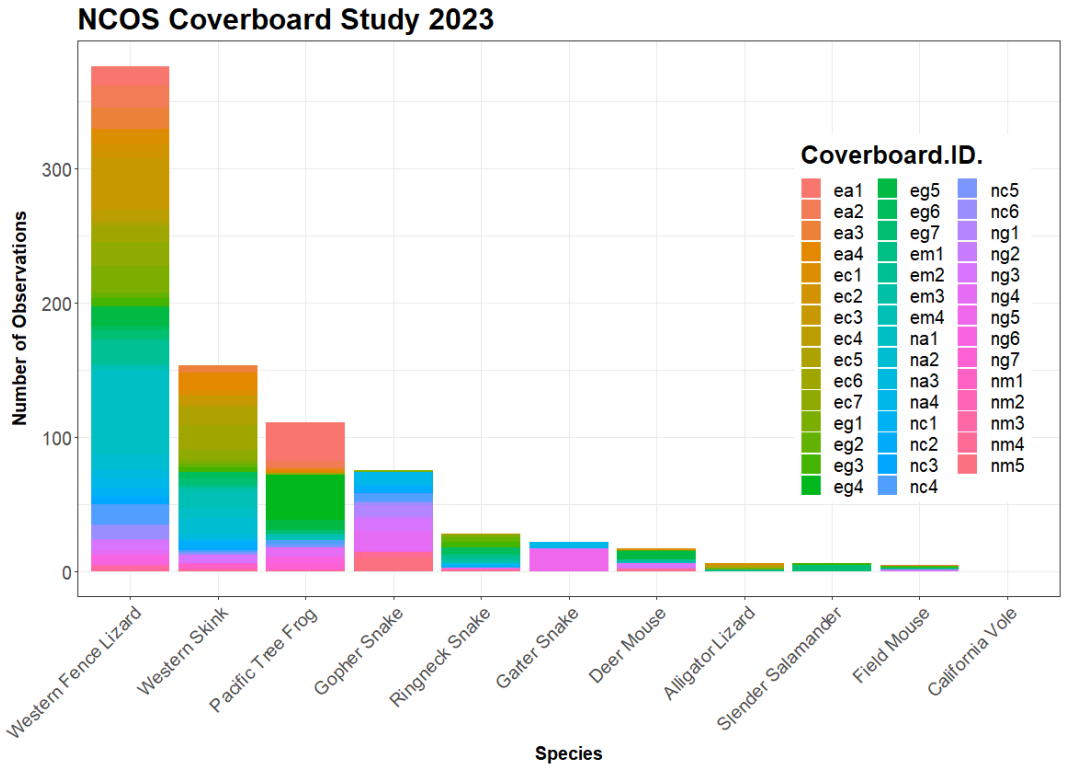


Figure 29. Location that species are found in the 2023 coverboard surveys.

5. HYDROLOGY AND WATER QUALITY

Hydrology and water quality monitoring at North Campus Open Space contributes to several objectives of the restoration project, such as: documenting the reduction of flood levels, monitoring the development and functionality of wetland habitats such as Devereux Slough and the newly created vernal pools, and developing long-term datasets that help improve knowledge and understanding of coastal ecosystems and how they may be affected by predicted future sea-level rise. Water quantity and quality is also correlated with our other monitoring efforts such as bird observations, vegetation success and small mammal counts.

In this section, we describe the monitoring methods and data for the following:

- various aspects of the hydrology of Devereux Slough,
- the hydrology of the vernal pools created on the NCOS mesa,
- dissolved oxygen and salinity levels at different locations and depths in the slough,

The hydrology of Devereux slough has varied each year. 2019 was a wet year with many scattered small storms, 2020 was an average year in terms of rainfall quantity with mostly medium sized storms. 2021 was very dry- producing less than half of the average rainfall and one large storm was responsible for more than 60% of the year's water. In 2021 the slough breached in January and there was no subsequent water to fill the slough. 2022 was also dry, but not as extreme as 2021. The majority of rainfall occurred early in the season with many scattered storms in December resulting in an early breach. There was enough late season rain that the slough did not dry up until mid-summer. 2023 was an especially interesting water year. The frequent and intense rainstorms caused the sand berm to breach 3 times in 2023. The total 2023 water year had nearly twice as much rain as the average (32 inches).

Surface water overview

The hydrology data is important for documenting the increased water holding capacity of Devereux Slough, and the timing, frequency, and duration of tidal flux. There is a sand berm at the mouth of the slough that typically breaches once a year causing Devereux slough to become tidal. In the 2023 water year the atmospheric rivers and persistent rain caused the berm to breach 4 times throughout the year. The breaches during 2023 water year were near the timing of high tide, therefore once they breached, they remained tidal for many days. In 2023 the slough breached on Jan 1, Feb 25 and March 10.

Table 4. Dates that the Devereux Slough breached, had tidal influence and closed

Water Year	Start date	End date	days tidal	Days not tidal
2019	Jan 7, 2019	March 21, 2019	47	26
2020	March 16, 2020	April 5, 2020	9	11
2021	Jan 28, 2021	Feb 15, 2021	18	0
2022	Dec 23, 2021	Jan 16, 2022	22	2
2023	Dec 31, 2022	Feb 4, 2023	28	7
2023	Feb 25, 2023	March 4, 2023	7	1
2023	March 10, 2023	March 30, 2023	20	1

The water stage monitoring loggers were relocated in the 2023 water year. The lower slough now contains a Solinst LTC levelogger and a minidot DO monitor, Venoco bridge has the YSI EXO and all other sites have a Sonlinst LT levelogger. The Leveloggers are set at a fixed depth within a few inches of the bottom or floor of the channel or pond. The approximate elevation (in North American Vertical Datum 1988, NAVD88) of the deployed leveloggers has been determined using either a Real Time Kinematic GPS unit, or by measuring the difference in elevation relative to the nearest reference point.

Table 5. Deployment location and elevation (in feet NAVD88) of pressure transducer loggers (YSI EXO1 and Solinst Leveloggers) that record water levels every 15 minutes in Devereux Slough and the North Campus Open Space. The deployment locations are indicated in the map in Figure 30.

Deployment Location	Logger Elevation (ft. NAVD88)
Devereux Slough Pier	3.4
East Arm Trail Bridge	4.51
Phelps Creek - Marymount Bridge	9.99
Venoco Bridge - north side (YSI EXO1 sonde)	2.96
West Arm - Devereux Creek	8.41
Whittier Storm drain	10.41
Whittier Pond	5.04

All loggers record the water level every 15 minutes. The Solinst loggers are compensated using barometric pressure data from a solinst barrologger at the ROOST. Water level data is converted to water surface elevation (WSE) in feet (NAVD88) using either the known elevations of the loggers or regular readings of a WSE staff. Some of our older leveloggers had issues in recording data due to age and technical difficulties. If there is a gap in the figures below it is due to errors in the device.

Elevation profiles of the beach berm at the mouth of the slough are measured at least twice per year. This contributes to the development of a long-term database that documents how the wetland functions under wet and dry conditions and improves our understanding of breaching and tidal patterns as well as evaporation and low flows. The data will also be valuable for documenting potential future changes in sand berm elevation associated with sea level rise.

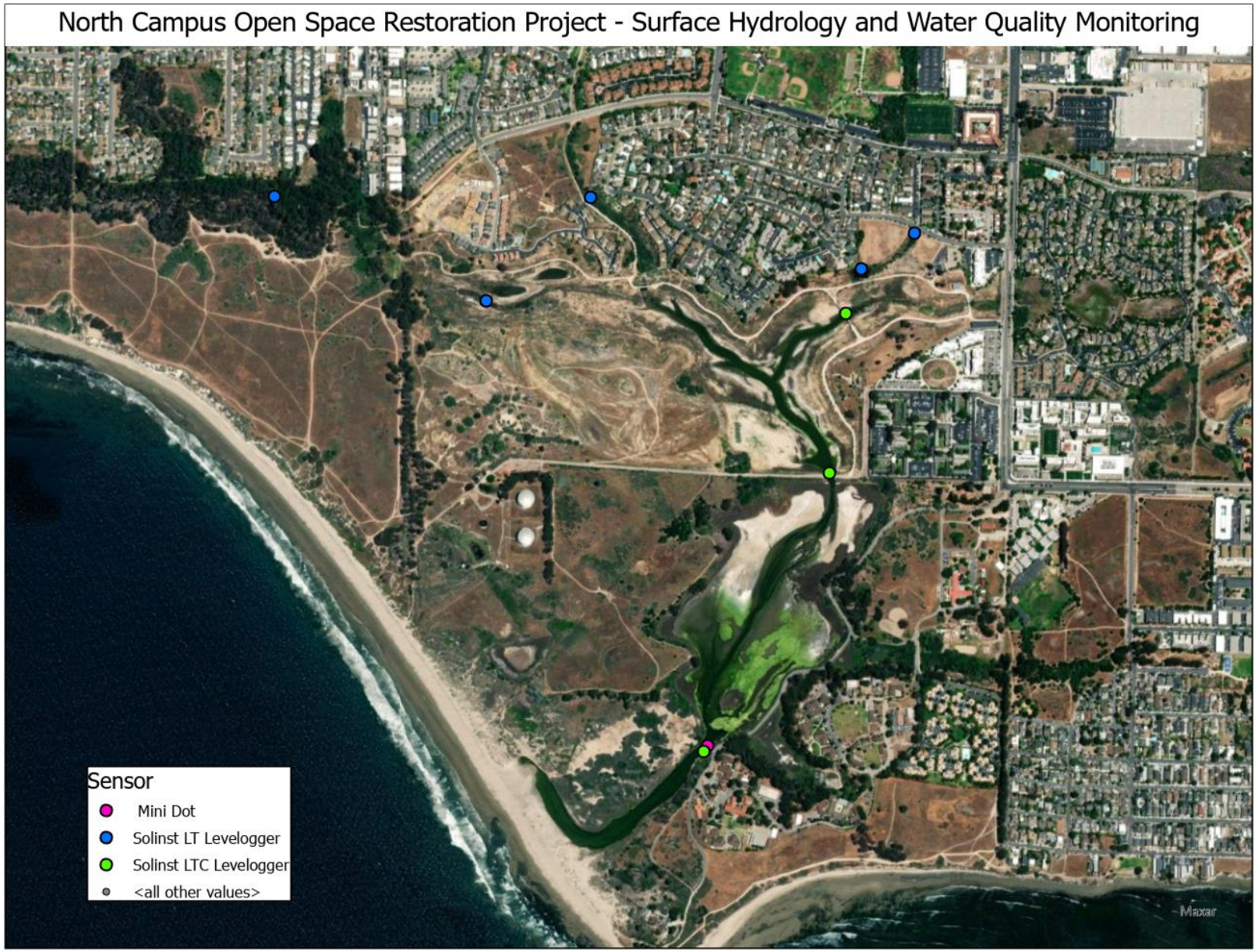


Figure 30. Map of the surface hydrology and water quality monitoring sites at North Campus Open Space and lower Devereux Slough. See Figure 1 for a legend of the habitats/vegetation communities.

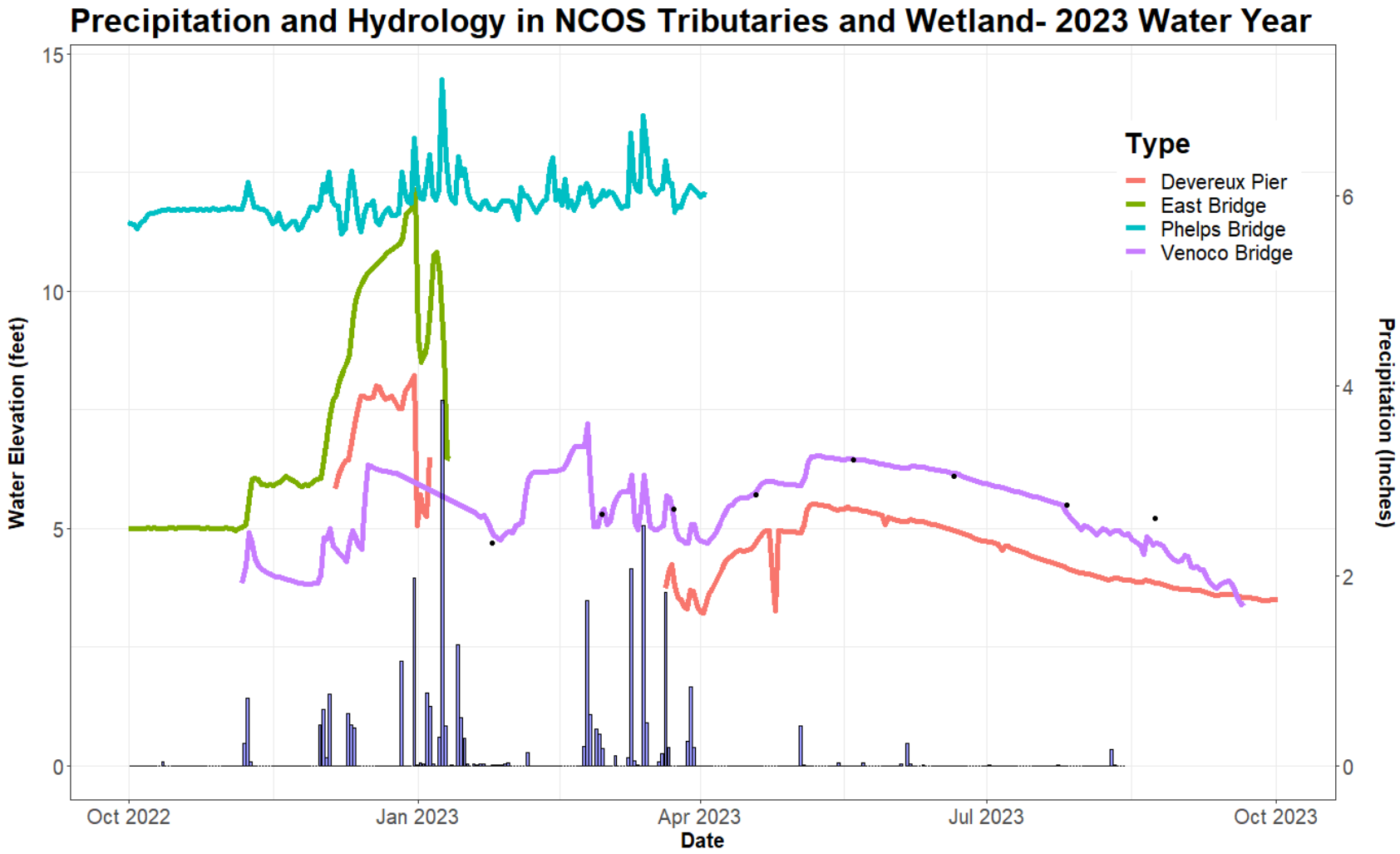


Figure 31. Water elevation collected from leveloggers located at NCOS tributaries and the Wetland (Devereux Slough). Rainfall from NOAA for Water year 2023. Dark blue dots represent manually collected water elevation at Venoco bridge.

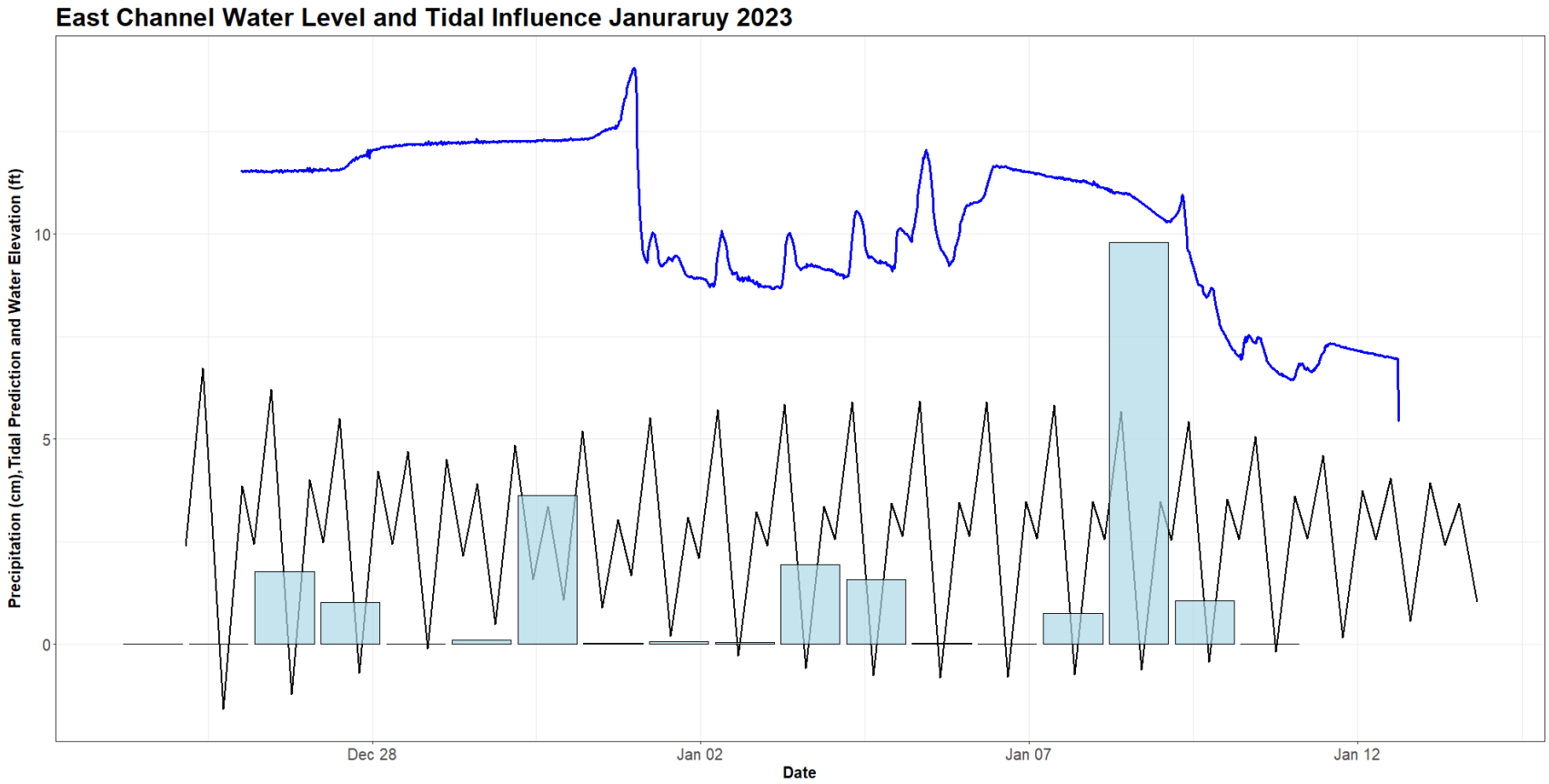


Figure 32. Water elevation collected from Solinst levelogger at East Channel Bridge (The Venoco Bridge pressure transducer was out of service at the time). Tidal predictions and rainfall from NOAA for Water year 2023.

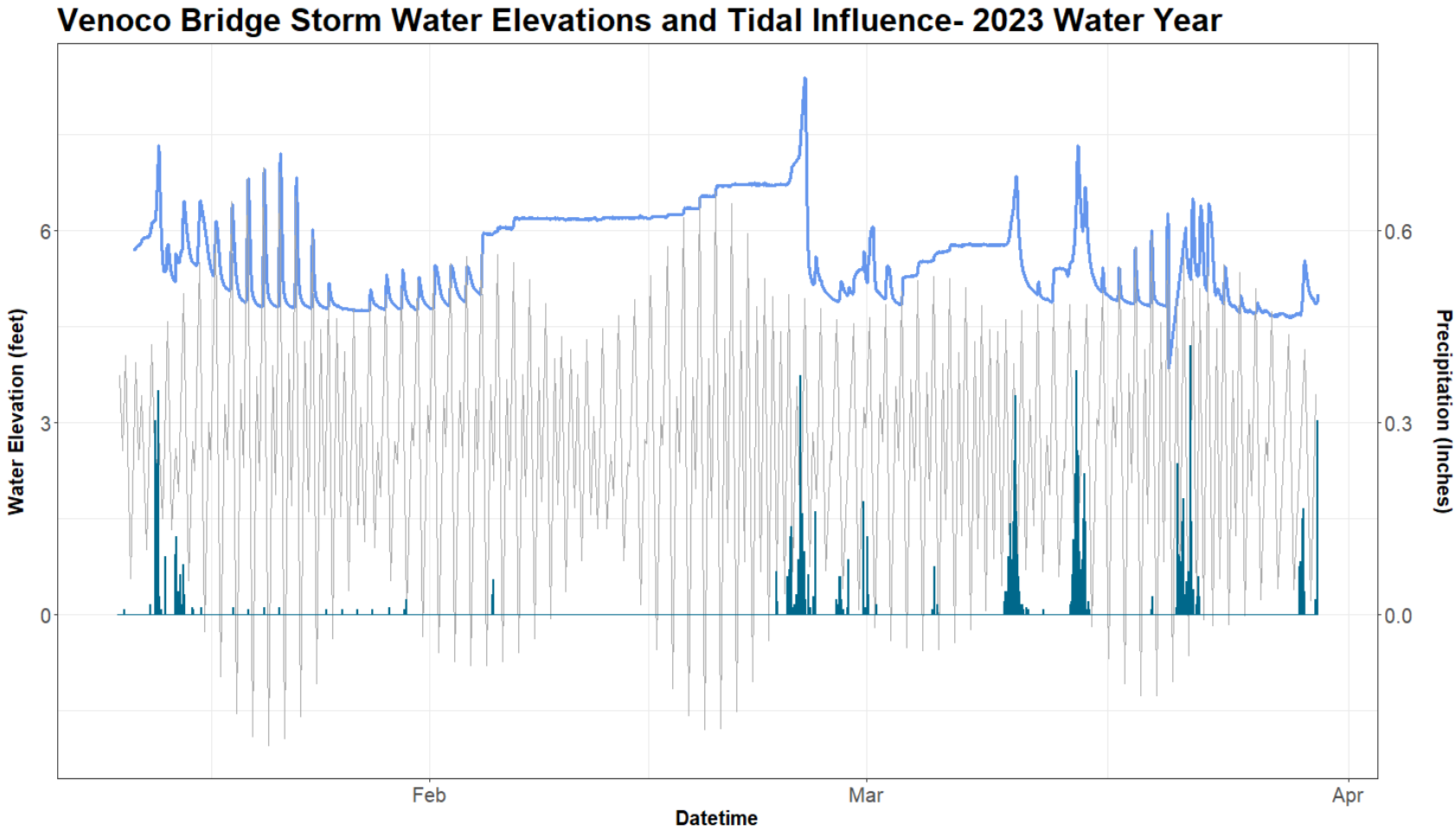


Figure 33. Water elevation collected from Solinst levelogger at Venoco Bridge. Tidal predictions and rainfall from NOAA for Water year 2023.

Surface Water Levels

Prior to the NCOS restoration project, half of the larger wetland's potential water-holding capacity was supplanted by fill soil deposited to create the Ocean Meadows golf course. This led to flooding of the golf course and adjacent low-lying areas near homes during storm events. Our hydrology data shows that the amount of water level rise in Devereux and Phelps Creeks during storms has decreased from pre-project levels by at least one foot. The efforts of this project earned major recognition in September 2021 when FEMA officially issued a LOMR (Letter of Map Revision), which formally documents a change to the flood hazard zone of an area. The flood hazard zone is the extent of a particular landscape subject to a 1% chance of flooding in a year. Structures within the Flood Hazard Zone are required to secure flood insurance if they have federally backed mortgages. Because of the project efforts and this official revision some local residential communities are no longer considered to be in a flood hazard zone. The full article can be found on the CCBER webpage.

Vernal Pool Hydrology

Vernal pool hydrology monitoring consists of standardized recording of water levels in the restored pools created on the NCOS mesa to assess their development and ecological functionality. Water levels in the eight vernal pools on the mesa (see map in Figure 39) are monitored on a weekly basis starting when the pools begin to hold water after the first rains of the wet season and continuing until the pools become dry. Water levels in the pools are measured to the nearest quarter inch by reading a ruler attached to a pvc pipe that is installed at the deepest area of each pool. This monitoring is conducted by Cheadle Center staff and student interns.

The sixth year of vernal pool hydrology monitoring (water year 2023) began on December 16th, 2022 after the first rainstorm. Vernal pools 1, 2, 4, 5 and 8 were all inundated for more than 100 days indicating that they can provide the ecological function of a natural vernal pool. All vernal pools stayed wet for longer than the previous 2 water years due to the frequency and consistency of rainfall throughout the rainy season. Vernal pools stayed inundated longer in the 2020 water year despite there being more rain in 2023.

Figure 34. Map of the mesa area of North Campus Open Space with the restored vernal pools labeled with their number. See Figure 1 for a legend of habitat features/plant communities.

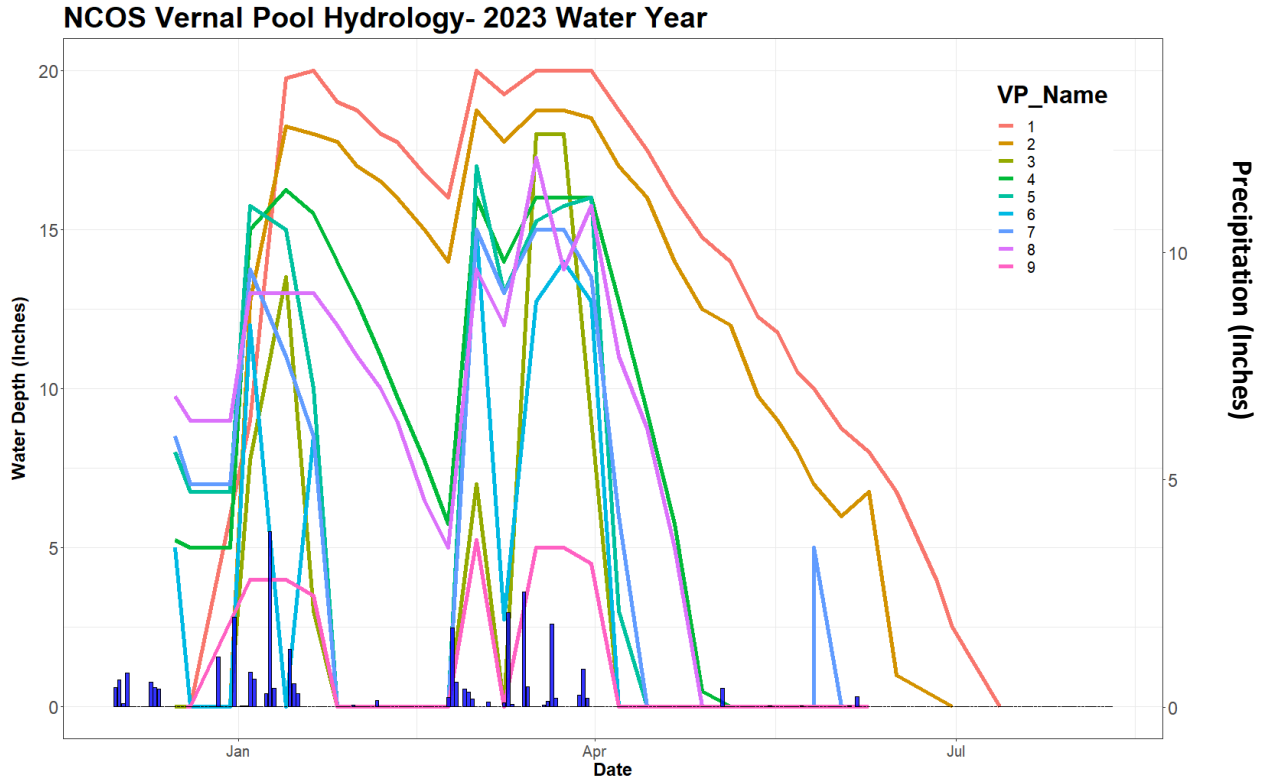


Figure 35. Hydrograph of weekly water depth (inches) in nine of the restored vernal pools on the North Campus Open Space (NCOS) mesa in the 2023 water year

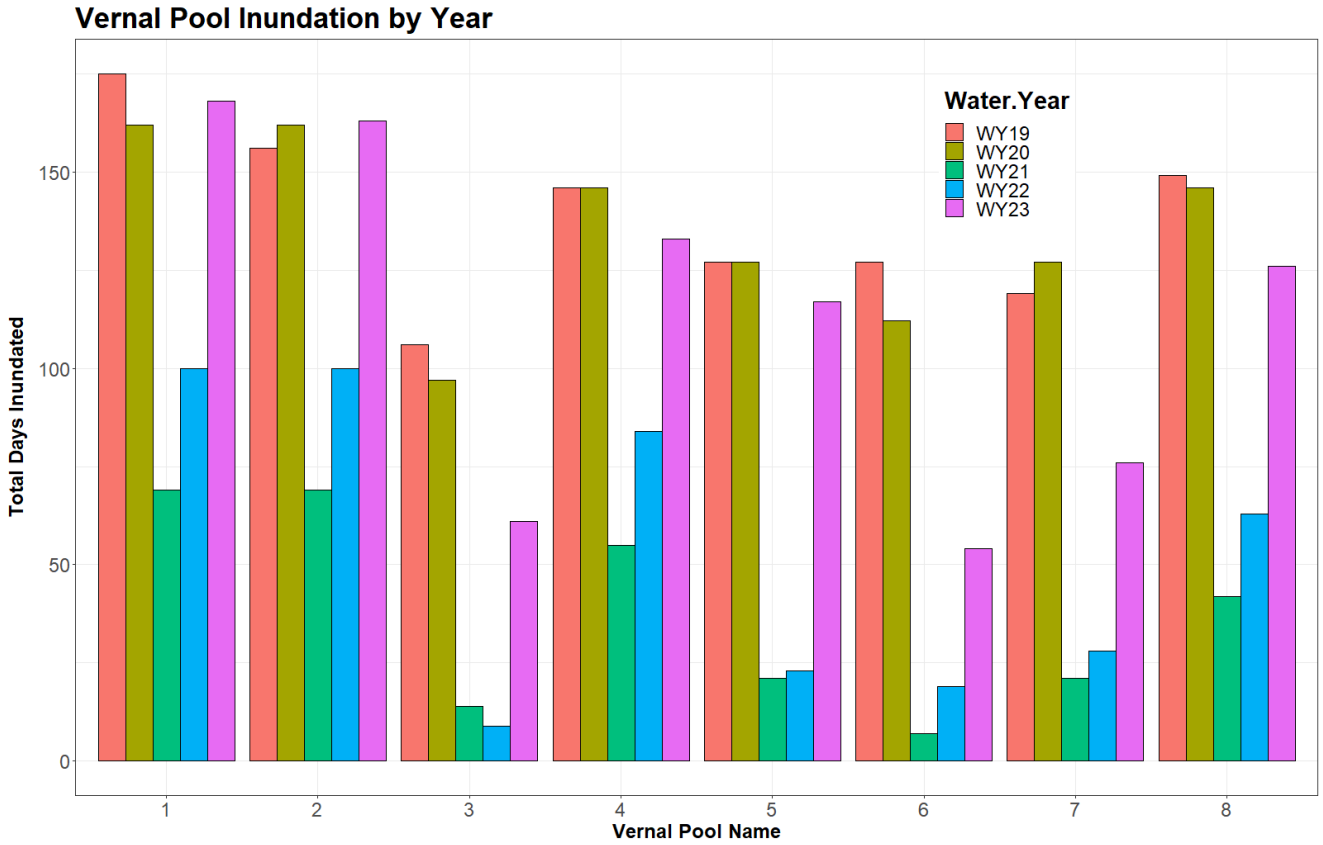


Figure 36. Number of days that Vernal Pools are inundated for each water year monitored. Vernal pool water depth is determined by Cheadle Center field staff and is monitored once per week. If vernal pools dry out between rain events, it is assumed that they are dry for 5 days, since days that are not monitored are not accounted for.

Devereux Slough Water Quality

The enhancement of the ecological health and function of Devereux Slough is a key goal of the NCOS restoration project. The Cheadle Center monitors many aspects of water quality to track progress toward this goal. In year six this monitoring consists of two components:

1. Automated collection of data on dissolved oxygen, conductivity, salinity and temperature as well as water level using a multi-parameter sonde at a fixed location in the lower section of the slough in Coal Oil Point Reserve.
2. Weekly collection of data on dissolved oxygen, conductivity, salinity, and temperature at one foot depth intervals at three locations in the restored upper arms of the slough at NCOS using a handheld water quality sensor.

In years 1-5 we also collected storm nutrient data. This can be found in the Year 1-5 reports.

Lower Slough Water Quality Data - Methods

Data was collected with a multi-parameter YSI EXO1 sonde until January and in March we replaced the device with a Solinst LTC and minidot logger due to YSI malfunctions. The YSI is now functioning properly and deployed at Venoco bridge.

In this report, we present the daily average of the parameters recorded by the EXO1 sonde for the 2023 water year. Data from previous years can be found in previous reports. Water years differed greatly in the amount of precipitation received and the response of water quality measurements. Unfortunately, all years experienced some extent of equipment malfunction.

Lower Slough Water Quality Data – Data Summary & Main Observations

The dissolved oxygen tends to be highest during the rainy season due to the frequent movement of water both from rainfall flow and tidal flow. This pattern has been observed all years to different extents. The conductivity in the 2023 water year is significantly lower than the conductivity in all other monitoring years. This is likely to the increased precipitation and scattered late season precipitation after the slough mouth had closed.

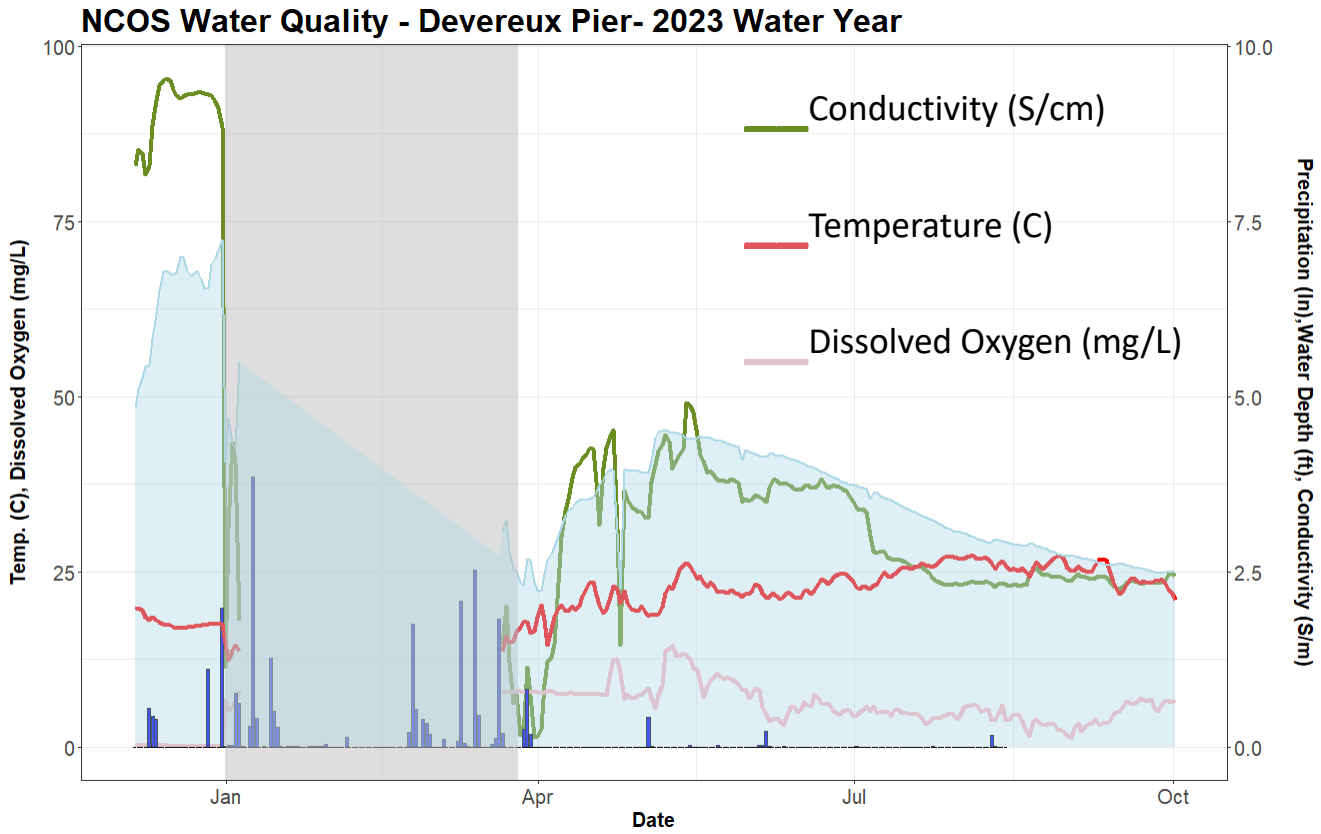


Figure 37. Daily average water quality and level data recorded in the 2023 water year (October 1st to September 30th) with a YSI EXO1 sonde and minidot logger in the lower portion of Devereux Slough (see map in Figure 32). The water surface elevation is in NAVD 88. Precipitation data was recorded at a NOAA climate station on Coal Oil Point Reserve. Grey portion represents a period with missing data.

Restored Upper Slough Water Quality Monitoring - Methods

In the restored upper Devereux Slough, we collect dissolved oxygen, conductivity/salinity, and temperature data at three locations on a weekly basis (figures 38-40) using a portable YSI Pro2030 at the three bridges that cross the upper slough: the Marsh trail bridges over the Phelps Creek outlet and across the east channel, and the Venoco access road bridge. From the bridges, the sensor is lowered to the water and data are recorded at the surface and at each foot of depth down to the bottom. The purpose of this monitoring is to assess the stratification and variability of these water quality parameters at different locations in the wetland. This data provides environmental information for interpreting results from the monitoring of aquatic organisms such as arthropods and the tidewater goby, and it contributes to our understanding of the functionality of the wetland.

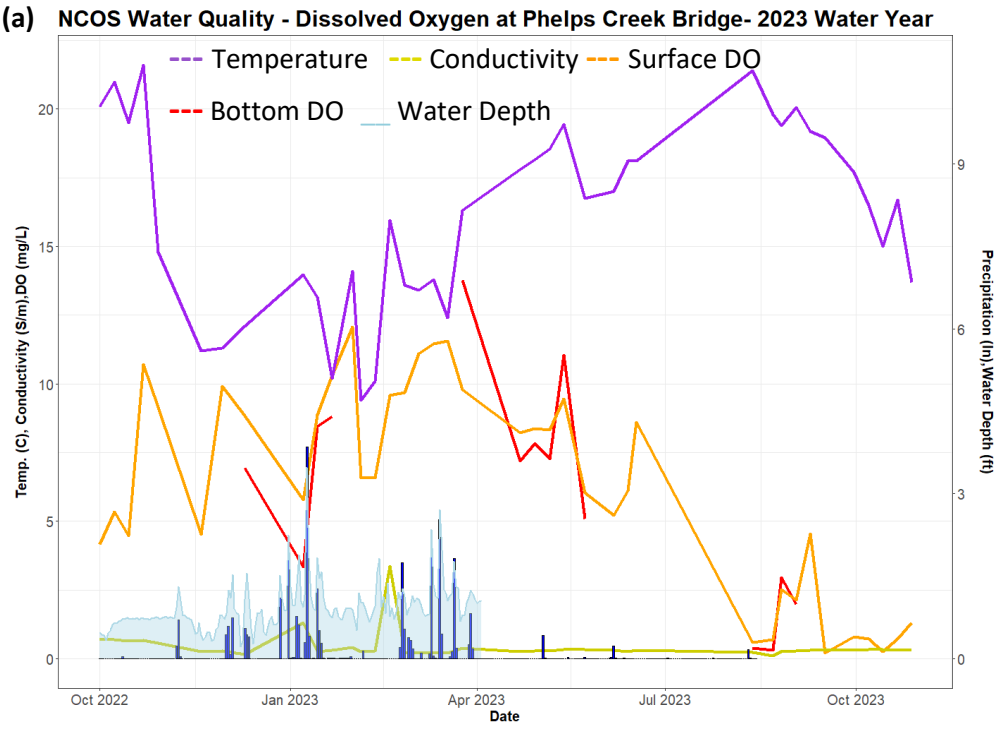
Restored Upper Slough Water Quality Monitoring – Data Summary & Main Observations

There are many factors that affect DO concentrations in water; one of the more prevalent factors is stratification. In stratified waters, the water's surface typically has more DO than the bottom for two reasons. First, water at the top typically has low salinity and can hold more O_2 than water at the bottom with high salinity. Second, plants such as duckweed that float on the water's surface produce O_2 while

organisms at the bottom consume O_2 and oxygen can enter the surface from the air through diffusion which is facilitated by surface wind and mixing. We see the most stratification at our sites in the winter when rainfall is most frequent and the water is the deepest. The winter also typically has higher DO than summer because low salinity and low temperatures result in a higher capacity for water to hold DO.

In most years we see stratification of the DO levels, however there was no clear stratification in 2023 due to the frequent heavy rainstorms and the long periods of tidal connectivity. Regular DO levels above 2 mg/L indicates that the wetland can functionally support aquatic wildlife year-round. DO was above this critical threshold for all months except for a brief dip in September 2023 at all sites.

Venoco Bridge has the highest conductivity of the 3 sites due to its juxtaposition to the open slough. East bridge will experience some slight tidal influence and therefore salinity increase during high tide events after slough breaks. Conductivity at the Phelps Creek outlet remains at freshwater levels, with occasional brief increases likely caused by brackish water reaching the area when the slough is tidal. In the 2023 water year there were many heavy rainstorms accompanied with the frequent opening of the Slough. This caused more mixing of the water than usual and therefore stratification was less evident.



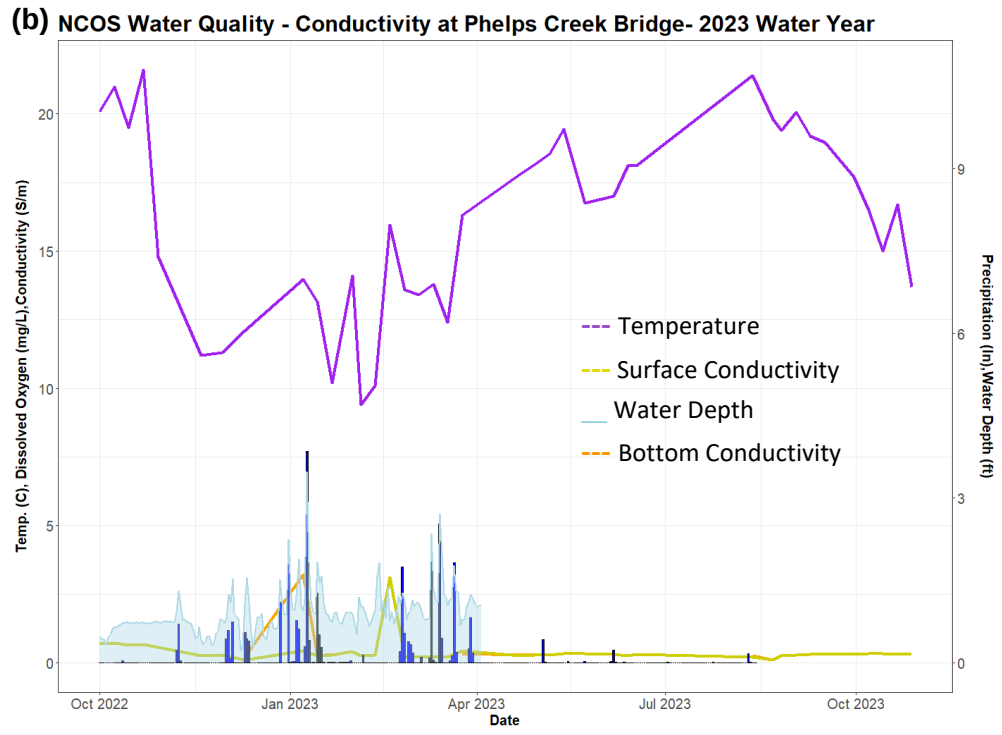


Figure 38. (a) . Dissolved oxygen (mg/L) at the surface (top 1 ft) and bottom of the water column recorded weekly in the 2023 water year with a YSI Pro2030 (b) Conductivity (Siemens/meter) at the surface (top 1 ft of water column) and bottom of the water column recorded weekly in the 2023 water year with a YSI Pro2030 at the Phelps Creek outlet to the upper Devereux Slough, North Campus Open Space. The temperature (Celsius) is averaged across all depths. Precipitation data was obtained from a NOAA climate station.

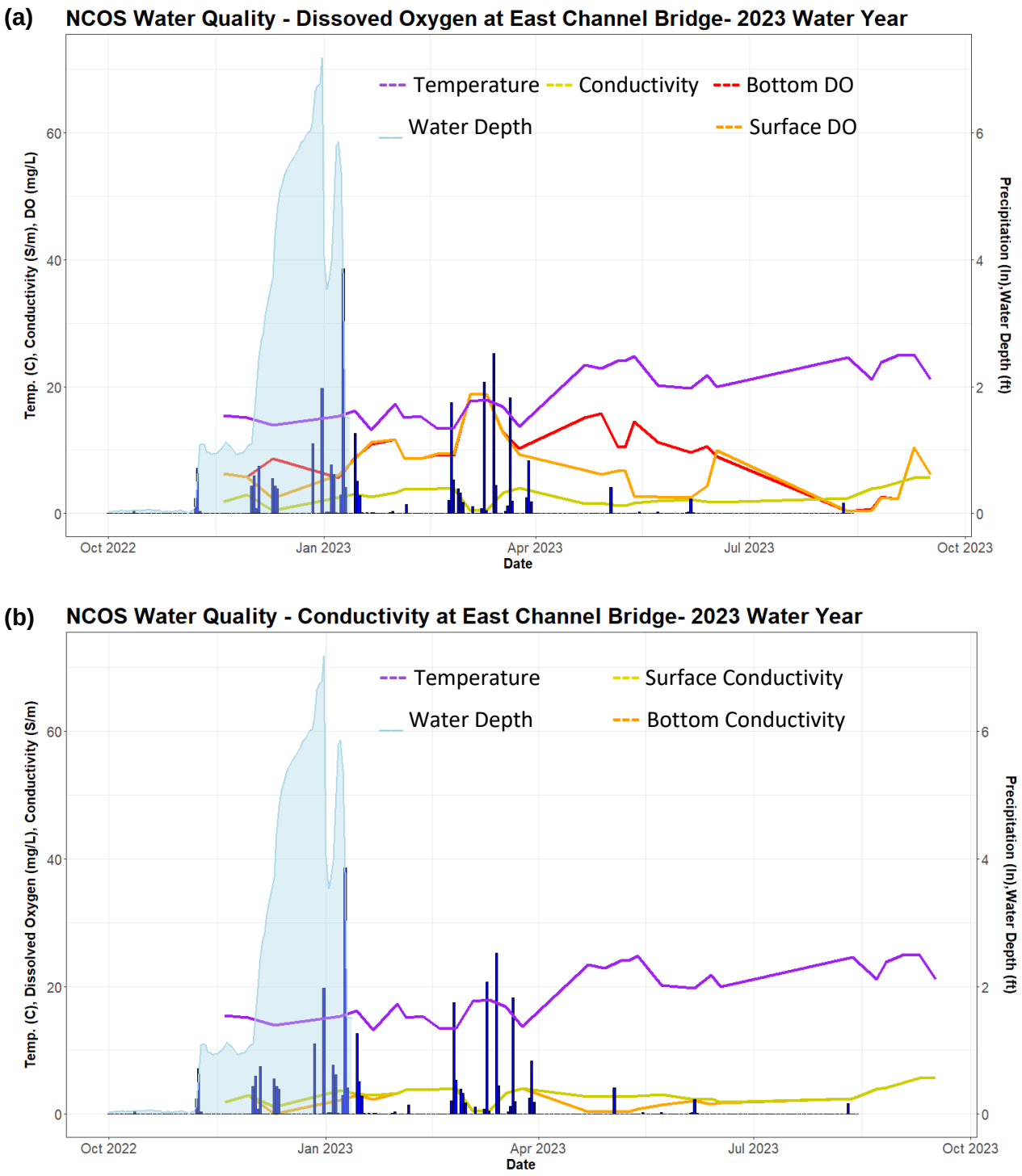


Figure 39. (a) Dissolved oxygen (mg/L) at the surface and bottom of the water column (b) Conductivity (S/m) at the surface and bottom of the water column recorded weekly in the 2023 water year with a YSI Pro2030 in the east channel of North Campus Open Space. The temperature (C) and conductivity are averaged across all depths. Precipitation data was obtained from a NOAA climate station on Coal Oil Point Reserve.

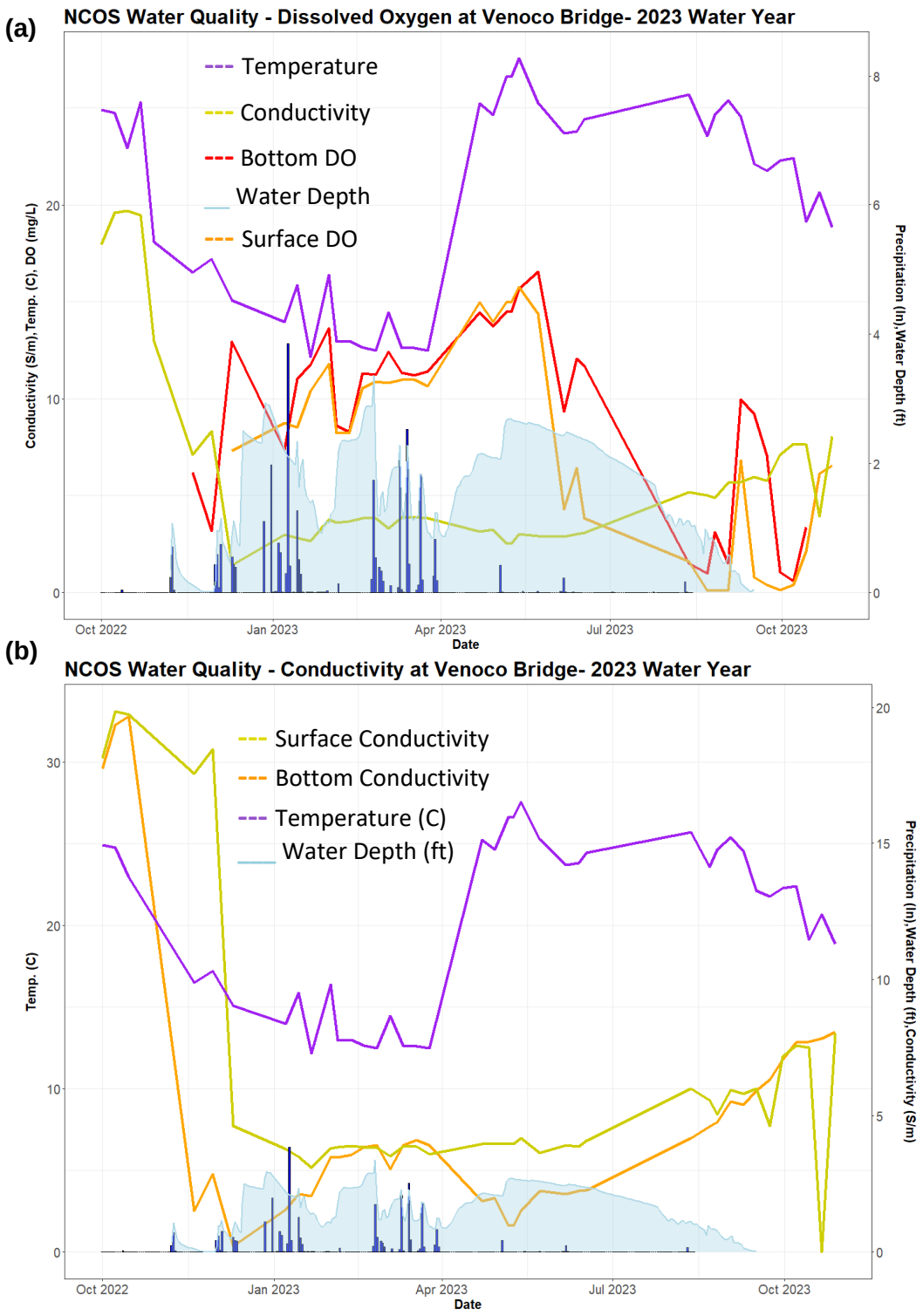


Figure 40. (a) Dissolved oxygen at the surface and bottom of the water (mg/L) (b) Conductivity (S/m) at the surface and bottom of the water column recorded weekly in the 2023 water year with a YSI Pro2030 in the main channel at the Venoco access road bridge, North Campus Open Space. The temperature (Celsius – purple line) is averaged across all depths. Precipitation data was obtained from a NOAA climate station on Coal Oil Point Reserve.

APPENDIX 1 – PHOTO-DOCUMENTATION SAMPLES

The following photographs are samples from the photo-documentation monitoring of the North Campus Open Space restoration project taken from the five points circled in turquoise in the map below (14, 20, 31, 33a, and 41).

Map of photo monitoring points at the NCOS restoration project. See Figure 2 for a larger map with legend.

Photo point 14 – looking northwest over the Mesa from the east leg of the Mesa trail

Year 1 – July 2018

Year 5 - October 2022

Year 6 – October 2023 (post cultural burn)

Photo point 20 – looking northwest from the southeast corner of the NCOS project site

Year 1 – October 2018

Year 6 – October 2023

Photo point 31 – looking east from trail overlook on east side of Phelps Creek

Year 1 – October 2018

Year 6 – October 2023

Photo point 33a – looking southwest from upper end of east arm of restored wetland

Year 1 – October 2018

Year 6 – October 2023

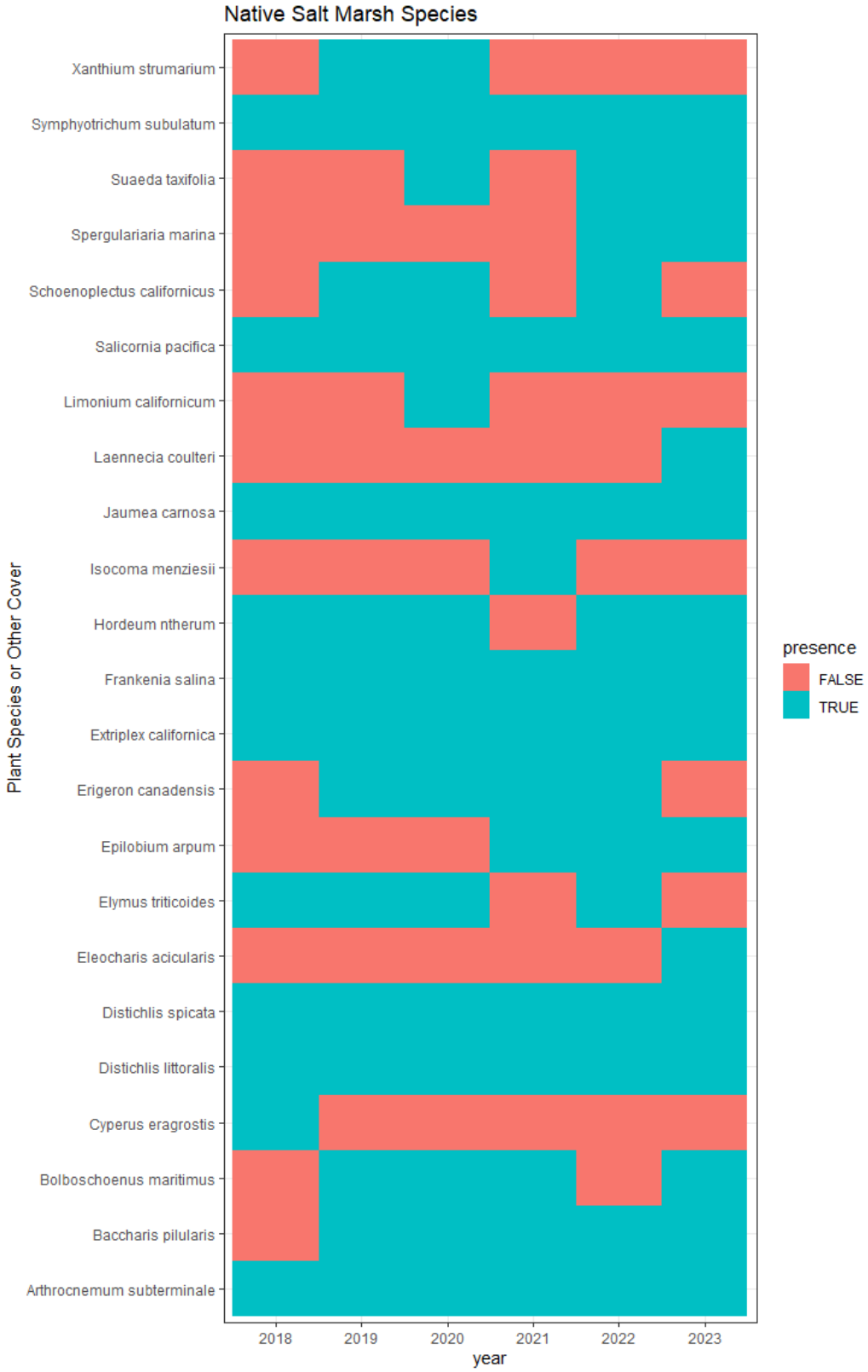
Photo point 41 – looking south from trail along north side of east arm of restored wetland

Year 1 – October 2018

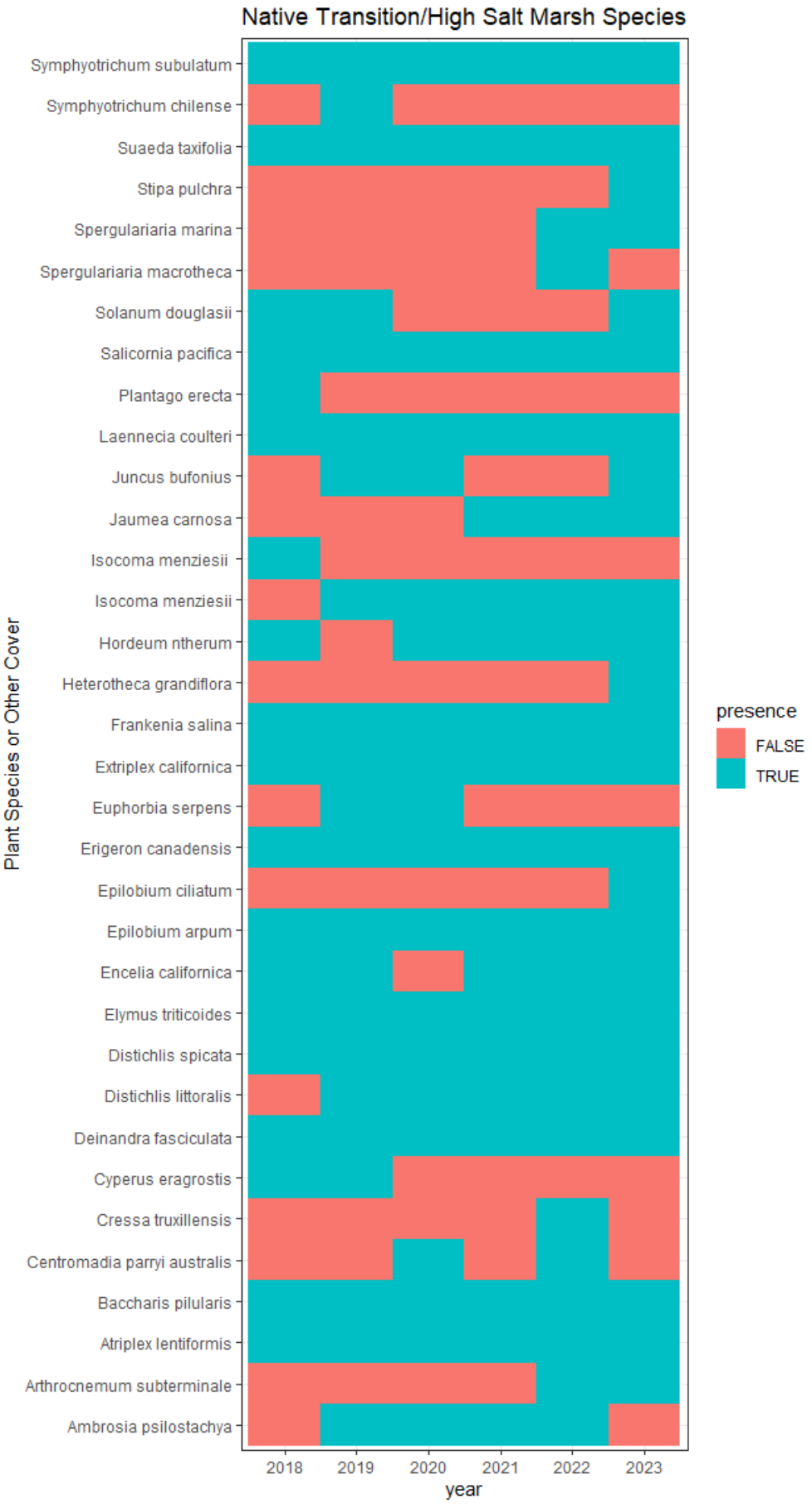
Year 6 – October 2023

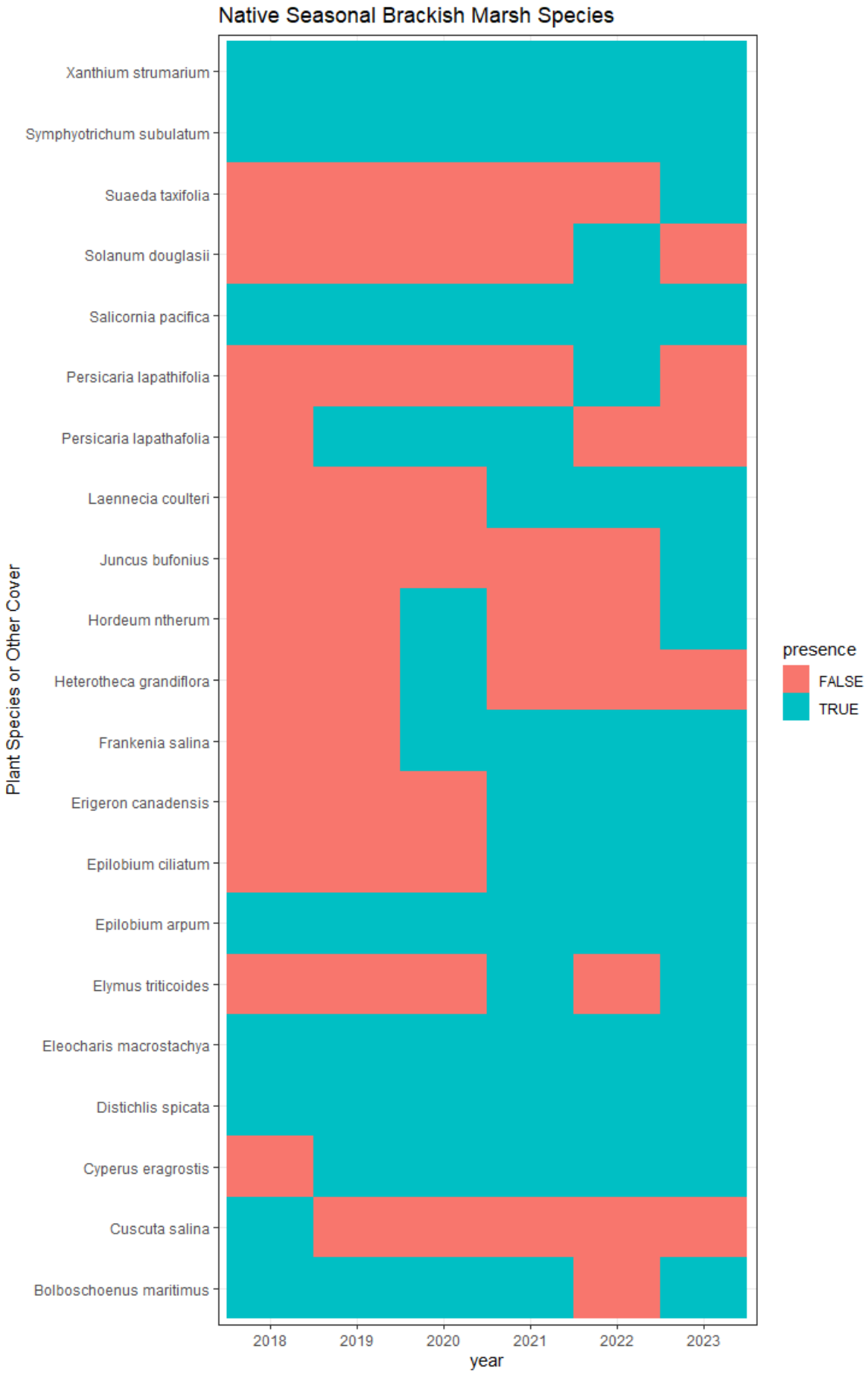
APPENDIX 2 – VEGETATION MONITORING PLANT SPECIES LISTS

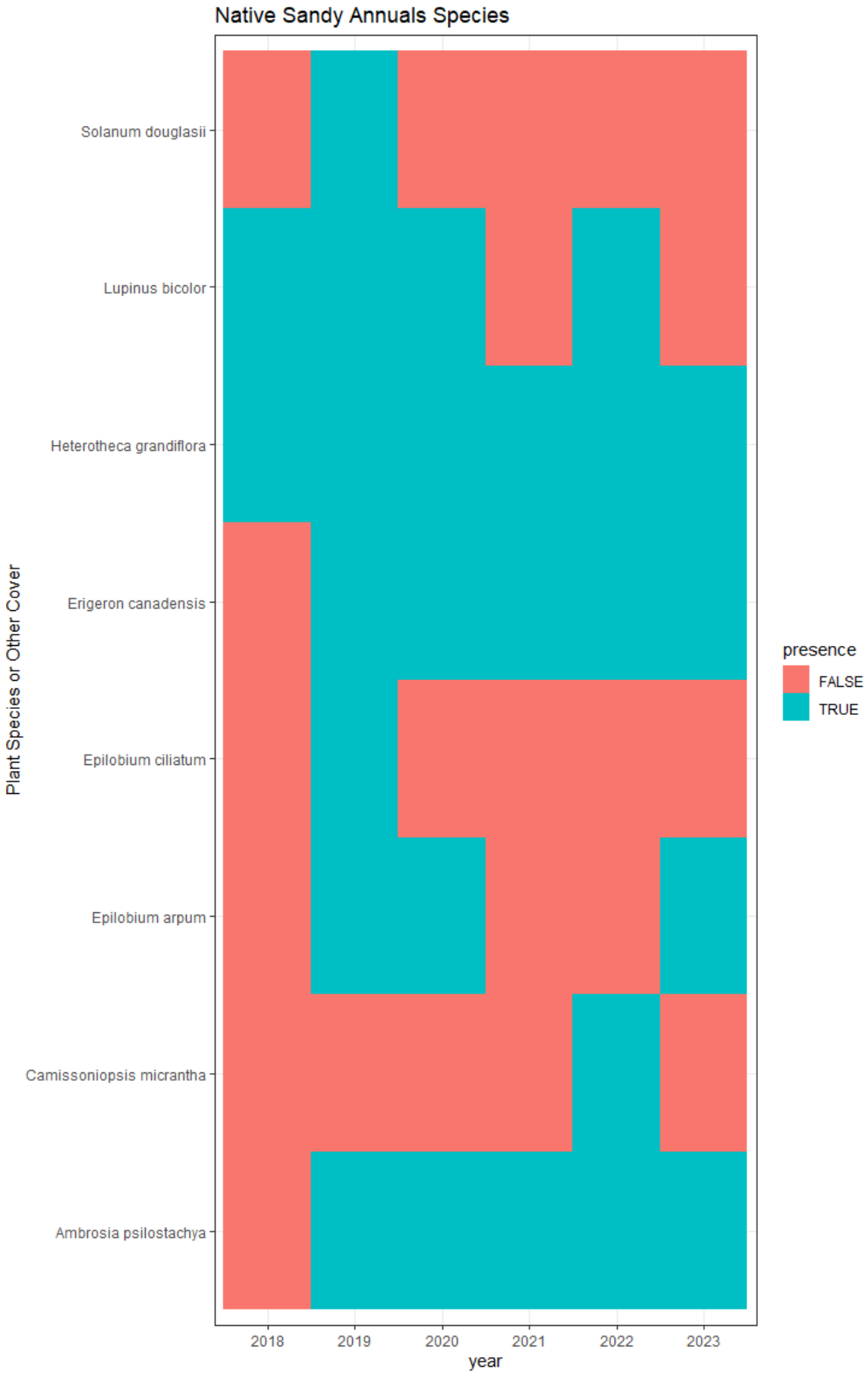
Table A2.1. Native plant species recorded during vegetation monitoring at the North Campus Open Space project by plant community and covering presence/absence by year.

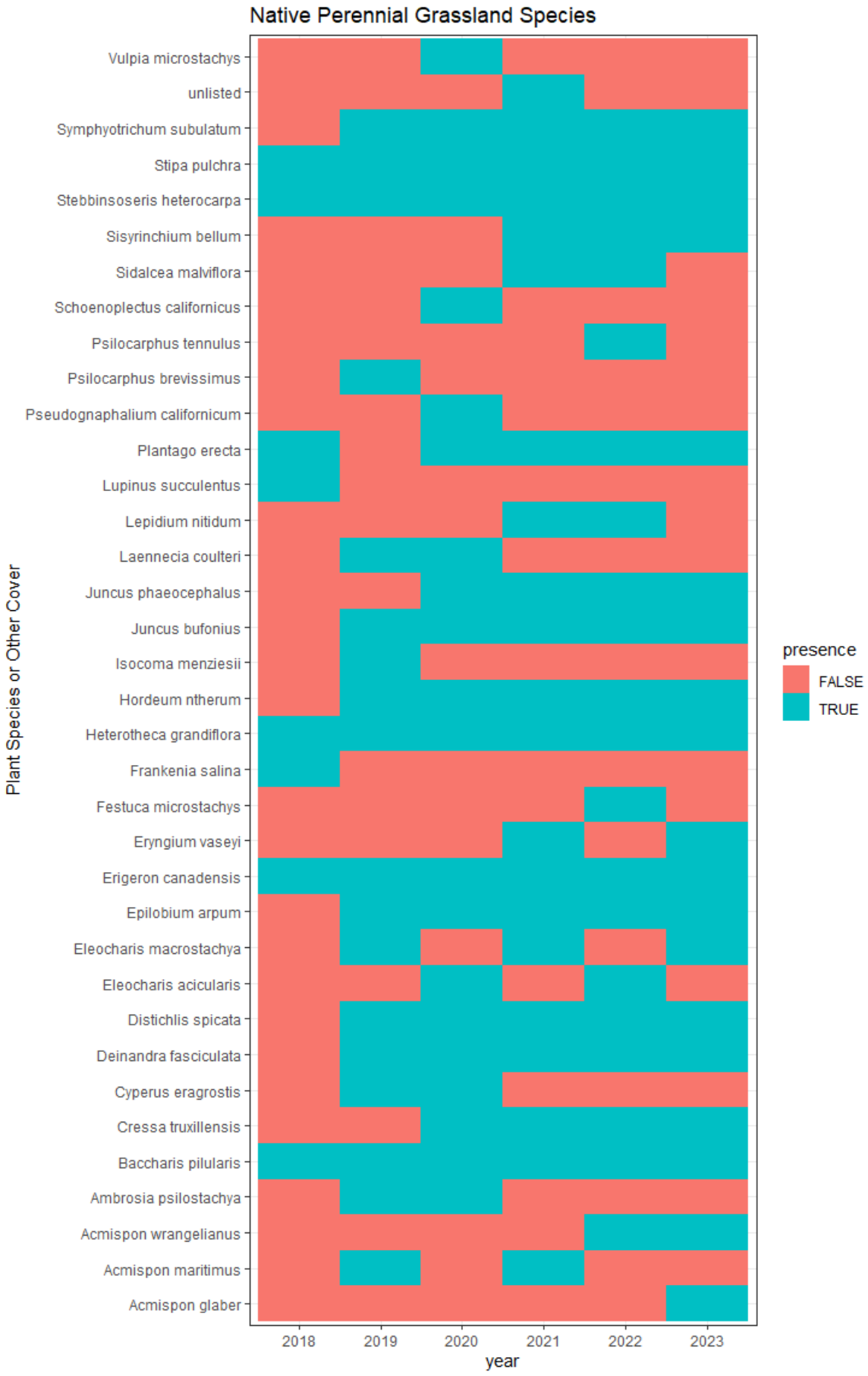


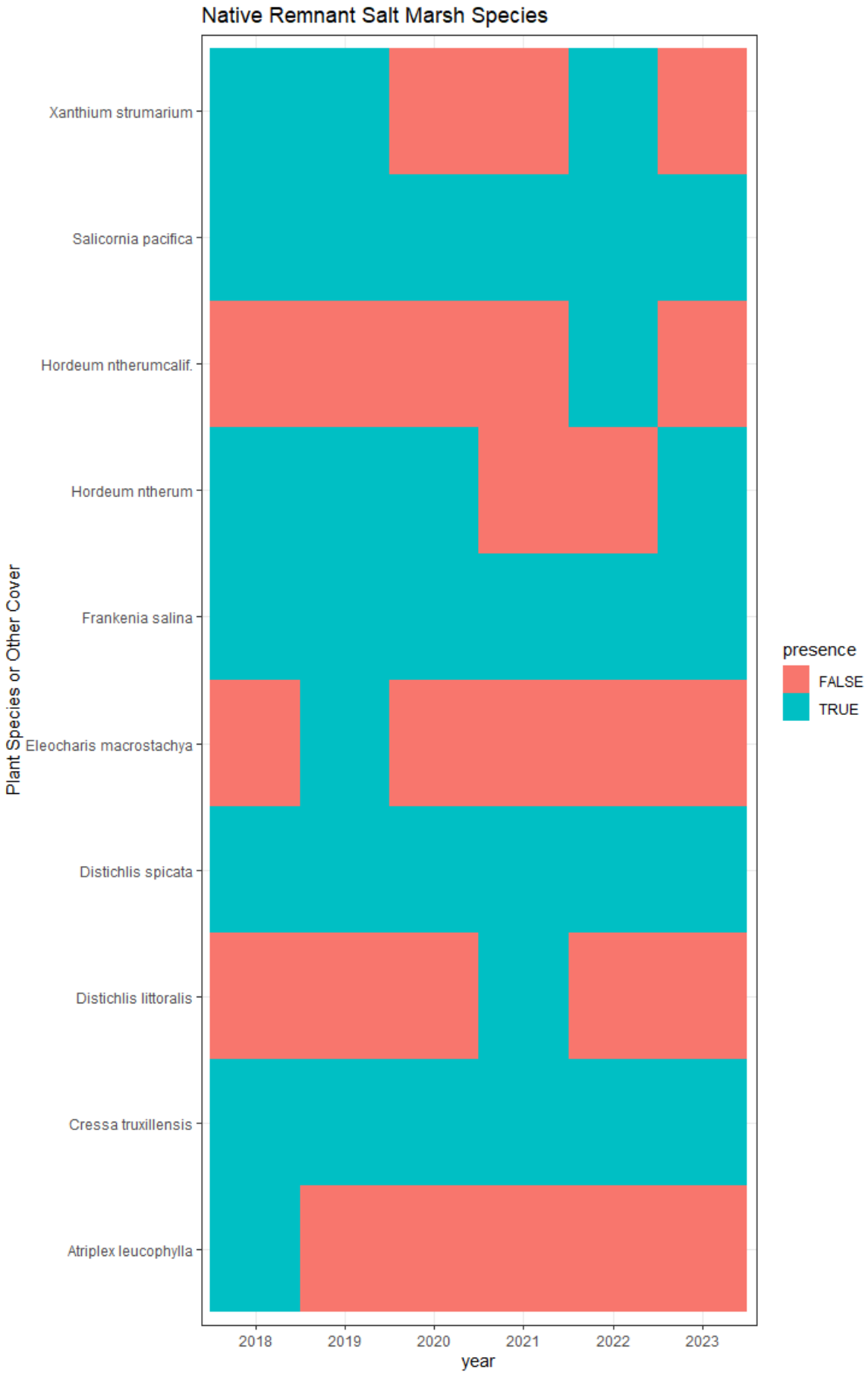

Native Vernal Pool Species
unlisted
Typha latifolia
Symphyotrichum subulatum
Symphyotrichum chilense
Stipa pulchra
Stebbinsoseris heterocarpa
Spergulariaria marina
Spergularia marina
Solanum douglasii
Sisyrinchium bellum
Schoenoplectus californicus
Salvia leucophylla
Salix lasiolepis
Rhus integrifolia
Quercus agrifolia
Psilocarphus tennulus
Psilocarphus brevissimus
Plantago erecta
Plagiobothrys undulatus
Plagiobothrys bracteatus
Phalaris lemmonii
Melica imperfecta
Madia sativa
Lupinus succulentus
Lepidium nitidum
Laennecia coulteri
Juncus phaeocephalus
Juncus patens
Juncus occidentalis
Juncus mexicanus
Juncus bufonius
Hordeum ntherumcalif.
Hordeum ntherum
Heterotheca grandiflora
Grindelia camporum
Frankenia salina
Euphorbia serpens
Eryngium vaseyi
Eriophyllum confertiflorum
Eriogonum parvifolium
Erigeron canadensis
Epilobium arpum
Encelia californica
Elymus glaucus
Eleocharis macrostachya
Eleocharis acicularis
Distichlis spicata
Distichlis littoralis
Deinandra fasciculata
Datura wrightii
Cyperus eragrostis
Crassula aquatica
Corethrogyne filaginifolia
Centromadia parryi australis
Bromus carinatus
Brickellia californica
Bolboschoenus maritimus
Baccharis salicifolia
Baccharis pilularis
Artemisia californica
Ambrosia psilostachya
Alopecurus saccatus
Acmispon wrangelianus
Acmispon maritimus
Acmispon glaber
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Native Transition/High Salt Marsh Species
Symphyotrichum subulatum
Symphyotrichum chilense
Suaeda taxifolia
Stipa pulchra
Spergulariaria marina
Spergulariaria macrotheca
Solanum douglasii
Salicornia pacifica
Plantago erecta
Laennecia coulteri
Juncus bufonius
Jaumea carnosa
Isocoma menziesii
Isocoma menziesii
Hordeum ntherum
Heterotheca grandiflora
Frankenia salina
Extriplex californica
Euphorbia serpens
Erigeron canadensis
Epilobium ciliatum
Epilobium arpum
Encelia californica
Elymus triticoides
Distichlis spicata
Distichlis littoralis
Deinandra fasciculata
Cyperus eragrostis
Cressa truxillensis
Centromadia parryi australis
Baccharis pilularis
Atriplex lentiformis
Arthrocnemum subterminale
Ambrosia psilostachya
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Native Seasonal Brackish Marsh Species
Xanthium strumarium
Symphyotrichum subulatum
Suaeda taxifolia
Solanum douglasii
Salicornia pacifica
Persicaria lapathifolia
Persicaria lapathafolia
Laennecia coulteri
Juncus bufonius
Hordeum ntherum
Heterotheca grandiflora
Frankenia salina
Erigeron canadensis
Epilobium ciliatum
Epilobium arpum
Elymus triticoides
Eleocharis macrostachya
Distichlis spicata
Cyperus eragrostis
Cuscuta salina
Bolboschoenus maritimus
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE

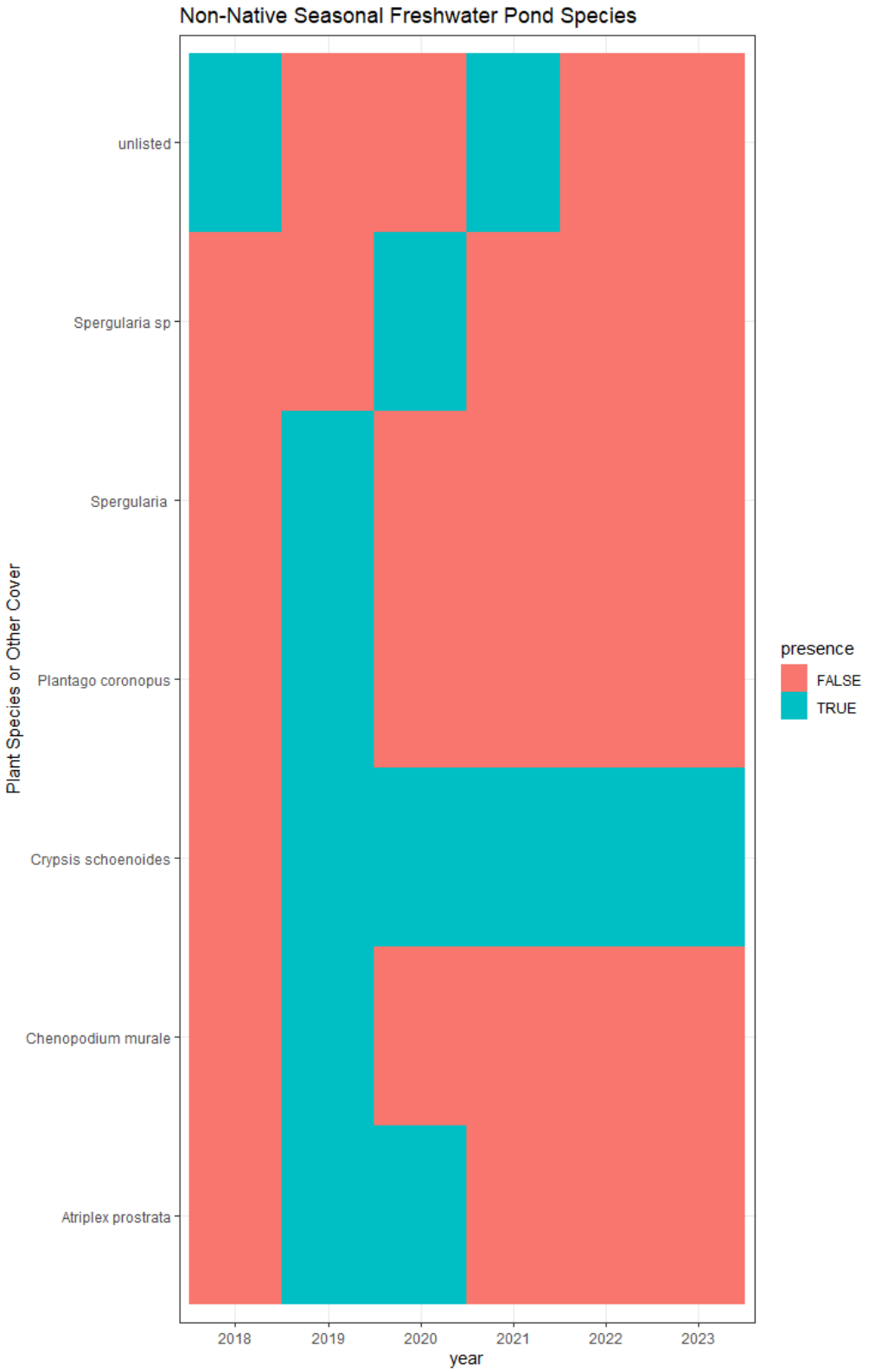

Native Sandy Annuals Species
Solanum douglasii
Lupinus bicolor
Heterotheca grandiflora
Erigeron canadensis
Epilobium ciliatum
Epilobium arpum
Camissoniopsis micrantha
Ambrosia psilostachya
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Native Perennial Grassland Species
Vulpia microstachys
unlisted
Symphyotrichum subulatum
Stipa pulchra
Stebbinsoseris heterocarpa
Sisyrinchium bellum
Sidalcea malviflora
Schoenoplectus californicus
Psilocarphus tennulus
Psilocarphus brevissimus
Pseudognaphalium californicum
Plantago erecta
Lupinus succulentus
Lepidium nitidum
Laennecia coulteri
Juncus phaeocephalus
Juncus bufonius
Isocoma menziesii
Hordeum ntherum
Heterotheca grandiflora
Frankenia salina
Festuca microstachys
Eryngium vaseyi
Erigeron canadensis
Epilobium arpum
Eleocharis macrostachya
Eleocharis acicularis
Distichlis spicata
Deinandra fasciculata
Cyperus eragrostis
Cressa truxillensis
Baccharis pilularis
Ambrosia psilostachya
Acmispon wrangelianus
Acmispon maritimus
Acmispon glaber
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Native Remnant Salt Marsh Species
Xanthium strumarium
Salicornia pacifica
Hordeum ntherumcalif.
Hordeum ntherum
Frankenia salina
Eleocharis macrostachya
Distichlis spicata
Distichlis littoralis
Cressa truxillensis
Atriplex leucophylla
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Native Peripheral Uplands Species
Symphyotrichum subulatum
Stipa pulchra
Spergularia marina
Solanum douglasii
Sisyrinchium bellum
Scrophularia californica
Salvia leucophylla
Salix lasiolepis
Quercus agrifolia
Psilocarphus brevissimus
Pseudognaphalium californicum
Plantago erecta
Persicaria lapathafolia
Moss (Ceratodon purpureus)
Melica imperfecta
Malacothrix saxatilis v. tenu.
Malacothris saxatilis var implicata
Lupinus succulentus
Lonicera subspicata v. subsp.
Lepidium nitidum
Laennecia coulteri
Juncus phaeocephalus
Juncus patens
Juncus occidentalis
Juncus bufonius
Isolepis cernua
Isocoma menziesii
Isocoma menziesii
Hordeum ntherum
Heterotheca grandiflora
Hazardia squarrosa
Frankenia salina
Euphorbia serpens
Euphorbia maculata
Eriophyllum confertiflorum
Eriogonum parvifolium
Erigeron canadensis
Epilobium ciliatum
Epilobium canum
Epilobium arpum
Encelia californica
Elymus triticoides
Elymus glaucus
Elymus condensatus
Eleocharis macrostachya
Eleocharis acicularis
Distichlis spicata
Deinandra fasciculata
Daucus pusillus
Datura wrightii
Cyperus eragrostis
Cressa truxillensis
Centromadia parryi australis
Bromus carinatus
Bolboschoenus maritimus
Baccharis pilularis
Atriplex lentiformis
Artemisia californica
Ambrosia psilostachya
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE

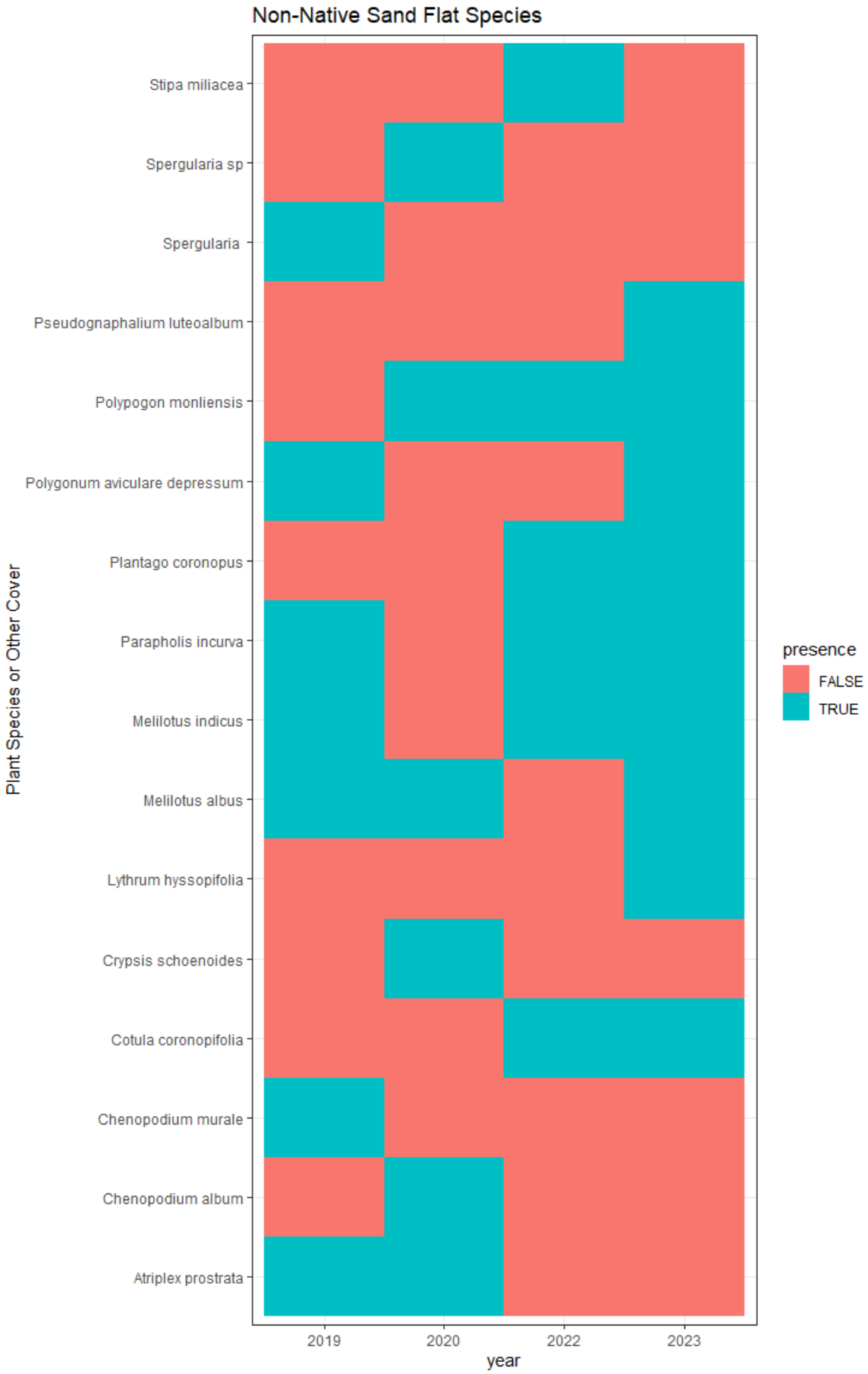
Table A2.2. Non-native plant species recorded during vegetation monitoring at the North Campus Open Space project.



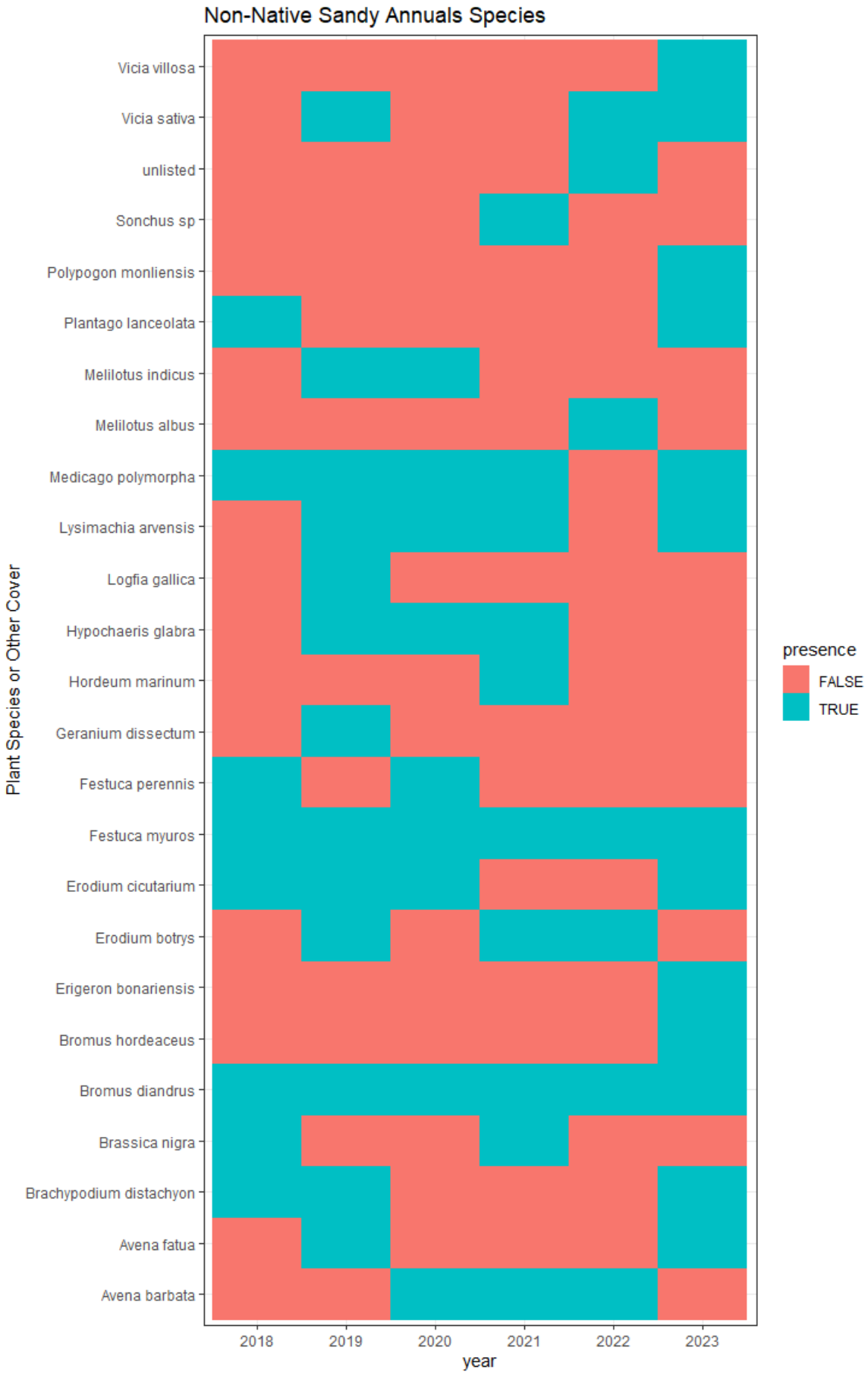

Non-Native Vernal Pool Species
Plant Species or Other Cover
Vicia villosa
Vicia sativa
Urormum piciroides
unlisted
Trifolium repens
Trifolium hirtum
Tamarix ramosissima
Stipa miliacea
Spergularia villosa
Spergularia sp
Spergularia bocconi
Spergularia
Spergula arvensis
Sorghum
Sonchus sp
Sonchus oleraceus
Sonchus ar
Sonchus
Silene gallica
Salsola tragus
Rumex cris
Pseudognaphalium luteoalbum
Polypogon viridis
Polypogon monliensis
Polypogon interruptus
Polygonum aviculare depressum
Poa annua
Plantago lanceolata
Plantago coronopus
Phalaris aquatica
Parapholis incurva
Oxalis pes-caprae
Melilotus indicus
Melilotus albus
Medicago polymorpha
Medicago lupulina
Malva parviflora
Lythrum hyssopifolia
Lysimachia arvensis
Logfia gallica
Lepidium didymum
Lactuca serriola
Lactuca saligna
Hypochaeris glabra
Hordeum murinum
Hordeum marinum
Helminthotheca echioides
Hedypnois cretica
Geranium dissectum
Foeniculum vulgare
Festuca perennis
Festuca myuros
Festuca bromoides
Euphorbia serpens
Erodium cicutarium
Erodium botrys
Erigeron bonariensis
Crypsis schoenoides
Cotula coronopifolia
Convolvulus arvensis
Centaurium tenuiflorum
Carduus pycnocephalus
Bromus hordeaceus
Bromus diandrus
Bromus catharticus
Brassica nigra
Brachypodium distachyon
Avena fatua
Avena barbata
Atriplex prostrata
Aegilops cylindrica
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE

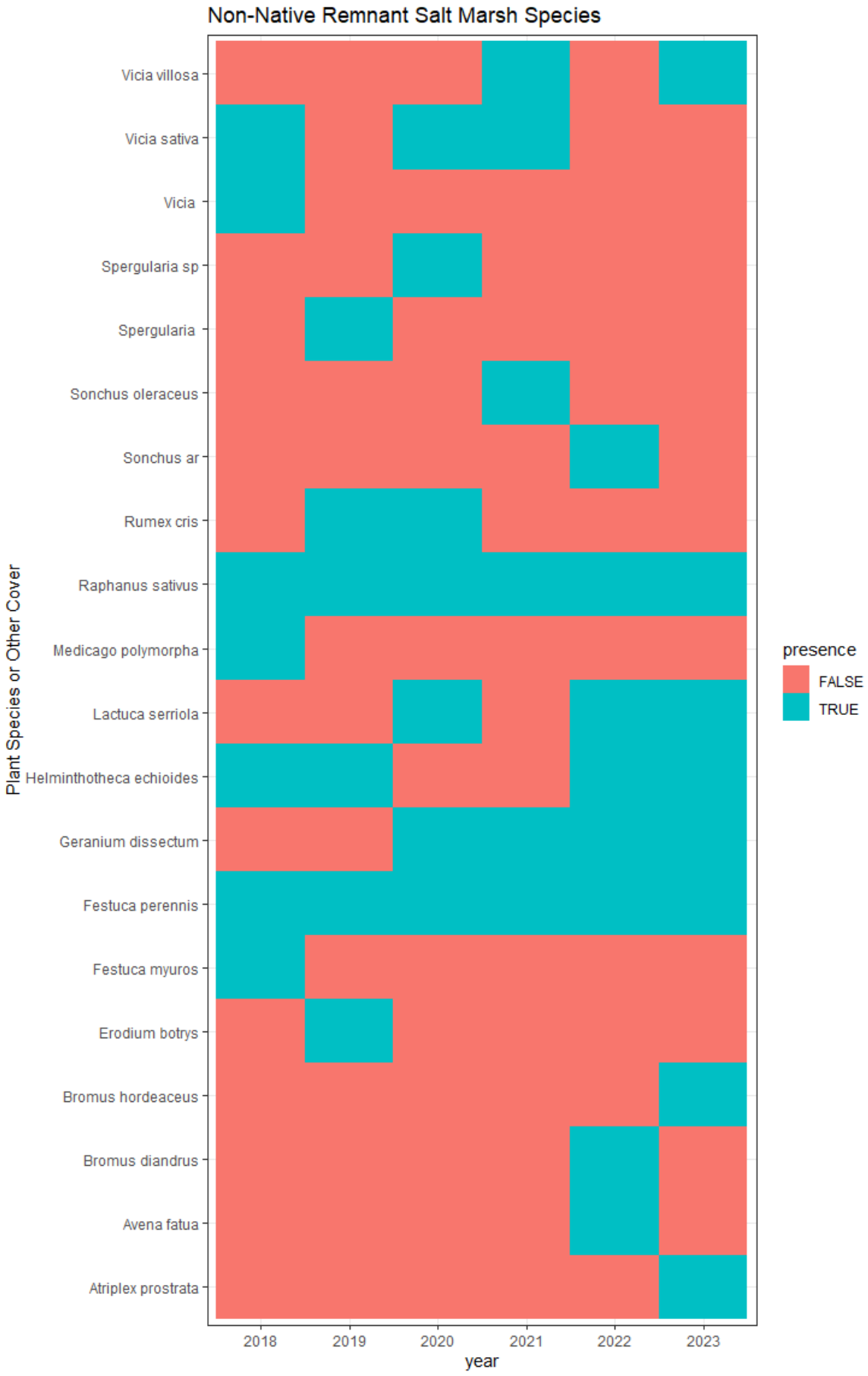

Non-Native Transition/High Salt Marsh Species
Plant Species or Other Cover
Vicia sativa
Triticale
Trifolium hirtum
Spergularia sp
Spergularia
Spergula arvensis
Sonchus sp
Sonchus oleraceus
Sonchus ar
Sonchus
Salsola tragus
Rumex cris
Pseudognaphalium luteoalbum
Polypogon viridis
Polypogon monliensis
Polypogon interruptus
Polygonum aviculare depressum
Poa annua
Plantago lanceolata
Plantago coronopus
Pennisetum clandestinum
Parapholis incurva
Palum dilatatum
Melilotus indicus
Melilotus albus
Medicago polymorpha
Matricaria discoidea
Malva parviflora
Lythrum hyssopifolia
Lysimachia arvensis
Lotus corniculatus
Lepidium didymum
Lactuca serriola
Hordeum murinum
Hordeum marinum
Helminthotheca echioides
Geranium dissectum
Foeniculum vulgare
Festuca perennis
Festuca myuros
Festuca bromoides
Euphorbia maculata
Erodium cicutarium
Erodium botrys
Erigeron bonariensis
Dichondra micrantha
Cynodon dactylon
Cotula coronopifolia
Centaurium tenuiflorum
Centaurium
Bromus madritensis
Bromus hordeaceus
Bromus diandrus
Bromus catharticus
Brassica nigra
Brachypodium distachyon
Beta vulgaris
Avena fatua
Avena barbata
Atriplex semibaccata
Atriplex rosea
Atriplex prostrata
Amaranthus albus
Aegilops cylindrica
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Non-Native Salt Marsh Species
Plant Species or Other Cover
Vicia sativa
Triticale
Trifolium hirtum
Spergularia sp
Spergularia
Spergula arvensis
Sonchus sp
Sonchus oleraceus
Sonchus ar
Sonchus
Salsola tragus
Polypogon monliensis
Polypogon interruptus
Polygonum aviculare depressum
Plantago coronopus
Pennisetum clandestinum
Parapholis incurva
Mesembranthemum nodiflorum
Melilotus indicus
Medicago polymorpha
Lysimachia arvensis
Lepidium didymum
Lactuca serriola
Lactuca saligna
Hordeum murinum
Hordeum marinum
Hirschfeldia incana
Helminthotheca echioides
Geranium dissectum
Festuca perennis
Festuca myuros
Erigeron bonariensis
Cynodon dactylon
Crypsis schoenoides
Cotula coronopifolia
Convolvulus arvensis
Chenopodium murale
Carduus pycnocephalus
Capsella bursa-pastoris
Bromus hordeaceus
Bromus catharticus
Brassica nigra
Avena fatua
Atriplex semibaccata
Atriplex rosea
Atriplex prostrata
Amaranthus albus
Aegilops cylindrica
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE

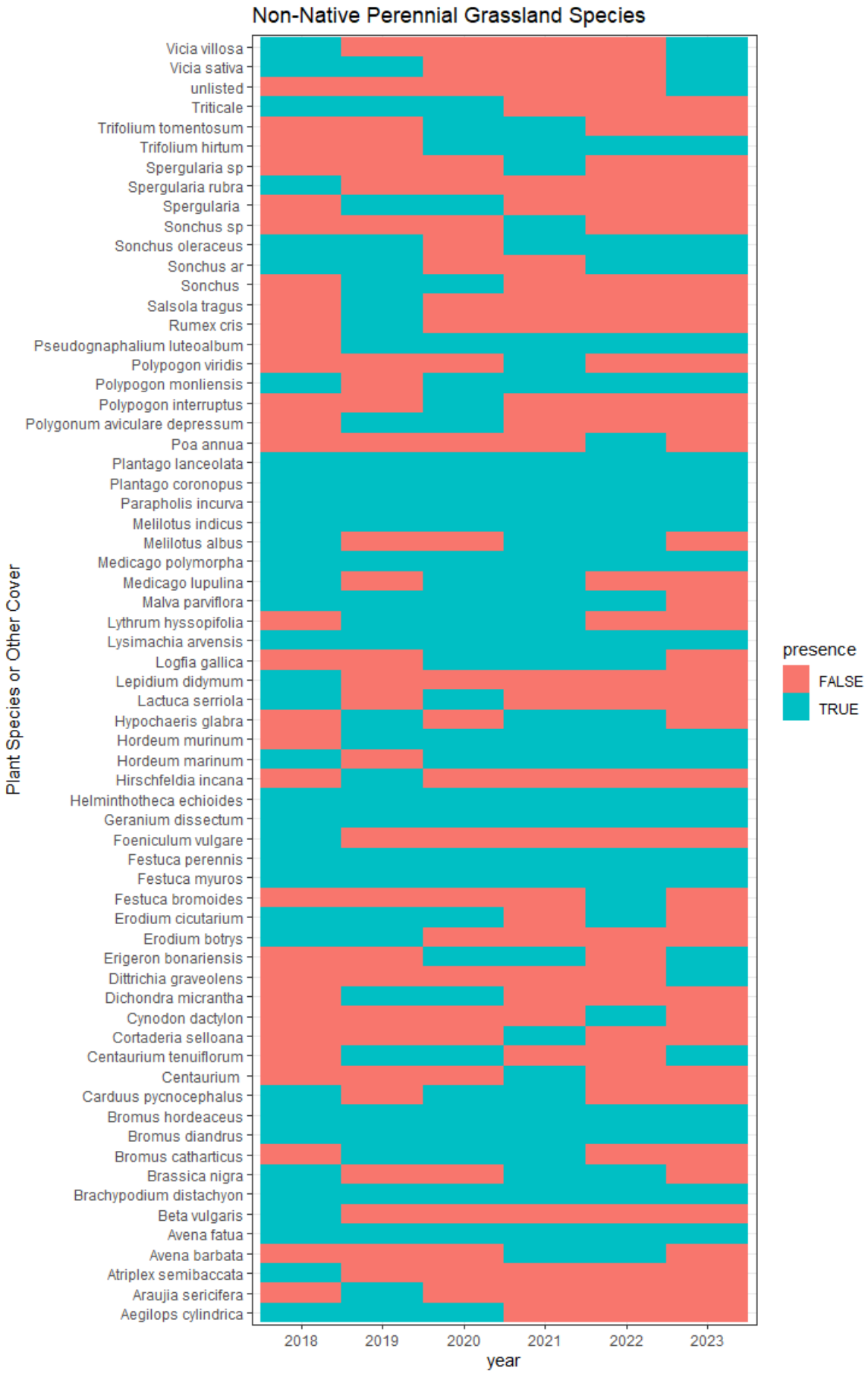

Non-Native Sand Flat Species
Stipa miliacea
Spergularia sp
Spergularia
Pseudognaphalium luteoalbum
Polypogon monliensis
Polygonum aviculare depressum
Plantago coronopus
Parapholis incurva
Melilotus indicus
Melilotus albus
Lythrum hyssopifolia
Crypsis schoenoides
Cotula coronopifolia
Chenopodium murale
Chenopodium album
Atriplex prostrata
Plant Species or Other Cover
2019
2020
2022
2023
year
presence
FALSE
TRUE


Non-Native Seasonal Brackish Marsh Species
Trifolium repens
Trifolium hirtum
Spergularia sp
Spergularia
Sonchus sp
Sonchus ar
Rumex cris
Pseudognaphalium luteoalbum
Polypogon monliensis
Polygonum aviculare depressum
Plantago coronopus
Melilotus indicus
Medicago polymorpha
Lythrum hyssopifolia
Hordeum murinum
Hordeum marinum
Helminthotheca echioides
Festuca perennis
Festuca myuros
Festuca bromoides
Cynodon dactylon
Crypsis schoenoides
Cotula coronopifolia
Chenopodium album
Centaurium tenuiflorum
Centaurium
Bromus hordeaceus
Bromus diandrus
Bromus catharticus
Avena fatua
Atriplex prostrata
Arujia sericifera
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Non-Native Sandy Annuals Species
Plant Species or Other Cover
Vicia villosa
Vicia sativa
unlisted
Sonchus sp
Polypogon monliensis
Plantago lanceolata
Melilotus indicus
Melilotus albus
Medicago polymorpha
Lysimachia arvensis
Logfia gallica
Hypochaeris glabra
Hordeum marinum
Geranium dissectum
Festuca perennis
Festuca myuros
Erodium cicutarium
Erodium botrys
Erigeron bonariensis
Bromus hordeaceus
Bromus diandrus
Brassica nigra
Brachypodium distachyon
Avena fatua
Avena barbata
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Non-Native Remnant Salt Marsh Species
Vicia villosa
Vicia sativa
Vicia
Spergularia sp
Spergularia
Sonchus oleraceus
Sonchus ar
Rumex cris
Raphanus sativus
Medicago polymorpha
Lactuca serriola
Helminthotheca echioides
Geranium dissectum
Festuca perennis
Festuca myuros
Erodium botrys
Bromus hordeaceus
Bromus diandrus
Avena fatua
Atriplex prostrata
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Non-Native Peripheral Uplands Species
Plant Species or Other Cover
Washingtonia robusta
Vicia villosa
Vicia sativa
Trifolium repens
Trifolium hirtum
Tragopogon porrifolius
Taraxacum officinale
Stipa miliacea
Spergularia sp
Spergularia bocconi
Spergularia
Sonchus sp
Sonchus oleraceus
Sonchus ar
Sonchus
Senecio vulgaris
Salsola tragus
Rumex cris
Pseudognaphalium luteoalbum
Portulaca oleracea
Polypogon viridis
Polypogon monliensis
Polypogon interruptus
Polygonum aviculare depressum
Polycarpon tetraphyllum
Poa annua
Plantago major
Plantago lanceolata
Plantago coronopus
Pinus pinea
Pinus halepensis
Pennisetum clandestinum
Parapholis incurva
Palum dilatatum
Melilotus indicus
Medicago polymorpha
Medicago lupulina
Malva parviflora
Lythrum hyssopifolia
Lysimachia arvensis
Logfia gallica
Lepidium didymum
Lactuca serriola
Hordeum murinum
Hordeum marinum
Helminthotheca echioides
Geranium dissectum
Festuca perennis
Festuca myuros
Festuca bromoides
Euphorbia serpens
Euphorbia maculata
Eucalyptus sp
Eucalyptus globulus
Eucalyptus
Erodium cicutarium
Erodium botrys
Erigeron sumatrensis
Erigeron bonariensis
Erharta erecta
Dyania ambrosioides
Dichondra micrantha
Cynodon dactylon
Cyclormum leptophyllum
Cyclormum
Cotula coronopifolia
Convolvulus arvensis
Chenopodium murale
Chenopodium album
Centaurium tenuiflorum
Centaurium
Capsella bursa-pastoris
Bromus madritensis
Bromus hordeaceus
Bromus diandrus
Bromus catharticus
Brassica nigra
Brachypodium distachyon
Bassia hyssopifolia
Avena fatua
Avena barbata
Atriplex semibaccata
Atriplex prostrata
Aloe maculata
Aegilops cylindrica
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE


Non-Native Perennial Grassland Species
Vicia villosa
Vicia sativa
unlisted
Triticale
Trifolium tomentosum
Trifolium hirtum
Spergularia sp
Spergularia rubra
Spergularia
Sonchus sp
Sonchus oleraceus
Sonchus ar
Sonchus
Salsola tragus
Rumex cris
Pseudognaphalium luteoalbum
Polypogon viridis
Polypogon monliensis
Polypogon interruptus
Polygonum aviculare depressum
Poa annua
Plantago lanceolata
Plantago coronopus
Parapholis incurva
Melilotus indicus
Melilotus albus
Medicago polymorpha
Medicago lupulina
Malva parviflora
Lythrum hyssopifolia
Lysimachia arvensis
Logfia gallica
Lepidium didymum
Lactuca serriola
Hypochaeris glabra
Hordeum murinum
Hordeum marinum
Hirschfeldia incana
Helminthotheca echioides
Geranium dissectum
Foeniculum vulgare
Festuca perennis
Festuca myuros
Festuca bromoides
Erodium cicutarium
Erodium botrys
Erigeron bonariensis
Dittrichia graveolens
Dichondra micrantha
Cynodon dactylon
Cortaderia selloana
Centaurium tenuiflorum
Centaurium
Carduus pycnocephalus
Bromus hordeaceus
Bromus diandrus
Bromus catharticus
Brassica nigra
Brachypodium distachyon
Beta vulgaris
Avena fatua
Avena barbata
Atriplex semibaccata
Araujia sericifera
Aegilops cylindrica
Plant Species or Other Cover
2018
2019
2020
2021
2022
2023
year
presence
FALSE
TRUE

APPENDIX 3 – BIRD SURVEY SPECIES LISTS

Table A3.1. Bird species and the average number of each species observed in monthly bird surveys at the North Campus Open Space. Each Survey Year begins in September and ends in August. The species are grouped by guild, and by eBird Clements v2018 integrated checklist (August 2018).

Guild & Common Name	Year 1 # of Obs.	Year 2 # of Obs.	Year 3 # of Obs.	Year 4 # of Obs.	Year 5 # of Obs.	Year 6 # or Obs.
Cormorants and Anhingas	**1**	**3**	**5**	**8**	**6**	**8**
Double-crested Cormorant	1	3	5	8	6	8
Gulls, Terns, and Skimmers	**13**	**28**	**27**	**13**	**28**	**29**
California Gull	2	4	5	1	9	5
Caspian Tern			2		1	1
Mew Gull		3	1			1
Ring-billed Gull	3	6	4	4	5	7
Western Gull	8	15	15	8	13	15
Herons, Egrets, and Ibis	**34**	**43**	**78**	**45**	**65**	**63**
Black-crowned Night-Heron	2	2	15	20	23	17
Great Blue Heron	14	5	17	6	9	13
Great Egret	6	13	20	11	17	15
Green Heron	7	3	2	1	3	2
Snowy Egret	4	19	24	7	12	16
White-faced Ibis	1	1			1	
Hummingbirds	**88**	**84**	**104**	**135**	**150**	**140**
Allen's Hummingbird	5	5	9	13	19	11
Anna's Hummingbird	81	78	94	117	124	116
Black-chinned Hummingbird			1	1		1
Rufous Hummingbird	2	1				1
Selasphorus sp				4	7	12
Insectivores	**429**	**670**	**765**	**815**	**795**	**896**
Blackbirds	***37***	***50***	***35***	***33***	***50***	***44***
Bullock's Oriole	1		1		1	1
Great-tailed Grackle	1		3	1		
Hooded Oriole	4	7	10	4	3	2

Guild & Common Name	# of Obs.	# of Obs.	# of Obs.	# of Obs.	# of Obs	
Red-winged Blackbird	12	22	7	12	32	22
Western Meadowlark	19	20	13	15	14	19
Yellow-headed Blackbird		1	1	1	0	
Cardinals, Gros-beaks, and Allies		***2***		***1***	***0***	
Western Tanager		2		1	0	
Catbirds, Mockingbirds, and Thrashers	***2***		***3***	***1***	***1***	***2***
California Thrasher	2		3	1	1	2
Gnatcatchers	***8***	***25***	***48***	***66***	***32***	***24***
Blue-gray Gnatcatcher	8	25	48	66	32	24
Kinglets	***5***	***15***	***16***	***32***	***33***	***17***
Ruby-crowned Kinglet	5	15	16	32	33	17
Martins and Swallows	***46***	***39***	***40***	***31***	***26***	***37***
Barn Swallow	6	8	6	2	3	4
Cliff Swallow	26	25	27	22	18	30
Northern Rough-winged Swallow	10	3	2	3	2	2
Tree Swallow	4	2	4	4	3	
Violet-green Swallow		1	1		0	1
New World Sparrows	***117***	***212***	***271***	***292***	***308***	***399***
Fox Sparrow	1					
Golden-crowned Sparrow	1		1		3	1
Lincoln's Sparrow		5	9	17	8	18
Savannah Sparrow	1	10	17	9	34	58
Savannah Sparrow (Belding's)	8	8	5	8		
Song Sparrow	69	121	154	183	166	208
White-crowned Sparrow	37	68	85	75	97	114

Guild & Common Name	# of Obs.	# of Obs.	# of Obs.	# of Obs.	# of Obs.	
Nuthatches		***3***	***8***	***7***	***5***	***3***
Red-breasted Nuthatch			8	5		
White-breasted Nuthatch		3		2	5	3
Parrotbills, Wrentit, and Allies		***3***	***3***	***5***	***2***	***10***
Wrentit		3	3	5	2	10
Penduline-Tits & Long-tailed Tits	***9***	***21***	***31***	***24***	***31***	***34***
Bushtit	9	21	31	24	31	34
Starlings and Mynas	***6***	***11***	***14***	***7***	***19***	***4***
European Starling	6	11	14	7	19	4
Swifts	***1***	***1***			***1***	
Vaux's Swift	1	1			1	
Thrushes	***28***	***31***	***32***	***38***	***30***	***36***
Hermit Thrush		1	1	1	2	3
Western Bluebird	28	30	31	37	28	33
Tits, Chickadees, and Titmice		***5***	***4***	***11***	***9***	***12***
Oak Titmouse		5	4	11	9	12
Tyrant Fly-catchers: Pewees, Kingbirds, & Allies	***121***	***193***	***184***	***173***	***182***	***179***
Ash-throated Flycatcher		3			4	2
Black Phoebe	65	112	89	86	92	90
Cassin's Kingbird	11	28	30	20	27	30
Pacific-slope Flycatcher	1	1	3			3
Say's Phoebe	42	47	51	59	52	42
Tropical Kingbird		1	3	2	2	5
Western Kingbird	1		7	6	4	6
Western Wood-Pewee	1	1				1
Willow Flycatcher			1		1	
Wagtails & Pipits	***24***	***19***	***8***	***9***	***23***	***19***
American Pipit	24	19	8	9	23	19

Guild & Common Name	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	
Woodpeckers	***6***	***11***	***15***	***12***	***11***	***19***
Acorn Woodpecker	2		1		3	3
Downy Woodpecker	2	2	6	5	1	7
Hairy Woodpecker	2		6	1	1	
Northern Flicker		3	1	2		2
Nuttall's Woodpecker		6	1	4	6	7
Wrens	***19***	***29***	***53***	***73***	***34***	***57***
Bewick's Wren	13	14	17	21	17	41
House Wren	4	9	26	33	12	11
Marsh Wren		3	10	19	5	5
Rock Wren	2	3				
Kingfishers		**5**	**4**	**1**	**4**	**5**
Belted Kingfisher		5	4	1	4	5
Omnivores	**152**	**140**	**144**	**156**	**159**	**189**
Blackbirds		***1***				**1**
Brewer's Blackbird		1				***1***
Catbirds, Mockingbirds, and Thrashers	***6***	***18***	***15***	***7***	***6***	***9***
Northern Mockingbird	6	18	15	7	6	9
Jays, Magpies, Crows, & Ravens	***53***	***47***	***72***	***77***	***75***	***67***
American Crow	53	46	72	75	74	64
Common Raven				1		
California Scrub Jay		1		1	1	3
New World Sparrows	***79***	***57***	***47***	***62***	***61***	***87***
California Towhee	78	56	47	57	57	83
Spotted Towhee	1	1		5	4	4
Old World Sparrows	***14***	***17***	***10***	***13***	***17***	***25***
House Sparrow	14	17	10	13	17	25
Raptors	**64**	**79**	**86**	**98**	**97**	**55**
Falcons & Caracaras	***5***	***6***	***5***	***8***	***12***	***6***
American Kestrel	5	5	4	7	6	5

Guild & Common Name	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	
Peregrine Falcon				1	3	
Merlin		1	1	1	3	1
Owls		***7***	***6***	***10***	***2***	***2***
Burrowing Owl		6	3	9		
Great Horned Owl		1	3	1	2	2
Shrikes	***9***	***9***	***11***	***5***	***1***	***1***
Loggerhead Shrike	9	9	11	5	1	1
Vultures, Hawks, & Allies	***50***	***57***	***64***	***74***	***82***	***46***
Cooper's Hawk	11	16	19	23	23	11
Accipiter sp.				1		
Northern Harrier			2	4	3	1
Osprey		1		1		
Red-shouldered Hawk	8	8	15	8	17	5
Red-tailed Hawk	17	19	15	16	25	11
Turkey Vulture	7	7	9	12	13	18
White-tailed Kite	7	6	4	9	1	
Seed & Fruit Eaters	**174**	**205**	**201**	**245**	**255**	**287**
Blackbirds	***1***	***1***	***2***	***1***	***1***	***2***
Brown-headed Cowbird	1	1	2	1	1	2
Cardinals, Grosbeaks, & Allies	***1***	***1***	***1***			**1**
Black-headed Grosbeak			1			1
Blue Grosbeak	1	1				
Estrildids	***23***	***33***	***28***	***27***	***40***	***22***
Scaly-breasted Munia	23	33	28	27	40	22
Finches, Euphonias, & Allies	***85***	***99***	***95***	***61***	***145***	***205***
House Finch	72	76	73	16	88	146
Lesser Goldfinch	13	22	20	43	56	49
American Goldfinch				1	1	
Purple Finch		1	2	1		1

Guild & Common Name	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	
Grouse, Quail, & Allies		***1***				
California Quail		1				
New World Sparrows	***3***	***16***	***20***	***10***	***15***	***12***
Chipping Sparrow		2	1			
Clay-colored Sparrow		1				
Dark-eyed Junco	1			1	5	6
Lark Sparrow	2	13	19	9	10	6
Pigeons & Doves	***61***	***54***	***55***	***46***	***54***	***45***
Eurasian Collared-Dove	9	2	5	5	1	5
Mourning Dove	23	19	18	13	23	16
Rock Pigeon (Feral Pigeon)	29	33	32	28	30	24
Shorebirds	**224**	**189**	**175**	**99**	**112**	**114**
American Avocet			2		1	1
Black-necked Stilt	5	11	23	4	12	3
Dunlin	1	1			1	
Greater Yellowlegs	18	14	18	12	11	18
Killdeer	94	93	71	45	36	51
Least Sandpiper	45	30	17	18	28	15
Lesser Yellowlegs			1	1	1	
Long-billed Curlew	2	3	2		2	5
Long-billed Dowitcher		2	5	1	2	
Pectoral Sandpiper		1	1			
Red-necked Phalarope	2	3	5		3	1
Sanderling		1				
Semipalmated Plover	16	7	7	4	4	6
Solitary Sandpiper		1				1
Spotted Sandpiper	1	1	5		1	
Western Sandpiper	36	17	11	10	5	12
Western Snowy Plover	1	2	4		4	
Whimbrel		1			1	

Guild & Common Name	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	**# of Obs.**	
Willet	1					
peep sp.				1		
Wilson's Snipe	2	1	3	3		1
Warblers	**56**	**114**	**193**	**185**	**188**	**216**
Common Yellowthroat	16	41	77	107	93	117
Orange-crowned Warbler	3	3	11	6	12	15
Yellow Warbler	1	4	4		3	8
Yellow-rumped Warbler	36	66	101	72	80	76
Waterfowl & ALLIES	**104**	**202**	**262**	**136**	**219**	**170**
Grebes	***2***	***10***	***21***	***8***	***7***	***3***
Clark's Grebe			5			
Eared Grebe	2	6	4		2	2
Pied-billed Grebe		2	11	8	5	1
Western Grebe		2	1			
Rails, Gallinules, & Allies	***7***	***59***	***48***	***23***	***31***	***24***
American Coot	5	45	39	16	29	18
Sora	2	14	7	4	2	4
Virginia Rail			2	3		2
Waterfowl	***95***	***133***	***193***	***105***	***181***	***143***
American Wigeon	3		8	10	16	6
Blue-winged Teal	1	2	2			
Bufflehead	2	4	2		3	1
Cackling Goose (Aleutian)	5	1		1	1	
Canada Goose	16	22	21	17	25	18
Canvasback			1			
Cinnamon Teal	7	8	17	5	1	7
Cinnamon Teal x Northern Shoveler (hybrid)		1				
Gadwall	7	10	21	11	25	16
Greater White-fronted Goose	7	2	4	2	2	1
Green-winged Teal		3	5	1	4	4

Guild & Common Name	# of Obs.	# of Obs.	# of Obs.	# of Obs.	# of Obs.	
Hooded Merganser	1	2	1	2	2	1
Mallard	35	53	62	40	63	66
Mute Swan		1			2	
Northern Pintail	2		6		2	2
Northern Shoveler	3	14	17	6	20	15
Redhead	1	2	8	4	6	
Ring-necked Duck			1		1	
Ross's Goose		2	1	1	1	
Ruddy Duck	5	4	15	3	5	5
Snow Goose		2	1	2	2	1
Grand Total	**1339**	**1763**	**2044**	**1936**	**2080**	**2172**

Table A3.2. Number of observations of breeding behavior recorded during monthly bird surveys at NCOS (highlighted in green) and reported to the Santa Barbara Audubon Society's Breeding Bird Study (highlighted in pink) in 2018-2023. Note that some of the NCOS bird survey observations are also reported to the Breeding Bird Study.

	NCOS Monthly Bird Survey Observations (in green), Santa Barbara breeding bird survey (in pink)					
Species Common Name	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
American Crow			2 3	1 1	2 1	
Allen's Hummingbird					1	
Anna's Hummingbird		1			1	
Ash-throated Flycatcher					1	
Barn Swallow			1	1		
Bewick's Wren			1			
Black-necked Stilt					1	
Black Phoebe	3	2 1	1 3	2	2 3	
Bushtit	1			1		
California Towhee	2 1		1 2	1 1		2
Canada Goose		2 1	2 1	3	1	1
Cassin's Kingbird		1			1	
Cliff Swallow	5 3	4 3	1 3	3 2	1 1	
Common Yellowthroat					1	5
Cooper's Hawk	1		2 1			1
Dark-eyed Junco				1		
European Starling		1	1		2	
Gadwall		2 3	1	2		
Great Egret		1				
Great Horned Owl	1		1	1		
Hooded Oriole					1	

House Finch	2	2	3	4	3	3	3	5	1	1						
House Sparrow	2	2	1						1				1			
Killdeer	4	5	3	6	2	2	2		2	3			2			
Lark Sparrow			2		1	1	2		3				1			
Lesser Goldfinch			1	1	1	1	1		2							
Mallard	1	2	2	2	2	2	2						3	4		
Mourning Dove							1									
Northern Mockingbird							1	1								
Northern Rough-winged Swallow							1									
Nuttall’s Woodpecker							1									
Red-shouldered Hawk	1				1		1		2				1			
Red-tailed Hawk			1													
Rock Pigeon (Feral Pigeon)	1	1														
Savannah Sparrow (Belding's)					3	4	1	2								
Say's Phoebe	1		1				2	1	1	2			1	1		
Scaly-breasted Munia													1			
Song Sparrow			2	7	1	1	4	2	1				2	1		
Western Bluebird	1	1					1		2				1	1		
Western Kingbird							1	1								
Western Sandpiper	1															
Western Snowy Plover	2		1		1	1			2	2						
White-tailed Kite							2									
White-breasted Nuthatch							1									
Wrentit					1											

APPENDIX 4 – JULY 2020 AQUATIC SPECIES SURVEY REPORT

Technical Memorandum

Date:	July 28, 2023
To:	Chris Dellith (chris_dellith@fws.gov), Chris Kofron (chris_kofron@fws.gov), Eric Morrissette (eric_morrissette@fws.gov)
CC:	Lisa Stratton (stratton@ccber.ucsb.edu)
From:	Hannah Donaghe (hdonaghe@ce.solutions)
RE:	**Devereux Slough and UCSB North Campus Open Space 2023 Post-Construction Tidewater Goby Survey Report**

Introduction

The Cheadle Center for Biodiversity and Ecological Restoration (CCBER) at the University of California, Santa Barbara (UCSB) is in the process of restoring the former Ocean Meadows Golf Course to native upland and wetland/marsh habitats in Santa Barbara County. This area is called the North Campus Open Space (NCOS) and includes the downstream end of Devereux Creek from the west, Phelps Creek from the north, and stormwater inflows from the northeast via East Channel that converge and drain into Devereux Slough (Figure 1). Prior to restoration, Devereux Creek flowed into Devereux Slough at a weir on the north side of the Venoco Access Road. The weir has been removed, and grading has restored portions of the upper channels of Devereux Creek, allowing tidal influence upstream to near the Phelps Creek confluence and into the eastern channel.

Pre-construction surveys of Devereux Creek and Phelps Creek in 2016, and post-construction surveys in the fall of 2017, 2018, 2020, 2021, and 2022 found no tidewater gobies (*Eucyclogobius newberryi*) to be present. The 2019 post-construction tidewater goby survey conducted on October 17, 2019, by Dr. Rosemary Thompson and CCBER staff found tidewater gobies in Devereux Slough downstream of Venoco Road. The 2018-2022 surveys also found no southwestern pond turtles or California red-legged frogs.

A post-construction survey was conducted on June 21, 2023, in Devereux Slough, the restored channels, and lower Phelps Creek by Catalyst Environmental Solutions (Catalyst) biologist Hannah Donaghe (federal permit 14532C-2) with assistance from CCBER staff (Lisa Stratton, Alison Rickard, Jeremiah Bender, and Chris Berry). Ms. Donaghe was approved by the U.S. Fish and Wildlife Service (USFWS) to conduct surveys for tidewater goby under the Biological Opinion for the UCSB Devereux Slough Restoration Project (08EVEN00-2016-F-0484). During the 2023 survey, tidewater gobies were observed in Devereux Slough upstream of the mouth and pier sites as well as further upstream at the Phelps Bridge site.

Due to discovery of the invasive New Zealand mudsnail (*Potamopyrgus antipodarum*) in the Phelps Creek area by CCBER staff, sampling at that site was completed last and gear was decontaminated following completion of

work in an attempt to limit any spread of the invasive species. CCBER staff identified the presence of New Zealand mudsnail using aquatic eDNA sampling which was then verified with hand sampling and identification by a local expert.

The methods used and results of the surveys are described in the sections below.

Methodology

Fish Sampling

Sampling sites were selected in the field based on access, water depth, density of *Ruppia maritima* (wigeon grass; aquatic plant), and approximate location sampled in previous years (Figure 2). Sample locations include three locations in Devereux Slough plus three locations in the restored channels, one near Venoco Road, one in the East Channel, and one in the West Arm of the Main Channel. Photographs of the sampling sites are provided in Attachment A.

Sampling was conducted between 9:00 AM and 2:00 PM. A minnow seine 10-feet long by 4-feet high with 1/8inch mesh was used for the sampling. Seine hauls varied in length from approximately 20 to 40 feet. The seine was pulled across the channel perpendicular to the shore and then swept into the shoreline, lifted, and placed on the shore. Seining was generally performed by walking the seine off the bank and then performing the haul directly towards shore. Fish were removed from the net immediately, identified, and counted. After counting, all species were immediately released back into the water. At sites where the substrate was too rocky to conduct an effective seine haul (Phelps Creek, Phelps Bridge, and South of Venoco Bridge) or abundance of *Ruppia maritima* (wigeon grass; aquatic plant) and *Ulva intestinalis* algae were too dense to move the seine through it (West Arm), dip net sweeps were completed to sample the area. Many sweeps were made using fine-mesh dip nets wherever open water occurred with minimal obstructions. Organisms captured were identified and released.

Water Quality

Water quality parameters (temperature in degrees Celsius [°C], dissolved oxygen in milligrams per liter [mg/L], and salinity in parts per thousand [ppt]) were measured by CCBER staff with a YSI Pro 2030 at each sampling location.

Results and Discussion

Table 1 summarizes the fish captured at each sampling site. All fish captured are native to the area, except mosquitofish (*Gambusia affinis*) which were captured at several sites and can tolerate a wide range of salinities and Mississippi silversides (*Menidia audens*) which were captured at the Venoco Bridge north site.

Tidewater gobies were captured at the Devereux Slough sample sites upstream of the estuary mouth and pier as well as the Phelps Bridge site. A total of 63 tidewater gobies were captured during the survey, with 46 captured at the Devereux Slough mouth site, 15 captured at the Devereux Slough pier site, and 2 captured at the Phelps Bridge site (Table 1). Tidewater goby has been reported in Phelps Creek in the past but were not captured in the

creek upstream of Phelps Bridge in 2023. Removal of the weir at the Venoco Road crossing has allowed fish access to upstream areas. Tidewater gobies in Devereux Slough have likely expanded into NCOS aquatic habitats further upstream, as they were observed at the Phelps Bridge site. Tidewater gobies generally only live one year (Swift et al. 1989, Moyle 2002).

The non-native red swamp crayfish continues to occur in Phelps Creek, with one individual captured during dip net sampling. Several crayfish were also found at the Phelps Bridge site. Its spread into the restored channels will likely be limited by its intolerance of high salinity. One Baja California treefrog tadpole was also captured during dip net sampling in Phelps Creek. CCBER staff observed the invasive New Zealand mudsnail on submerged portions of rocks at the Phelps Bridge site.

Table 2 provides the results of the water quality sampling completed at each site. Dissolved oxygen ranged from 4.5 to 13.4, with suitable levels for tidewater goby observed. Salinity was highest at the lower Devereux Slough sites (27-28 ppt) and decreased moving upstream to the restored channels and upstream to Phelps Creek (2 ppt). Temperatures were lowest at the most upstream sample sites at Phelps Creek and bridge (21.1 and 21.4°C, respectively). The lower estuary sites and the West Arm site ranged from 22.6 to 23.6°C. The other sample sites, Venoco Bridge sites and East Channel, had higher temperatures ranging from 25.1 to 28.4°C.

Water depth at the lower estuary sites were generally 2 to 3.5 feet, and other sites were generally shallower, ranging from 6 inches to 2.5 feet. The water depth in Phelps Creek ranged from 6 inches to 3 feet. Water levels in the restored estuarine channels on NCOS were higher than previous sampling events, which were conducted in the fall. Storm events and high rainfall occurred during the winter preceding the 2023 survey, with the berm of Devereux Slough open for a long period of time, which may have contributed to the recolonization of tidewater goby in Devereux Slough. At the time of sampling, the berm was closed.

Table 1: Fish Captured during 2023 Survey – June 21, 2023

Site	Common Name	Scientific Name	Number			Method
Phelps Creek	Mosquitofish	*Gambusia affinis*	7			Dip net
Phelps Bridge	**Tidewater goby**	***Eucyclogobius newberryi***	**2**			Dip net
	Longjaw mudsucker	*Gillichthys mirabilis*	4			
	Mosquitofish	*Gambusia affinis*	8			
West Arm	California killifish	*Fundulus parvipinnis*	2			Dip net
	Mosquitofish	*Gambusia affinis*	5			
East Channel	Longjaw mudsucker	*Gillichthys mirabilis*	1	0		Seine (2 hauls)
	Topsmelt	*Atherinops affinis*	1	3		
	California killifish	*Fundulus parvipinnis*	1	9		
	Mosquitofish	*Gambusia affinis*	1	2		
Venoco Bridge North	Topsmelt	*Atherinops affinis*	19			Seine
	California killifish	*Fundulus parvipinnis*	31			
	Mississippi silverside	*Menidia audens*	3			
Venoco Bridge South	Longjaw mudsucker	*Gillichthys mirabilis*	1			Dip net
	Topsmelt	*Atherinops affinis*	1			
	California killifish	*Fundulus parvipinnis*	1			
	Mosquitofish	*Gambusia affinis*	2			
Devereux Slough-Pier	**Tidewater goby**	***Eucyclogobius newberryi***	**11**	**4**		Seine (2 hauls)
	Longjaw mudsucker	*Gillichthys mirabilis*	10	2		
	Pacific staghorn sculpin	*Leptocottus armatus*	1	1		
	Topsmelt	*Atherinops affinis*	100	41		
	California killifish	*Fundulus parvipinnis*	0	2		
Devereux Slough-Mouth	**Tidewater goby**	***Eucyclogobius newberryi***	**6**	**17**	**23**	Seine (3 hauls)
	Arrow goby	*Clevelandia ios*	0	1	0	
	Longjaw mudsucker	*Gillichthys mirabilis*	4	3	1	
	Pacific staghorn sculpin	*Leptocottus armatus*	3	0	0	
	Topsmelt	*Atherinops affinis*	1	19	18	

Table 2: Water Quality at Fish Sampling Sites – June 21, 2023

Location	Approx. Latitude	Approx. Longitude	Temperature (°C)	Salinity (ppt)	Dissolved Oxygen (mg/L)
Phelps Creek	34.422963	-119.879851	21.1	2.1	8.3
Phelps Bridge	34.421330	-119.878909	21.4	2.3	6.6
West Arm	34.420759	-119.877798	23.6	10.3	4.5
East Channel	34.420628	-119.874310	27.9	12.6	10.6
North of Venoco Bridge	34.417846	-119.874249	25.1	18.8	13.4
South of Venoco Bridge	34.417350	-119.874066	28.4	21.3	8.6
Devereux Slough-Pier	34.412124	-119.876542	23.3	28.0	7.2
Devereux SloughMouth	34.409813	-119.879393	22.6	27.4	8-10

Figure 1. Creeks and Channels at North Campus Open Space

Figure 2. Approximate Fish Sampling and Water Quality Locations (yellow)

References

Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkeley and Los Angeles. Pp 431434.

Swift, C., J. L. Nelson, C. Maslow, and T. Stein. 1989. Natural History Museum of Los Angeles County, Contributions in Science, Number 404:1-19.

ATTACHMENT A

SAMPLE SITE PHOTOGRAPHS

Seining at Devereux Slough mouth site, tidewater goby present (6/21/23).

Devereux Slough pier site, tidewater goby present (6/21/23).

Venoco Bridge south sampling site, dip net sampling conducted (6/21/23).

Seining conducted at NCOS restored East Channel site (6/21/23).

Dip net sweeps conducted at NCOS restored channel West Arm site (6/21/23).

Dip netting conducted at Phelps Bridge site, tidewater goby present (6/21/23).

Phelps Creek sample site upstream of bridge, no tidewater goby present (6/21/23).