Arana Gulch Habitat Management Plan
City of Santa Cruz

Year 10 (2023) Annual Report

CDFW Permit No. 2081 (a)-13-013-RP
CDFW Permit No. 2081 (a)-18-016-RP
Coastal Development Permit No. 3-11-074 (Arana Gulch)

January 29, 2024

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1. Executive Summary

This monitoring report evaluates the City's progress implementing the Arana Gulch Habitat Management Plan (HMP). The HMP guides the long-term restoration of the 67-acre Arana Gulch Open Space. The plan provides management goals and objectives to enhance three specific management areas: Hagemann Gulch Riparian Woodland Management Area, Arana Creek Wetland and Riparian Management Area and the Coastal Prairie/Tarplant Management Area.

The HMP was developed as part of the California Coastal Commission's (CCC) Coastal Development Permit process for the adoption of the Arana Gulch Master Plan (Master Plan). The Master Plan includes management guidelines for access, resource management, and education. Since Arana Gulch lies within the CCC's Coastal Zone, a permit was necessary to implement the Master Plan. The CCC conditionally approved the permit on December 8, 2011. Special permit conditions required, among other things, developing and implementing an HMP, establishing a technical advisory group to advise the City on habitat management actions, and submitting annual monitoring reports to document compliance with the HMP.

The City finalized and began implementing the HMP in 2013. A technical advisory group was formed, the Adaptive Management Working Group (AMWG). Actions outlined in the HMP were initiated in 2013 and 2014 and continued in 2015-2020; these actions are described in the Year 1 (2014), Year 2 (2015), Year 3 (2016), Year 4 (2017), Year 5 (2018), Year 6 (2019), Year 7 (2020), Year 8 (2021), and Year 9 (2022) Annual Reports. Actions implemented in Year 10 (2023) are described in this report. The AMWG provided input to the City during the implementation of the Year 10 activities.

The purpose of this annual report is to describe the current condition of the Arana Gulch habitat areas, evaluate the performance of each area in relation to the interim performance standards outlined in the HMP and included in the CDP, and provide management recommendations for the following year to ensure progress toward and achievement of success criteria. In Year 10 (2023), the City continued to focus on improving the habitat and population of the Santa Cruz tarplant (SCT), a federally Threatened and a California State Endangered species. The City continued seasonal cattle grazing and continued to implement management to control invasive weeds from the prairie/tarplant management area. A third year of experimental outplantings of SCT was conducted in February and the plantings were monitored for survival and seed production. Outplanting is a term that refers to the process of translocation of greenhouse-grown plants to an outdoor location. The plants were propagated from seed collected on-site in summer 2018 under an agreement between the City and the University of California, Santa Cruz (UCSC). All of these actions taken by the City are to continue progress to meet the HMP objectives.

AMWG coordination activities included two field meetings (April and November), as well as email and web-based correspondence.

The habitat management activities undertaken in 2023 are summarized below.

Master Plan Improvements

In 2023 the City continued to maintain the Coastal Prairie Loop Trail, the Arana Gulch Multi-Use Trail, and the Agnes Street Connector Trail. In collaboration with a volunteer trail-building organization, the City attempted to repair an eroded section of the Coastal Prairie Loop Trail. Trail construction over Hagemann Gulch and Arana Creek affected riparian woodland and in 2014 the City prepared a revegetation plan pursuant to a CDFW Streambed Alteration Agreement. Revegetation at/around Arana Creek was installed in January and February 2015 by City staff and volunteers; additional plants were installed in February 2016. In 2020 oak tree plantings were installed in this area as part of an Urban Tree Inventory and Planting Project. No new Master Plan site improvements were implemented in 2023.

Summary of Coastal Prairie/Santa Cruz Tarplant Management Area Activities

Management actions in Year 10 included seasonal grazing and seasonal mowing. A third year of experimental outplantings of SCT was conducted in February; 997 SCT plants were installed in the southern portion of Area A and 94 SCT plants were installed in an enclosure in Area C. For a third year, cattle were excluded from the southern part of Area A; however, periodic spring season flail-mowing and a fall season mow/rake session occurred in this area for grassland management. Under the guidance of the Stocking and Work Program prepared in 2014, the City continued to contract with a local rancher for seasonal grazing within the northern portion of Area A and Areas C and D; grazing (cow/calf) was initiated on February 10 and was continued through December 31, 2023. Additional activities in the management areas included monitoring plant composition, plant cover, canopy height, and residual dry matter (RDM), implementing removal/control of invasive weed infestations, and documenting site conditions at previously established permanent photo stations. In summer and early fall, the management areas were censused for SCT.

Grassland site conditions were documented in May; photo-monitoring of permanent points was not conducted in 2023. Canopy heights were measured in February, May, and December. RDM measurements were obtained in October and bare ground/plant cover with SCT-occupied areas was recorded in December. The data was collected amid an above-average rainfall season.

As per guidelines in the HMP, seasonal mowing was conducted in May for grassland/prairie areas located outside the grazing fences. Mowing was conducted to reduce the canopy height of the non-native grasses and forbs to benefit the coastal prairie species diversity and habitat function. A rotary mower was used. Area B was weed whipped in June. Bird surveys were completed prior to mowing and no nests were observed. Buffer areas were created near the wooded areas and islands were left in the drainage areas to maintain some tall grass for birds to hide and nesting as per previous recommendations from the Santa Cruz Bird Club. Colonies of native grasses and forbs were flagged and were not mowed. Blue bird nest boxes installed in 2018 continue to be used by this species.

The 2022/23 water year was an above-average rainfall season (36.78 inches), which followed three consecutive years of below average rainfall. 2023 was the ninth season of grazing (grazing was initiated in winter/spring 2015).

A census of SCT was conducted in late spring, summer, and early fall 2023. Within Area A, three colonies of historic naturally-occurring SCT were found (13 SCT plants). This is an increase from 0 plants in 2002, yet a decrease from 21 SCT plants from 3 colonies in 2021. There was one SCT in 2020, 50 plants in 2019, 267 plants in 2018, and 0 plants in 2017. The areas subject to 2021 and 2022 experimental SCT outplanting were monitored for SCT recruitment (i.e., F_1 and F_2 generations). In Area A, an estimated 431 SCT naturally recruited in the 2022 plots (F_1 generation) and an estimated 511 SCT naturally recruited in/around the 2021 plots (F_2 generation). The plants grew from SCT seed naturally broadcast by the survivors of the 2021 and 2022 SCT outplantings. The highest number of plants recruited into previous woodchip mulched plots; however, recruitment was also observed in un-mulched areas. Over half of the plants were well-developed and branched, averaging 16 inches in height and 40 flowerheads per plant; however, one 2022 plot (with woodchip mulch) produced over 400 small, single stem plants with only 1 or a few flowerheads each. Total flowerhead production from the F_1 and F_2 generations was estimated at 10,456. In Area C, no SCT plants recruited from the 2021 or 2022 outplantings.

The 2023 outplantings in Area A and Area C experienced a survival rate of 88% and 81%, respectively. This was an improvement over the 2022 outplantings, wherein plant survival was only 20%, and an improvement from the 65% survival of the 2021 planting. The high survival rate is likely attributed to the above-average rainfall season, compared to drought conditions in both 2021 and 2022. Some herbivory by gophers was observed in 2023, yet visual observations found damage was light (i.e., less than 20 plants). Within Area A, the surviving 874 plants produced an estimated 34,980 flowerheads; most plants were tall (16-18 inches) and multi-branched, averaging 40 flowerheads per plant. Within Area C, the surviving 76 plants produced an estimated 3,040 flowerheads. These plants were also tall (averaging 20 inches) and multi-branched. An experimental hand broadcast of SCT seed (with chaff) that was implemented in the southern edge of Area A in December 2022, resulted in four (4) SCT plants. Total number of SCT on site in 2023 was 1,899 plants.

Increasing the SCT population to above the 2006 population level of 267 plants[1] is an HMP goal. This goal was met in 2023. Although there was a sufficient number of SCT plants to allow collection of SCT seed (minimum of 50 plants is required as per CDFW agreement), no SCT seed collection was conducted in 2023. In October 2023, the City entered into an agreement with UCSC Greenhouses to propagate approximately 1,000 SCT plants for outplanting in 2024.

[1] See Section 3.3, Page 52 of Arana Gulch HMP

Four species of native perennial grasses were outplanted in the southern portion of Area A to boost native plant cover and species diversity. Plugs (400) of California oatgrass (*Danthonia californica)*, blue wild rye (*Elymus glaucus)*, California brome (*Bromus carinatus)*, meadow barley (*Hordeum brachyantherum)*, and tufted hairgrass (*Deschampsia ceaspitosa)* were installed within five 15 x15-foot plots in February. The survival of the plantings was monitored in summer 2023; survival rate averaged 56% (all species). Tufted hair grass exhibited 93% survival, followed by blue wild rye (71%), California oatgrass (67%), California brome (62%) and meadow barley (0%).

To facilitate SCT seed dispersal and to aid in grassland management, the southern portion of Area A and the SCT enclosure in Area C were subject to a fall season program of selective mowing and raking. In early November, the grassland surrounding the SCT population in Area A was mowed with a flail mower. In November a 20-foot wide swath of mowed grassland surrounding the SCT population was hand-raked to remove thatch and to expose bare soil. To aid SCT seed dispersal, seed and plant parts from several SCT plants from the 2023 outplanting plots were hand-broadcast onto the hand-raked area. In late November/early December, the remainder of the grassland was raked, with the cut material baled and removed. The eastern portion of the SCT population was flail-mowed in mid-November. The western portion of the SCT population was left un-mowed/unraked. Conversations with the AMWG and the rancher were conducted in November for the placement of a cross fence in the southern portion of Area A, such that cattle could graze a portion of the area; however, these actions were not able to be implemented by December 31. In Area C, the cattle exclosure fence was opened in November and cattle were allowed to graze the grass and SCT population. To aid SCT seed dispersal, seed and plant parts from several SCT plants from the 2023 outplanting plots were hand-broadcast outward of the western fence.

In compliance with the HMP and an Invasive Weed Work Plan (IWWP) prepared for the management area, City staff, volunteers from the Santa Cruz Museum of Natural History Earth Stewards Project, the Volunteer Center of Santa Cruz County's Youth SERVE Summer Institute, and the rancher removed occurrences of invasive, non-native plant species (i.e., thistles and blackberry) within the central prairie/grassland.

Summary of Hagemann Gulch Riparian Woodland and Arana Gulch Creek Riparian Woodland and Wetland Areas Activities

The City continued to observe and manage activities within these two management areas. In 2023, actions were focused on public safety, vegetation management for fire safety, removal/control of transient encampments, and control/removal of invasive plant species. In December, volunteers from the Santa Cruz Museum of Natural History – Earth Stewards Project removed blackberry and ivy along the Marsh Vista Trail. Also, in December, City crews removed large expanses of ice plant from the Arana Creek marsh plain.

The City continued to implement clean-ups from illegal camping activities, such as removing trash and waste from the northernmost portion of the Arana Gulch Creek woodland areas.

Management Activities Proposed for 2024 (Year 11)

The following management actions are identified for 2024:

- Implement periodic seasonal mowing in the southern portion of Area A to keep canopy height below 10 inches, removing seed heads of non-native grasses.
- Implement seasonal grazing in the western half of the southern portion of Area A to aid in SCT seed dispersal. Monitor effects of cattle grazing on plant cover and SCT recruitment; remove cattle when SCT plants are evident and/or when they may be significantly affected by browse.
- Continue monitoring plant composition and plant cover, and implement removal/control of invasive weed infestations. Within SCT-occupied areas, monitor the amount of bare ground present in December, which coincides with the germination period of SCT.
- Conduct outplanting of SCT container-grown plants in January/February and monitor for survival and seed productivity in the summer/fall.
- If planting stock is available, install native grass plugs in January/February and monitor for survival in the summer/fall.
- Install interpretative signage with information on the SCT planting program at the cattle exclosure in Area C.
- Continue seasonal cattle grazing within the northern portion of Area A and Areas C and D, as per the approved grazing contract and Stocking and Work Program. Additional activities in these two management areas include monitoring plant composition, plant cover, and residual dry matter (RDM), removal/control of invasive weed infestations, and documenting site conditions at the permanent photo stations. Monitor SCT expression at the previous outplanting sites in Area C.
- Consider implementing interim grassland management actions in Areas A, C and D (i.e., focused mowing or other management) if cattle grazing is delayed and canopy height levels are above the target objective of 2-3 inches (5-8 cm) between the months of November thru April. Within SCT areas monitor the amount of bare ground present in December, which coincides with the germination period of SCT.
- Within the boundaries of the prairie/SCT management area, designated woody plants growing outside of the grazing area, yet within the designated grassland, will continue to be removed and herbicide treatment may need to be applied, if needed to control stump sprouting. Continual treatments will need to be planned and implemented to keep woody plants from encroaching into the prairie.
- Conduct a census for SCT in summer and early fall 2024; if feasible, document SCT occurring in previous year plots to evaluate natural plant recovery. Seed collection of SCT may be done if more than 50 SCT are present, pending prior approval from CDFW.
- Continue relationship with UCSC Greenhouses for seed storage, seed increase and plant propagules.
- Continue to implement management actions within the Arana Gulch Creek Management Area. Pending funding and staff availability, the City will continue to implement management actions within the Hagemann Gulch Management Area.

- Continue to work with the AMWG to form recommendations for improving trail sections to improve walkability and deter new trails from forming.
- Coordinate with the Resource Conservation District (RCD) on Arana Creek watershed management, including measures to reduce erosion and sediment entry into the watershed, if opportunities arise.
- Continue to confer with the AMWG on adaptive habitat management activities in 2024 through periodic meetings and group email correspondence.
- Continue to coordinate with environmental groups, such as the Natural History Museum, Watershed Stewards Program, and others, as opportunities arise.
- Re-organize City's Arana Gulch Habitat Management website to provide clearer access to pertinent information.

2. Introduction

2.1 Background

Arana Gulch is 67 acres of open space owned by and located within the City of Santa Cruz. The eastern half of the property features the riparian corridor of Arana Gulch Creek and a tidal wetland where the creek drains into Monterey Bay at the Santa Cruz Harbor. The western half is remnant coastal prairie grassland that supports the Santa Cruz tarplant, a federally Threatened and a California State Endangered species. A steep and narrow intermittent drainage called Hagemann Gulch crosses the property on the western boundary. The features of the greenbelt property are depicted on **Figure 1**.

The City of Santa Cruz developed a master plan for the property to improve natural resource protection and restoration, public access and education. Implementation of the Arana Gulch Master Plan required the City to obtain a coastal development permit (CDP) from the California Coastal Commission because a portion of the planning area lies within the designated Coastal Zone. The CDP (3-11-074) included both standard and special conditions, requiring, among other things, developing the Arana Gulch Habitat Management Plan (HMP) to guide the long-term restoration of the open space. Specifically, Special Condition 3 of CDP 3-11-074 states:

> Arana Gulch Habitat Management Plan. PRIOR TO ISSUANCE OF THE COASTAL DEVELOPMENT PERMIT, the Permittee shall submit for Executive Director review and approval three copies of a final Arana Gulch Habitat Management Plan (HMP). The HMP shall provide for the restoration, enhancement, and long-term management of all Arana Gulch habitat areas (including, as referenced by the Arana Gulch Master Plan, the Coastal Prairie/Tarplant Management Area, the Arana Gulch Riparian and Wetland Management Area, and the Hagemann Gulch Riparian Woodland Management Area) as self-sustaining and functioning habitats in perpetuity. The HMP shall be prepared by a qualified expert in restoration ecology for each of the habitat types, and shall take into account the specific conditions of the site as well as restoration, enhancement, and management goals. The HMP shall be substantially in conformance with the Master Plan documents submitted to the Coastal Commission, including the August 1, 2005 document entitled "A Management Program for Santa Cruz Tarplant (*Holocarpha macradenia*) at Arana Gulch"), including that it can be submitted in a package that includes relevant Master Plan documentation with an addendum that addresses this condition, provided all language is modified to be directive (e.g., "shall" rather than "should") and it complies with the following requirements and includes:
>
> (a) A baseline assessment, including photographs, of the current physical and ecological condition of the restoration and enhancement areas. All existing topography, wet features, and vegetation shall be depicted on a map.

(b) A description of the goals of the plan, including in terms of topography, hydrology, vegetation, sensitive species, and wildlife usage.

(c) A description of planned site area preparation and invasive plant removal.

(d) Any planting either of seeds or container plants shall be made up exclusively of native taxa that are appropriate to the habitat and Arana Gulch region. Seed and/or vegetative propagules shall be obtained from local natural habitats so as to protect the genetic makeup of natural populations. Horticultural varieties shall not be used.

(e) A plan for monitoring and maintenance of habitat areas in perpetuity, including:

- A schedule.
- A description of field activities, including monitoring studies.
- Monitoring study design for each habitat type, including, as appropriate: goals and objectives of the study; field sampling design; study sites, including experimental/revegetation sites and reference sites; field methods, including specific field sampling techniques to be employed (photo monitoring of experimental/re-vegetation sites and reference sites shall be included); data analysis methods; presentation of results; assessment of progress toward meeting success criteria; recommendations; and monitoring study report content and schedule.
- Adaptive management procedures, including provisions to allow for modifications designed to better restore, enhance, manage, and protect habitat areas.
- Provision for submission of reports of monitoring results to the Executive Director for review and approval in perpetuity, beginning the first year after initiation of implementation of the plan. Such Monitoring Reports shall be submitted annually until success criteria are met, and then shall be submitted on an every 3-year basis after that. Each Monitoring Report (annual and 3-year) shall be cumulative and shall summarize all previous results. Each report shall clearly document the condition of the habitat areas, including in narrative (and supporting monitoring data) and with photographs taken from the same fixed points in the same directions as the baseline assessment and prior Monitoring Reports. Each report shall include a performance evaluation section where information and results from the monitoring program are used to evaluate the status of the restoration, enhancement, and long-term management in relation to the interim performance standards and final success criteria. To allow for an adaptive approach, each report shall also include a recommendations section to address changes that may be necessary in light of monitoring results and/or other information, including with respect to current restoration information and data related to the habitat areas in question, and to ensure progress toward and achievement of success criteria. Actions necessary to implement the recommendations shall be implemented within 30 days of Executive Director approval of each Monitoring Report, unless the Executive Director identifies a different time frame for implementation.

(f) Interim success criteria to be achieved in the first year of implementation, tied directly to the annual reporting requirement. Also, measurable goals to achieve habitat improvement over time, subject to modification by the Adaptive Management Working Group.

(g) Implementation procedures, cost estimates, identification and allotment of funding for all HMP activities, and related reporting procedures.

(h) Provisions for minor adjustments to the HMP by the Executive Director if such adjustments: (1) are deemed reasonable and necessary; and (2) do not adversely impact coastal resources.

(i) Identification of the membership of the Adaptive Management Working Group, which initial composition and any future changes shall be subject to Executive Director approval. The Adaptive Management Working Group shall guide all HMP activities under the plan.

(j) All details associated with the grazing program, subject to Adaptive Management Working Group and Executive Director approval, in substantial conformance with the proposed cattle grazing program (see Exhibit P Tab 4).

PRIOR TO COMMENCEMENT OF CONSTRUCTION, the HMP shall be implemented by establishing the Adaptive Management Working Group (AMWG), receiving prioritized first-year management recommendations from the AMWG, and initiating implementation of the highest priority recommendations in the field.

The Permittee shall undertake development in accordance with the approved Arana Gulch Habitat Management Plan.

The HMP guides management of three habitat areas within Arana Gulch: the Hageman Gulch Riparian Woodland Management Area, the Arana Creek Wetland and Riparian Management Area and the Coastal Prairie/Tarplant Management Area. Within the Coastal Prairie/Tarplant Management Area, the HMP focuses on restoration of the coastal prairie and recovery of the Santa Cruz tarplant (SCT); this management area continued to receive the most attention in Year 10 (2023) due to the urgency to revitalize the SCT population. The population of SCT at Arana Gulch has been perilously low since 2007; fewer than 50 plants have been observed in all years but 2018 (267 plants). No SCT plants emerged in 6 different years since 2010, including 2022; however, 13 SCT plants emerged in natural areas in 2023. In addition, 942 SCT plants emerged within the previous year(s) (2021 and 2022) outplanting plots and four (4) plants arose from an experimental seeding, indicating a level of natural SCT recovery is occurring on site.

The HMP outlines various management tools for managing the three habitat areas on the site[2]. A key tool described in the HMP is an adaptive management framework for habitat restoration actions. Under this framework, and as required by the CDP, an Adaptive Management Working Group (AMWG) was formed to provide scientific expertise on

[2] See Section 3.1, page 33 of Arana Gulch HMP.

resource management activities to the City and the CCC[3]. In 2023, the AMWG provided input to the City during two meetings on implementation of several components of the HMP.

Implementation of the HMP coincided with the construction of the Arana Gulch Multi-Use Trail project. Bike paths, hiking trails, cattle grazing infrastructure, and bridges were built within the greenbelt. Most of these features were completed in 2014 and the grazing infrastructure was completed in early 2015. The construction activities associated with the multi-use trail project that are relevant to the restoration effort are fully described in the Year 1 (2014) Annual Report (City of Santa Cruz, November 2015).

This is the 10th annual report since adoption of the HMP and while some objectives of the plan have not yet been realized; Year 10 shows a positive trend in SCT recovery as there has been successful recruitment of SCT plants in natural stands as well as in previous year outplanting sites. The report is intended to report on the progress of the plan in the monitoring year, provide a comparison to previous year data and trends, and prepare for future management actions. The reader is directed to previous annual reports for specific details and data implemented in these years. The previous annual reports (e.g., Year 1 [2014] Annual Report, Year 2 [2015] Annual Report, Year 3 [2016] Annual Report, Year 4 [2017] , Year 5 [2018] Annual Report), Year 6 (2019), Year 7 [2020], Year 8 [2021], and Year 9[2022]) are available for review on the City's website (http://www.cityofsantacruz.com/departments/parks-recreation/parks-beaches-and-open-spaces/open-spaces/arana-gulch).

The HMP is grounded in an adaptive management framework. Implementation actions will constantly be reviewed and improved upon. Therefore, this annual report is not intended to lay out every action to be implemented for the upcoming year. It will highlight the actions that have been identified by the City and from AMWG meetings from the monitoring year; however, additional actions may be identified by the City and during AMWG meetings throughout the upcoming year.

[3] See Section 2.2, Page 22 of Arana Gulch HMP.

Figure 1. Location Map

2.2 Report Organization and Purpose

The purpose of this annual report is to describe the current condition of the Arana Gulch habitat areas, evaluate the performance of each area in relation to the interim performance standards outlined in the HMP and included in the CDP, and provide management recommendations for the following year to ensure progress toward and achievement of success criteria. In addition to activities approved under the CDP, this report also reports on activities authorized by a Scientific, Educational, or Management Permit issued by the California Department of Fish and Wildlife (Permit No. 2081 (a)-13-013-RP). This report includes all activities conducted in the calendar year 2023 which is considered to be Year 10 pursuant to actions outlined in the HMP and the CDFW 2081(a) permit.

Additionally, this report describes activities associated with the implementation of Arana Gulch Master Plan improvements where such activities intersect with the goals and objectives of the HMP. The City conferred with technical specialists, including AMWG members, regulatory agency personnel, the City of Santa Cruz Planning and Community Development Department, and members of the public while implementing adaptive habitat management activities on the greenbelt.

The adaptive management framework of the HMP is presented in Section 3. The habitat management actions associated with Master Plan improvements are described in Section 4. Actions implementing the HMP are presented in Sections 5 through 7 under their respective management area. Each management area section includes a summary of the implemented actions as they pertain to the goals and objectives in the HMP, and a performance evaluation. Recommendations for Year 10 (2023) are summarized in Section 8. Please refer to the HMP for technical background information on the Arana Gulch greenbelt and HMP goals and objectives. Please refer to previous annual reports (i.e., Year 1 [2014], Year 2 [2015], Year 3 [2016], Year 4 [2017], Year 5 [2018], Year 6 [2019], Year 7 [2020], Year 8 [2021], and Year 9 [2022]) for specific details on actions implemented in those years.

3. Adaptive Management Framework

3.1 Adaptive Working Group (AMWG)

The City adopted an adaptive management framework for implementation of the HMP. The City facilitated and coordinated habitat management activities with the AMWG in 2023. Two meetings were held with the AMWG in 2023; the minutes from the April 18 and November 7 meetings are presented in **Appendix A**. In addition, the City coordinated and facilitated group email correspondence between AMWG members to solicit input on management activities. The HMP outlines the formation of the AMWG, voting procedures, and other procedures.[4] The list of current members is presented in the meeting minutes **(Appendix A).**

The AMWG provided input to the City on habitat management activities within Arana Gulch throughout 2023. A detailed discussion of AMWG recommendations is included in the sections for each management area and in the meeting minutes. In short, the AMWG provided recommendations on the timing and intensity of seasonal grazing, mowing and other grassland strategies, interest in SCT management actions, and SCT increase and outplanting.

3.2 Public Outreach

In 2023 the City maintained a webpage on the City of Santa Cruz website to communicate restoration efforts to the public and to provide a place for documents related to the requirements of the CDP. The City periodically updated the webpage throughout 2023.

The AMWG meetings (field and virtual meetings) were open to the public and provided a forum for members of the public to express their ideas directly to the members and City. Public comments were also generated through the City's website and the AMWG was briefed of public comments and concerns during AMWG meetings.

Signage was maintained onsite with a web address for notifying the City on any concerns regarding grazing or other public access issues within the greenbelt. The City also coordinated with UCSC, the Santa Cruz Natural History Museum, the Coastal Watershed Council, the California Native Plant Society, and other volunteers for the SCT outplantings that occurred in February 2023 and with the Earth Stewards program for invasive plant management.

3.3 Evaluation of Adaptive Management HMP Goals

A goal of the HMP is to maintain an adaptive management framework to allow stakeholders to conduct and evaluate actions. To meet this goal there are two objectives: conduct an annual AMWG meeting and maintain funding levels. In 2023, two meetings were held with the AMWG (April and November) and there was email correspondence with AMWG members to present information and solicit feedback. The City dedicated funding to implement the habitat management actions identified in the HMP based on a prioritization recommended by

[4] See pages 22-24 of Arana Gulch HMP

the AMWG. The City and the AMWG re-visited HMP management actions in 2023, particularly the prairie/SCT recovery actions. The AMWG also provided input to the City during the review of the 2023 SCT outplantings, the fall season management actions, and plans for SCT outplantings in 2024.

To meet Objective 1B, the City dedicated Arana Gulch management as a line item in the City Parks and Recreation Departments operating budget. The City also hired a maintenance person that is partially dedicated to the Arana Gulch greenbelt. The position was filled in January 2016.

A second adaptive management goal is to conduct a two-tracked program of management and research with monitoring. The management actions implemented in 2023, such as seasonal grazing, seasonal mowing in the southern portion of Area A, and perimeter seasonal mowing, were monitored to determine their effectiveness in meeting biological variables. The HMP identified a timescale for implementation of the management actions relative to the SCT with an objective of increasing the number of aboveground SCT to at least the 2006 level (348 plants) by 2016 (first year after grazing). Plant propagation occurred at UCSC Greenhouses and with the experimental outplanting of over 1,000 SCT plants onto the site in 2023 (in addition to outplantings in 2021 and 2022), the project met this target in 2023 with plant recruitment in Area A from the SCT 2021 and 2022 outplantings as well as SCT plants found in historic naturally-occurring areas. The research report on the dormancy of ray achenes was completed in 2023, with UCSC's submittal of the germination study report to USFWS in March 2023 and a final progress report for the USFWS grant in April 2023.

The timescale presented in the HMP for restoration of the coastal prairie or invasive plant control is to progress to a more functioning system by 2020. In 2023, the City continued to implement a mowing program in the southern portion of Area A for SCT as well as for coastal prairie enhancement. In 2023 there were also outplantings of native grasses to boost native plant species diversity in this portion of Area A. Monitoring of the grassland in 2024 will provide additional information on the effectiveness of these actions for prairie enhancement.

The third adaptive management goal is to develop educational opportunities within Arana Gulch, with efforts to conserve and restore its rare resources. Students and staff volunteers from UCSC as well as public volunteers participated in the SCT outplantings; some students received volunteer class credit. Volunteers from the Watershed Stewardship Program and Earth Stewards Project also participated in on-site habitat management. The City maintained a web page on the City's website to post information about the HMP and received input from the AMWG and the public consistent with Objective 3A. Additional recommendations for public outreach were identified by the AMWG and the public (i.e., signs for cattle grazing and developing a brochure on cattle grazing) and the City implemented them. **Table 1** presents a summary of the objectives for adaptive management, actions implemented in 2023, and whether the actions were in compliance with the HMP.

Table 1. Monitoring of Adaptive Management Variables

Objective and Variable	Actions in Year 10 (2023)	Year 10 (2023) Results	Objective Met?
Goal 1. Maintain an adaptive management framework that allows stakeholders to scientifically conduct and evaluate actions			
Objective 1A. Conduct at least 3 AMWG meetings in 2013 with a quorum of members present each time. In subsequent years, the frequency of meetings beyond an annual November meeting can be determined by the needs of the AMWG.	Meetings held April 18 and November 7	Meeting minutes presented in Appendix A	Yes, two meetings in 2023. Email correspondence was conducted with AMWG members periodically in 2023
Objective 1B. Maintain funding levels to achieve a level of habitat management that is 1) indefinitely sustainable into the future, and 2) shows a stable or increasing trend in measured biological variables over a biologically appropriate timescale.	Funding allocated by City; line item established in operating budget	Funding allocated by City for fiscal year July 1, 2022 to June 30, 2023 and July 1, 2023 to June 30, 2024	Yes, the budget funds staff, consultant, and contractor time to improve management, implement projects, conduct studies, and /or implement improvement, resulting in an increase in the measured biological variables
Goal 2. Conduct a two-tracked program of management and research with built-in monitoring			
Objective 2A. Maintain a Management Track that leads to stable or increasing trend in measured biological variables over a biologically appropriate timescale.	The City incorporated AMWG recommendations into multiple management actions including a second year of outplanting, mowing, and grazing.	Data from studies and monitoring were considered by City and AMWG during management decisions	Yes, monitoring of biological variables and trends were conducted as outlined in the HMP. The AMWG recommended continued outplanting of SCT to develop a robust soil seedbank. AMWG recommended multiple management actions (mowing, raking, grazing) to aid in SCT seed dispersal and create suitable conditions for SCT germination.
Objective 2B. Utilize a Key Management Question (KMQ) framework to guide the Research Track when research is needed to achieve the specific goals and objectives for SCT and the coastal prairie.	An SCT outplanting plan was implemented in 2023 to add SCT seed into the system. A fall season management program was developed to examine SCT seed	Recruitment of SCT in F_1 and F_2 generations and 85% survival of all 2023 SCT outplantings. Total population of SCT in 1.899 plants in two areas.	Yes, the SCT Outplanting Plan developed in 2021 and 2002 was successful and was repeated in 2023. The fall season management actions will be evaluated as to whether the actions continue to provide SCT population recovery.

Table 1. Monitoring of Adaptive Management Variables

Objective and Variable	Actions in Year 10 (2023)	Year 10 (2023) Results	Objective Met?
	dispersal and management of SCT-occupied areas.		
Goal 3. Develop public educational opportunities associated with Arana Gulch and efforts to conserve and restore its rare resources			
Objective 3A. Maintain a website to communicate restoration efforts to the public and provide a place for documents related to the requirements of the CDP, such as Monitoring Reports.	Webpage on City website developed in 2013	Webpage updated in 2023 with new information	Yes, City periodically updated website with reports and information as needed

4. Implementation of Master Plan Improvements

Construction of the Arana Gulch Multi-Use Trail was initiated in fall 2013 and was completed in December 2014. This east-west trail extends from Brommer Street (east of the greenbelt) westward to Broadway Street (west side of greenbelt, across Hagemann Gulch). The Agnes Street Trail extends southward from Agnes Street to join the east-west multi-use trail midway within the greenbelt. This trail was also constructed in 2014. Cattle infrastructure was installed in 2014 including fences, access gates, water line/water troughs and a temporary holding corral near Agnes Street. The Marsh Vista Trail, a pedestrian trail located along the east side of Arana Creek, was constructed in 2013. In 2018, improvements were made to a portion of the Coastal Loop Trail. The location of this trail and other master plan improvements is presented in **Figure 2**. Figure 2 also includes the location of the historic SCT areas called A-D.

4.1 Multi-Use Trail and Infrastructure Management

4.1.1. Current Management

In collaboration with a volunteer trail-building organization, the City attempted to repair an eroded section of the Coastal Prairie Loop Trail in 2023. In response to public concern about user impacts to Area B, split-rail fencing was installed in 2021 near the Hagemann Gulch bridge to reduce off-trail use. Hydromulch and hydroseeding have been utilized in various areas for erosion control related to use along the edge of paved trails and also along user-created trails.

Cattle grazing signs, installed at each entrance and along the fence, were maintained throughout the year. The signs continue to provide contact information to the City and rules of the site. The water troughs were maintained throughout the grazing season. Some vegetation recolonized the site of the former water trough site in Area A (trough was moved southward approximately 100 feet in 2016).

4.1.2. Past Management

Project conditions of approval required the salvage of topsoil from areas within 20-feet of mapped tarplant if such areas were disturbed during trail construction. In December 2013, the upper 6 inches of topsoil from an area upslope of Tarplant Area D was salvaged and spread onto an approximately 3,750 square foot area south of Tarplant Area C. No SCT plants have been observed within the receiver site.

The Agnes Street Trail Connector construction disturbed a section of soil within 20 feet of Tarplant Area C in September 2014. On September 15, 2014, the upper 6 inches of topsoil from this area of approximately 2,900 square feet was salvaged and spread onto areas southwest and northwest of Tarplant Area C. No SCT plants have been observed within the

receiver site. The temporary construction access road used during trail construction in 2013 and 2014 was allowed to naturally revegetate from the existing soil seed bank.

Poor drainage along the edge of the central east-west trail was observed in winter 2016. An AMWG member expressed concern that water was not passing under the trail, as designed, and water was prevented from reaching the downslope prairie. In 2016, City staff installed a series of small gravel drains to enable water to penetrate the engineered drainage system under the pathway. Staff believed that the clay content of the top soil was not allowing effective penetration to the drainage rocks beneath it. City staff have continued to monitored these areas.

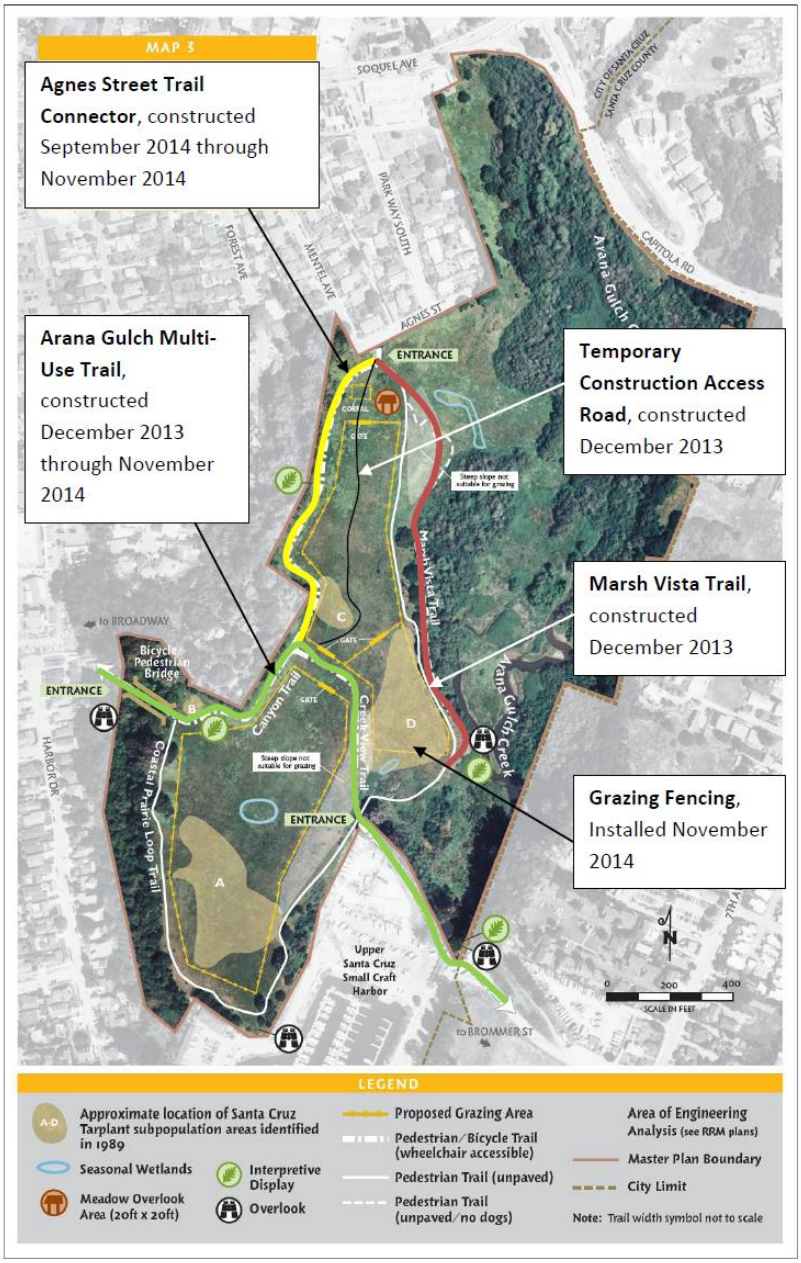


Figure 2. Master Plan Improvements, 2013 - 2023

4.2 Photo Point Monitoring

Photo points for long-term monitoring were established in April 2015. These photo points are to be re-taken each year. The photo points (15) are distributed throughout the coastal prairie with two additional points on the Arana Creek Causeway and two on Hagemann Bridge (**Figure 3**). All points are located at either an interpretative sign or a fence corner for easy reference. Four photos are taken per point in a clockwise order facing into the enclosure; Photo 1 looks straight ahead, Photo 2 is to the right, Photo 3 looks straight behind, and Photo

4 to the left. All photos can be taken in about one hour, preferably when the sun is high in the sky and casting few shadows. The two points taken on the causeway looking into Arana Creek give a general idea of conditions in the riparian area. The additional points located on Hagemann Gulch Bridge look out and down into the Gulch. One extra point is taken standing in front of the entry sign at Frederick Street in order to observe the recovery from the construction. Due to a scheduling error by a City consultant, the photo -monitoring did not occur in 2023; however, it is scheduled for April 2024.

Figure 3. Location of Photo Points for Long-Term Monitoring

5. Coastal Prairie/Santa Cruz Tarplant Management Area

The coastal prairie occupies about 30 of the 67 acres at Arana Gulch and is essential because it has supported the third largest standing native Santa Cruz tarplant (SCT) population and is one of only 13 populations found in Santa Cruz County (USFWS, 2015). A primary focus for this management area is the recovery of the SCT, because the population at Arana Gulch has declined over the last two decades[5]. This section describes management and monitoring actions for the SCT (Section 5.1), coastal prairie grassland (Section 5.2), grazing and stocking work program (Section 5.3), and the invasive weed work plan (Section 5.4). Section 5.5 includes an evaluation of progress toward meeting the goals and objectives outlined in Section 3.0 of the HMP. Section 5.6 provides proposed actions for 2023.

Activities implemented within this management area in 2023 include: cattle grazing, perimeter mowing, seasonal mowing in the southern portion of Area A, experimental outplanting of container-grown SCT, and invasive weed control. Monitoring of these and previous year actions occurred throughout the year. City staff, City consultants, and volunteers from UCSC, the public, Santa Cruz Natural History Museum Earth Stewards Project, and the Watershed Stewardship Program implemented these tasks. In addition, the City and UCSC Greenhouses coordinated on SCT seed storage and plant propagation.

5.1 Santa Cruz Tarplant

The recovery actions for SCT implemented in 2023, including an annual census (5.1.1), outplanting (5.1.2), and management actions to aid in seed dispersal and species recovery (5.1.3), are described in the following sections.

5.1.1 Santa Cruz Tarplant Census

The HMP requires an annual census of the population (Goal 1) and a baseline assessment of SCT within the soil seed bank (Goal 4). Field surveys for SCT at Arana Gulch were first conducted in 1977 by botanist Randy Morgan but plant counts are lacking in the current database. In 1986, he estimated there were more than 100,000 plants on the property. In 1989, R. Doug Stone identified SCT in four locations he called Areas A-D (see **Figure 1 and 2**). These area designations have remained in use.

The census for SCT was conducted by Kathleen Lyons following guidelines from *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFW), *CNPS Botanical Survey Guidelines* (CNPS, 2001), and *Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and*

[5] See Section 3.1, page 63 of Arana Gulch HMP.

Candidate Species (UFWS (1996). Field surveys to determine the presence/absence of SCT were conducted in July, August and October 2023. This survey period coincided with the blooming period of SCT. Surveys were conducted by walking the grassland over multiple days to detect SCT. Survey days were April 18, May 3, June 27, July 19, July 21, July 26, October 3, and October 11. As per protocol, if a SCT was observed a waypoint would be taken with a handheld Global Positioning System (Gaia software) that would record the plant's patch location. If found, the protocol includes recording patch size, plant height, branching, flowering status, and estimating the number of flowering heads per plant. The 2023 survey was conducted in an above-average rainfall year.

Within Area A, 13 SCT plants were found in three patches within the historic naturally-occurring SCT area. This is an increase from 0 plants in 2002, yet a decrease from 21 SCT plants from 3 colonies in 2021. There was one SCT in 2020, 50 plants in 2019, 267 plants in 2018, and 0 plants in 2017.

The areas subject to 2021 and 2022 experimental SCT outplanting were also censused for SCT recruitment (i.e., F_1 and F_2 generations). In Area A, an estimated 431 SCT naturally recruited in the 2022 plots (F_1 generation) and an estimated 511 SCT naturally recruited in/around the 2021 plots (F_2 generation). The plants grew from SCT seed naturally broadcast by the survivors of the 2021 and 2022 SCT outplantings. The highest number of plants recruited into previous woodchip mulched plots; however, recruitment was also observed in un-mulched areas. Over half of the plants were well-developed and branched, averaging 16 inches in height and supporting 40 flowerheads per plant; however, one 2022 plot (with woodchip mulch) produced over 400 small, single stem plants with only 1 or a few flowerheads each. Total flowerhead production from the F_1 and F_2 generations was estimated at 10,456. In Area C, no SCT plants recruited from the 2021 or 2022 outplantings.

Within the 2023 SCT outplanting plots in Area A (see Section 5.1.2) 874 plants survived and produced an estimated 34,980 flowerheads; most plants were tall (16-18 inches) and multi-branched, averaging 40 flowerheads per plant. Within the Area C outplanting plots, 76 plants survived and produced an estimated 3,040 flowerheads. These plants were also tall (averaging 20 inches) and multi-branched. An experimental hand broadcast of SCT seed (with chaff) that was implemented in the southern edge of Area A in December 2022, resulted in four (4) SCT plants. Total number of SCT on site in 2023 was 1,899 plants, a summary is presented in **Table 2** and **Figure 4**. **Tables 3, 4, and 5** display the data from each location/occurrence. **Figures 5-9** show several SCT occurrences.

Table 2. Summary of SCT Census

Area	Sub Area	# SCT
A	Historic Areas	13
	2022 (December) Seeding Plot	4
	2023 (February) Outplanting Plots	874
	2021 Outplanting Plots (F2 generation)	511
	2022 Outplanting Plots (F1 generation)	431
Area A Total		**1,823**
C	Historic Areas	0
	February 2023 Outplanting Plots	76
Area C Total		**76**
Area D	**Historic Areas**	**0**
TOTAL SCT		**1,899**

Figure 4. Areas A South, Distribution of SCT Outside of 2023 Outplantings Plots, October 2023

Table 3. Area A South. 2023 SCT Outplanting Plot Data

Note: All SCT were installed in February 2023; plants were installed in failed 2022 plots [no SCT survival))							
Macroplot	**Plot**	**# Outplanted 2/23**	**Treatment**	**# Alive 7/23**	**Survival Rate**	**Average Height (in.)**	**Approx. Number of Flower heads[6]**
122	C	23	Bare and Woodchip	23	100%	20	920
	D	34	Straw	34	100%	20	1360
	E	35	Woodchip	35	100%	20	1400
	G	60	Bare and Straw	60	100%	18	2400
	H	27	Woodchip	27	100%	20	1080
222	A	56	Woodchip and straw	5	9%	16	200
	B	53	Woodchip	50	94%	20	2000
	C	70	Woodchip	70	100%	20	2800
	D	82	Woodchip	15	18%	20	600
	E	38	Woodchip	38	100%	20	1520
	F	35	Woodchip	35	100%	20	1400
	G	38	Woodchip	38	100%	20	1520
	H	38	Straw	38	100%	20	1520
322	A	64	Straw	64	100%	20	2580
	B	72	Woodchip	70	97%	20	2800
	C	70	Woodchip and Straw	70	100%	20	2800
	D	39	Woodchip	39	100%	18	1560
	F	60	Woodchip	60	100%	18	2400
	G	51	Woodchip	51	100%	20	2040

[6] 2023 plants are large and robust, averaging 40 flowerheads per plant

Note: All SCT were installed in February 2023; plants were installed in failed 2022 plots [no SCT survival))							
Macroplot	**Plot**	**# Outplanted 2/23**	**Treatment**	**# Alive 7/23**	**Survival Rate**	**Average Height (in.)**	**Approx. Number of Flower heads[6]**
	H	52	Woodchip and Straw	52	100%	20	2080
Total		**997**		**874**	**88%**		**34,980**

Table 4. Area C Cattle Exclosure, 2023 SCT Outplanting Plot Data

Note: All SCT were installed in Cattle Exclosure in February 2023; plants were installed in failed 2022 plots [no SCT survival])							
Macroplot	**Plot**	**# Outplanted 2/23**	**Treatment**	**# Alive 7/23**	**Survival Rate**	**Average Height (in.)**	**Approx. Number of Flower heads**
	A	29	Woodchip	20	69%	20	800
	B	20	Straw	20	100%	20	800
	C	25	Woodchip	25	100%	20	1000
	D	20	Woodchip	11	55%	20	440
Total		**94**		**76**	**81%**		**3,040**

Table 5. Other Occurrences of SCT (F1 and F2 Patches in Outplanted Areas and Historic Areas)

Pink shading are F1 plants in 2022 outplanting plots. Blue shading are plants in historic areas

Area A, South - 2022 Outplanting Plots							
Macroplot	**Plot**	**Outplanted 2/22**	**Treatment**	**# Alive 7/23**	**Survival Rate**	**Average Height (in.)**	**Approx. Number of Flower heads[7]**
122	A	-	None	6	-	16	240
	F	-	None	5	-	12	200
Total				**11**			**440**

[7] 2023 plants are large and robust, averaging 40 flowerheads per plant

Area A, South - Other SCT Occurrences								
Site Number (Flag #)	**GPS**	**Previous Outplanting Site?**	**Treatment?**	**# Alive 7/23**	**Patch Size (feet)**	**Average Height (in.)**	**Average # Flower heads per Plant**	**Approx. Number of Flower heads**
1	36.974322 -122.000174	Yes	?	1	1x1	5	1	5
2	36.974337 -122.000296	Yes	?	28	10x15	18	20	560
3	36.974424 -122.000577	Yes	Woodchip	34	10x15	18	26	884
5	36.97436 -122.00063			5	5x5	18	20	100
6	36.97437 -122.00069	2022 plot in macroplot 122		3	1x5	16	12	36
7	36.97442 -122.00063	2022 plot in microplot 222	Woodchip	7	10x15	20	40	280
8	36.97438 -122.00030	Yes	Woodchip	32	10x15	22	40	1280
9	36.97430 -122.00017	Yes	Woodchip	42	10x15	20	22	924
10	36.97461 -122.00058	No	Native Site	7	10x10	12	35	245
11	36,97945 -122.00037	No	Native Site	3	2x2	14	11	33
12	36,97443 -122.00051			3	1x8	16	14	42
13	36,97442 -122.00059	Yes	Woodchip	32	10x15	18	20	640
14	36.97442 -122.00059			16	5x10	12	7	84
15	36.97463 -122.00065	Yes	Woodchip	270	10x15	10	12	3240
16	36.97437 -122.00053			3	1x6	10	10	30

Site Number (Flag #)	GPS	Previous Outplanting Site?	Treatment?	# Alive 7/23	Patch Size (feet)	Average Height (in.)	Average # Flower heads per Plant	Approx. Number of Flower heads
17	36.97418 -122.00027	Yes		9	10x15	18	12	108
18	36.974370 -122.000188			1	1x1	20	15	15
19	36.97429 -122.00026	Yes	Woodchip	7	10x15	12	7	49
20	36.97425 -122.00030	Yes		15	10x15	18	15	225
21	36.97431 -122.00030			3	2x2	16	7	21
22	36.97423 -122.00056	2022 plot in macroplot 122		5	10x15	12	7	35
23	36.97427 -122.00079	Two 2022 plots in microplot 122	Woodchip	400	20x15	7	4	1600
24	36.97415 -122.00080	Yes, 2022 plot in microplot 322		5	1x6	8	4	20
26	36.97457 -122.00063	No	Native Site	3	2x2	16	10	30
SCT Seeding	36.97368 -122.00060	No	Seeded	4	12x12	10	8	32
Total				**938**				**10,518**

Figure 5. SCT Occurrence #3; 34 SCT Plants in Previous Woodchip Plot

Figure 6. SCT Occurrence #15; 270 SCT Plants in Previous Woodchip Plot

Figure 7. SCT Occurrence #10; 7 SCT Plants in Historic Site

Figure 8. SCT Occurrence #8; 32 SCT Plants in Previous Woodchip Plot

Figure 9. SCT Occurrence #23; Dense Patch of Small-Statured SCT (approximately 400) in Previous 2022 Woodchip Plot

No SCT seed was collected from the SCT plants in 2023. As per conditions of the City's 2081 permit with CDFW, SCT can be collected if there are more than 50 plants. The permit is valid until December 2023. UCSC Greenhouses has enough seed in storage that additional seed collection was not needed in 2023

5.1.2 SCT Outplanting

Background. Due to a highly depleted SCT seed bank and the failure of SCT recovery through site disturbance (e.g., mowing, grazing), an alternative SCT Habitat Enhancement Work Plan was developed in 2019, and amended in 2020. The work plan recommended changing site management from disturbance strategies designed to stimulate the seedbank (such as just grazing or scraping) to planting container-grown SCT as a means to increase the SCT seed bank for species recovery. Planting treatments were identified that represent a

gradient of management intensity. The treatments are listed below; the outplantings (treatments 3 and 4, below) did not receive supplemental irrigation.:

1) no treatment control ("grazing release" treatment in Area A and C),
2) mowing one time (simulated with string trim; Area A),
3) sheetmulch treatment (Area A), and
4) no treatment, with grazing (Area D).

Outplanting of nursery-grown SCT plants was initiated in 2020, wherein UCSC Greenhouses successfully propagated 28 SCT plugs from site-collected seed. These plants were installed into a pilot planting plot in Area C. The pilot outplanting resulted in 6 plants surviving to flower. Following the success of this first outplanting, subsequent plant propagation and outplantings were conducted in 2021, 2022, and 2023.

Grazing was suspended in Area A to evaluate the treatments independent of grazing impacts, and therefore the 2021 control treatment was considered a "grazing release" treatment. Treatment 3 consisted of sheet mulching the planted plots, using overlapping sections of single ply B-flute cardboard (flat on one side and corrugated on the other) followed by a layer of wood chips or straw mulch to a depth of 2-3 inches. Sheet mulching was used to suppress weed germination, enhance soil moisture retention, and increase organic matter accumulation.

2021 Outplanting. Utilizing site-specific SCT seed, collected on-site in 2018, the City pursued a second experimental outplanting of 1,000 SCT plants in 2021. The majority of the plants were installed within the historic SCT area in the central part of Area A (**Figure 4**). A total of 391 SCT were planted on January 26, 2021 within 10 x 10-foot sub-plots within 3 macroplots (40 x 60-feet). A second batch of 603 SCT were planted on February 22, 2021. The purpose of the two planting times was both logistical and also to take precautions against failure of one planting due to lack of rainfall or other disturbance. In Area D, 56 plants were planted in January in 7 clusters of 8 plants each dispersed through the lowest portion of the pasture, closest to Arana Creek. This planting was subject to grazing. In February, 69 SCT were planted within the 2020 grazing exclosure fencing in Area C and 27 were planted immediately outside the fencing.

Table 6 summarizes survival and flowerhead production in the 2021 planting. SCT planted into woodchip sheetmulch and weeded one time in the spring produced twice as many flowerheads as un-weeded plots. Surviving SCT in the control and mow one-time plots produced a combined total of only 2,000 flowerheads. Heavy seed rain was observed in the sheetmulch plots and the decision was made to rake the woodchip to the side of subplots in each macroplot in October. A second subplot in each macroplot was raked in November and one plot within each microplot was left unraked.

Table 6. SCT Survival and Flowerhead Production in the 2021 SCT Outplanting, Area A

Treatment	Woodchip Sheetmulch (weeded)	Woodchip Sheetmulch (unweeded)	Control/Mow	Total
Area A				
Total Flowerheads	34,104	15,569	2,077	**51,750**
Avg Flowerheads/plant	355-582	52-175	2-15	**na**
Number of SCT plants	82	132	307	**521**

In Area D, none of the 56 SCT planted that were unprotected from grazing survived to flower. In Area C, a total of 33 of 69 SCT (48% survival) planted within the 2020 grazing exclosure survived to flower in August. The plot was string-trimmed in April to reduce non-native grasses and radish and definitive branching above a cut point was observed on some surviving plants. Survivors produced a total of 192 flowerheads with an average of 6 per plant. None of the 27 SCT planted immediately outside of the grazing exclosure in Area C survived to flower.

Natural first-year recruitment of SCT from the 2021 plots was evaluated in summer 2022. Recruitment within the 2021 plots was extremely variable and was limited to the plots in Area A. There was virtually no recruitment in the control/mow plots. Recruitment only occurred within the sheetmulch plots. In June 2022, a "lawn" of thousands of emerging seedlings was observed in a single subplot; however, only 5 SCT emerged and flowered in another subplot. Several other subplots supported SCT; the average number of SCT plants in these subplots was 90 (plants per plot). By the time of the final assessment in late September 2022, the number of flowering SCT was still as variable and ranged from only 3 to an estimated 500 plants in 2 different sub-plots. Raking the woodchip in the fall appeared to improve recruitment. In un-raked subplots, an estimated 200 SCT recruited and flowered, producing around 900 flowerheads. Approximately 700 SCT recruited and flowered in plots raked in mid-October and 600 in plots raked in early November, producing an estimated 1,500 and 2,000 flowerheads, respectively. Overall an estimated 1,500 SCT recruited and produced 4,500 flowerheads.

Figure 10. Location of 2021 Experimental SCT Planting Plots in Area A (Orange), C (Blue), and D (Red).

***2022 Outplanting*.** In March 2021, the City submitted a proposal to the Ventura Fish and Wildlife Office Recovery Project requesting $22,050 funding to continue implementation of the Habitat Enhancement Plan with three main elements: additional greenhouse propagation of SCT plants at the UCSC Greenhouses, implementation of a second phase of outplanting in 2022, and laboratory research on SCT germination cues at UCSC. The primary goal of the additional round of planting in 2022 was to establish container-grown SCT plants to increase seed production and provide further protection against the possible extirpation of the population at Arana Gulch. The Ventura Fish and Wildlife Office selected the City's proposal in June, 2021. In the fall, Alison Stanton developed an experimental design similar to the 2021 planting to test additional planting strategies to determine which methods lead to the greatest *in situ* survival and reproduction, measured as mature SCT flower head production per plant. UCSC Greenhouses propagated approximately 1,400 SCT for use at Arana Gulch. A total of 600 SCT were planted on February 3, 2022 and 400 SCT were planted on February 24, 2022 in Area A. and another 1,000 plants in 2022. Planting locations in Area A are shown on **Figure 11.**

Figure 11. Locations of 2021 and 2022 SCT Macroplots in Area A

Survival of the 2022 planting cohort was much lower than expected. The cardboard-only treatment was discontinued almost immediately when the plots were destroyed by wind. The straw mulch treatment was only marginally more successful, with less than 10% of planted SCT surviving to flower. Average survival in other treatments was only 20 to 30%. The low survival is likely due to persistent drought conditions. Total precipitation from the beginning of January through May was only 3.7-inches, and no rainfall greater than a tenth of an inch fell from January 5th to March 27th. In addition to drought, extensive gopher herbivory was observed along with strong competitive pressure by weeds. The straw mulch appeared to be very prone to gopher damage and less effective at suppressing weeds. Most straw mulch plots failed completely and only 17 SCT total (7%) survived to flower out of 245 planted. Survival in the wood sheetmulch plots was only 20% on average, with only 11 plants total surviving in Macroplot 1 and 7 in Macroplot 2. In Macroplot 3, 34 plants survived in the wood mulch treatment, but 18 were in a single subplot, accounting for 26% of total survival in the wood mulch and straw mulch treatments combined. In spring 2023, natural recruitment of SCT

plants was observed in the outplanted plots; in April interns from UCSC hand-weeded some of these plots.

Table 7. SCT Survival and Flowerhead Production in the 2022 Outplanting

Treatment	Woodchip Sheetmulch (WS)	Straw sheetmulch (SS)	Control/Mow	Total
Area A				
Total Flowerheads	11,545	2,800	625	**14,970**
Avg Flowerheads/plant	325	150	6	**na**
Number of SCT plants	54	17	115	**186**
% Survival	20	7	28	
Area C				
Total Flowerheads	365	200	135	**700**
Number of SCT plants	6	7	11	**24**

5.1.2.1 SCT Outplantings in 2023

The goal of the 2023 SCT outplanting was to continue to establish container-grown SCT plants on site that would survive and produce seed, thus increasing the soil seed bank to aid in species recovery. The results of the 2021 and 2022 outplantings documented the success of the outplanting program, as evidenced by the success in growing SCT in the nursery, good plant survival of outplanted individuals, and the subsequent natural recruitment of SCT plants from seed distributed from the surviving outplanted plants. The previous year(s) experimental designs documented the best planting strategy that lead to the greatest *in situ* survival and reproduction, measured as mature SCT flower head production per plant. The most successful strategy to date is to install the SCT plants within plots, with sheetmulch (wood chips and/or straw). UCSC Greenhouses propagated 1,091 SCT plants in "stubby tubes" to be used in the outplanting. In February 2023, 997 plants were installed within the southern part of Area A (Area A South) (**Figure 12**) and 94 plants were installed in Area C (cattle exclosure).

Area A South. 24 plots were planted with 997 SCT in February 2023. The plantings occurred within 3 macroplots (122, 222, and 322) that were established in 2022. The plots were previously planted in 2022; yet there was no SCT survival in these plots; therefore, these vacant plots were re-planted in 2023. The plots were bare or were sheet-mulched with either straw or woodchip. **Table 8** displays the data on each plot, listed the number of plants installed and the mulch treatment.

Area C. Four plots were planted with 94 SCT in February 2023. The plantings occurred within two plots that were previously planted in 2022 where there was no SCT survival, as well as two new plots. The plots were sheet-mulched with either straw or woodchip. One plot (D) was planted along the edge of the cattle exclosure, abutting the pasture. **Table 9** displays the data on each plot, listed the number of plants installed and the mulch treatment.

Table 8. Area A, South, 2023 Outplanting Plot Data

Note: All SCT were installed in February 2023; plants were installed in failed 2022 plots [no SCT survival])							
Macroplot	**Plot**	**# Outplanted 2/23**	**Treatment**	**# Alive 7/23**	**Survival Rate**	**Average Height (in.)**	**Approx. Number of Flower heads[8]**
122	C	23	Bare and Woodchip	23	100%	20	920
	D	34	Straw	34	100%	20	1360
	E	35	Woodchip	35	100%	20	1400
	G	60	Bare and Straw	60	100%	18	2400
	H	27	Woodchip	27	100%	20	1080
222	A	56	Woodchip and straw	5	9%	16	200
	B	53	Woodchip	50	94%	20	2000
	C	70	Woodchip	70	100%	20	2800
	D	82	Woodchip	15	18%	20	600
	E	38	Woodchip	38	100%	20	1520
	F	35	Woodchip	35	100%	20	1400
	G	38	Woodchip	38	100%	20	1520
	H	38	Straw	38	100%	20	1520
322	A	64	Straw	64	100%	20	2580
	B	72	Woodchip	70	97%	20	2800
	C	70	Woodchip and Straw	70	100%	20	2800
	D	39	Woodchip	39	100%	18	1560
	F	60	Woodchip	60	100%	18	2400
	G	51	Woodchip	51	100%	20	2040

[8] 2023 plants are large and robust, averaging 40 flowerheads per plant

Note: All SCT were installed in February 2023; plants were installed in failed 2022 plots [no SCT survival])							
Macroplot	**Plot**	**# Outplanted 2/23**	**Treatment**	**# Alive 7/23**	**Survival Rate**	**Average Height (in.)**	**Approx. Number of Flower heads[8]**
	H	52	Woodchip and Straw	52	100%	20	2080
Total		**997**		**874**	**88%**		**34,980**

Table 9. Area C, Cattle Exclosure, 2023 SCT Outplanting Plot Data

Note: All SCT were installed in Cattle Exclosure in February 2023; plants were installed in failed 2022 plots [no SCT survival])							
Macroplot	**Plot**	**# Outplanted 2/23**	**Treatment**	**# Alive 7/23**	**Survival Rate**	**Average Height (in.)**	**Approx. Number of Flower heads**
	A	29	Woodchip	20	69%	20	800
	B	20	Straw	20	100%	20	800
	C	25	Woodchip	25	100%	20	1000
	D	20	Woodchip	11	55%	20	440
Total		**94**		**76**	**81%**		**3,040**

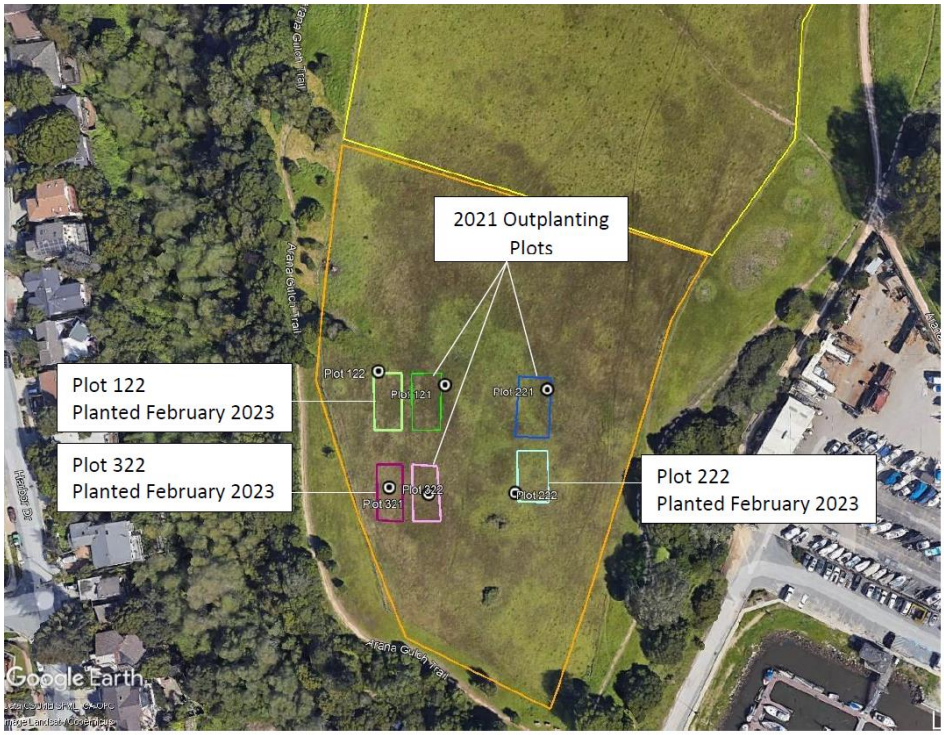


Figure 12. Locations of 2023 SCT Macroplots in Area A

Figure 13. Locations of 2023 SCT Macroplots in Area C

2023 Outplanting Results

Precipitation. The 2022/23 water year was above average. This occurred after 4 consecutive years of below average rainfall. Rainfall was 40.65 for the water year (October 1, 2022 to September 30, 2023). Rain began in November, with most occurring through March (**Figure 14**).

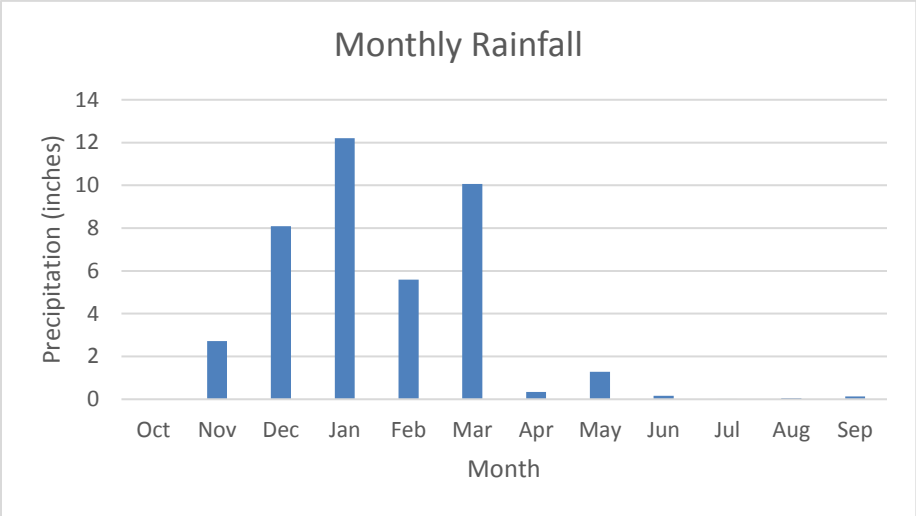


Figure 14. Monthly Rainfall from Delaveaga Weather Site, 2022/23 Water Year

Maintenance. The outplanting plots were not weeded or irrigated in 2023. In mid-July, the perimeter of the 2023 plots were weed-whipped to control non-native grass growth (mostly *Avena)* (**Figure 15**).

Figure 15. Weed-whipping the Perimeter of Outplanted Plots, July 2023

Monitoring. The macroplots were evaluated in April and May. No mowing, weeding, or supplemental irrigation was conducted. The final survival and reproduction data were collected in October. Once the surviving SCT were seeding in the sheetmulch plots, the woodchip and straw mulch was raked to the side in late-November to give the seed better access to the soil. The raked wood chips and straw mulch were removed from the site.

Within the Area A South, outplanting plots, the survey found 874 SCT plants within the plots, yielding an 88% survival rate. Plants were robust, with a fairly uniform height of 20 inches. The number of flower heads per plant is high; a sampling of plants found an average of 40 flowerheads per plant. The yield of flowerheads from the plants is approximately 34,980.

Within Area C, the survey found 76 SCT plants within the 4 plots, yielding an 81% survival rate. Plants were robust, with a fairly uniform height of 20 inches. The number of flower heads per plant is high; a sampling of plants found an average of 40 flowerheads per plant. The approximate yield of flowerheads from the plants is 3,040.

Photo Points, Area A South

Figure 16. View of Macroplot 222, February 2023 and July 2023

Figure 17. View North of Straw-mulched plot in Macroplot 222, February 2023 and July 2023

Figure 18. View Northwest of Macroplot 222, February 2023 and July 2023

Figure 19. View Southwest of Macroplot 322, February 2023 and July 2023 (tall *Avena* around SCT plots)

Figure 20. View West of Macroplot 122, February 2023 and July 2023

Figure 21. View West of plot with half straw mulch and half bare, February 2023 and July 2023

Figure 22. View West of Half Wood Chip Mulch and Bare Plot, February 2023 and July 2023

Photo Points, Area C

Figure 23. View South of Area C Plots, February 2023 and July 2023

Figure 24. Wood Chip Plot C, July 2023

Figure 25. Straw Mulch Plot, July 2023

Figure 26. Wood Chip Plot A, July 2023

Figure 27. Wood Chip Plot D, July 2023 (next to cattle fence)

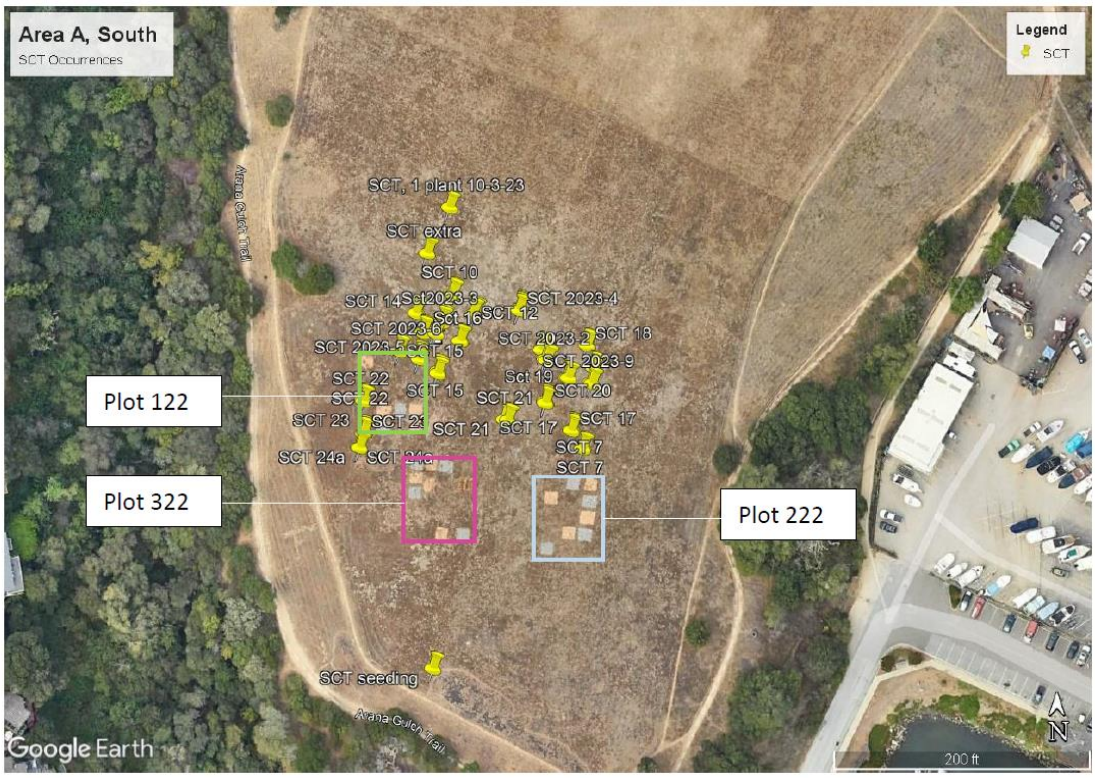


Figure 28. Location of 2023 Macroplots and SCT Outside of Plots

Please refer to **Tables 8 and 9** for plant survival data per plot. For all plots, plant survival in Area A was 88%. The use of wood chip mulch provided the highest average survival rate of 82%; many plots had 100% survival. **Figure 31** displays a summary of percent plant survival by plot treatment. **Table 10** displays flowerhead production from the 2023 outplanting. Within Area C plant survival rate was 81%. The three wood chip plots ranges from 55% to 100% survival; average survival rate was 75%. There was just one straw mulch plot and that plot had a 100% survival rate.

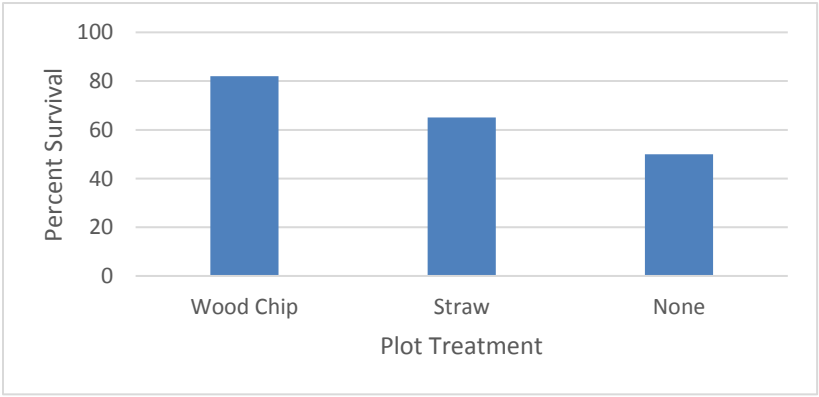


Figure 29. Average Percent Survival of SCT in 2023 Outplanting, by Plot Treatment, Area A

Table 10. SCT Survival and Flowerhead Production in 2023 Outplanting, Area A and Area C

Treatment	Wood Chip Sheetmulch	Straw Sheetmulch	Bare	Total
Area A South				
Total Flowerheads	24,580	9,200	1,200	**34,980**
Avg Flowerheads/plant	40	40	40	**na**
Number of SCT plants	615	229	30	**874**
% Survival	82%	65%	50%	
Area C				
Total Flowerheads	2,240	800	0	**3,040**
Number of SCT plants	56	20	0	**76**

SCT Seed Plot. In December 2022, SCT seed was hand-broadcast into a small wildfire-affected area in Area A. SCT seed and chaff from approximately 100 flowerheads (5-10,000 seeds) supplied by the USSC Greenhouses was spread onto three 10x20 ft hoed areas in the southern portion of Area A on December 22. The location of the seeded area is shown on **Figure 30**. Four SCT plants emerged in this area in summer/fall 2023. **Figure 31** shows an SCT plant in the seeded area.

Figure 30. Location of 2022 SCT Seeding Plot in Area A South

Figure 31. SCT in Seeded Plot, October 2023

5.1.3 SCT Research

No research studies were conducted on SCT in 2023; however, the results of a 2022 study on seed germination was completed in March 2023. The findings of that report were presented in the Year 9 (2022) Annual Report: *Germination Study: Dormancy in Ray Achenes of Holocarpha macradenia, a Rare Coastal Prairie Forb* (Childress, 2023).

USFWS prepared a Species Status Assessment (SSA) for SCT in 2023. A synopsis of the SSA was presented to the City and the AMWG at the November meeting. The assessment will be used by the USFWS to develop a species recovery plan and a species recovery implementation plan. The SSA identified the critical needs of the species and evaluated all accessible SCT sites to determine the range-wide condition of the species. Key site features for the species were determined to be seasonal saturation (on clay soils), flat topography, low competition, and a suitable disturbance regime. The study found that SCT is not pollinator limited. The SSA found that not one management strategy works for all sites and a specific management program needs to be developed for each site. Actions to reduce competing biomass is key once a site has a suitable size seedbank. The SSA study suggests a large seedbank is needed to maintain a population, but what constitutes "large" is not known. This study is expected to inform future actions at Arana Gulch, as the AMWG determined the SCT

seedbank is still in "recovery" mode (developing a suitable seedbank and identifying suitable management) and the population is not yet in a "maintenance" mode. The SSA discussed genetic variability and acknowledged that more research work is needed on genetic diversity, but that work is not currently funded.

5.2 Grassland/Coastal Prairie

5.2.1 Grazing and Mowing

Management actions for the SCT consisted of seasonal grazing of the historic SCT colonies in the northern portion of Area A and Areas C and D (and surrounding grassland), seasonal mowing in the southern portion of Area A, and seasonal mowing of Area B. Areas C and D were grazed from December 8, 2021 to August 27, 2022. The northern portion of Area A was grazed April 7 to August 27. Further details on the grazing program can be found in Section 5.3.

Mowing Within Area A South. Area A South was mowed in May with a Toro deck mower set at six inches. The 2023 SCT outplanting plots, as well as stands of purple needlegrass, were excluded from mowing. The purpose of the mowing was to reduce cover by non-native plants to benefit native plant species, including SCT. The area was flail-mowed again in early November as part of the fall management program for SCT. At that time all of Area A South, except for the western portion of the 2023 SCT occurrences, were flailed mowed. Areas not supporting SCT were raked, with the removed thatch and cut material baled and removed from the area.

Mowing Outside Grazing Fences. Outside of the grazing fences, grassland mowing occurred within areas delineated to remain as grassland (from the fence to the drip line of the adjacent woodland), as depicted in **Figure 32**. Perimeter fuel break mowing was also identified along the trails; this mowing occurred over two days in May (2th and 13th). At the time of the May mowing, grass height averaged three feet, taller than 2022, likely from the above average rainfall. Areas subject to mowing are depicted on **Figure 33**. The City weed whipped Area B once in mid-June.

Using previous year recommendations from the AMWG, mowing of non-grazed areas (except for southern portion of Area A) occurred once a year in June, after a botanist inspects the site to assure that native plants, such as Mariposa lilies, would not be adversely affected. Prior to the June mowing, the City authorized a botanical review and a breeding bird survey of the mowing areas to ascertain if native plant species or nesting birds would be directly affected by the mowing. Kathleen Lyons, plant ecologist, conducted the botanical review and Garvin Hoefler, wildlife biologist, conducted the breeding bird survey. No breeding birds were detected in the areas subject to mowing; however, several colonies of locally unique plants along the Prairie Loop Trail were flagged such that mowing would avoid these areas.

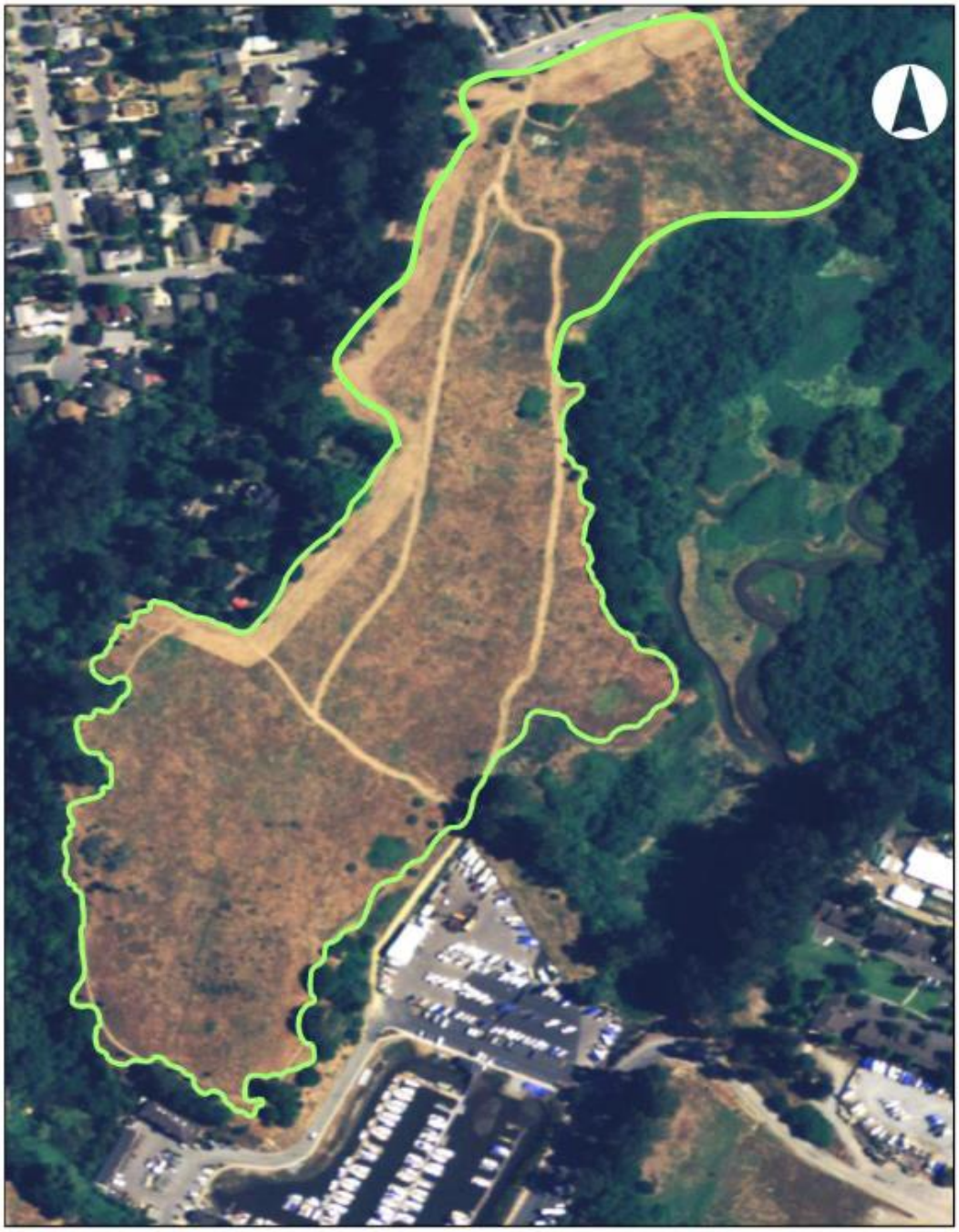


Figure 32. Delineated Grassland, April 2015

Figure 33. Areas Mowed in 2023

Fall Season SCT Mowing Program, Area A South and Area C Cattle Exclosure. In fall 2023 a program was developed to manage the grassland areas supporting SCT plants. A draft program was presented to the AMWG at the November meeting and the following actions were identified:

1. Area A, South: Flail mow all non-SCT occupied grassland in Area A, South, as shown in **Figure 34**.
2. Area A, South: Rake cut material/thatch material from mowed areas to reduce competition and reduce nutrient levels. Rake and bale material
    a. Highest Priority: Rake thatch a minimum of 20 feet outward from all SCT, as shown on **Figure 35**.
3. Area A South and Area C SCT Plot: Hand rake wood chips and straw mulch from the 2023 SCT plots. Lightly rake material to outer edge of each plot. Area A SCT Plots are shown on **Figure 33**.

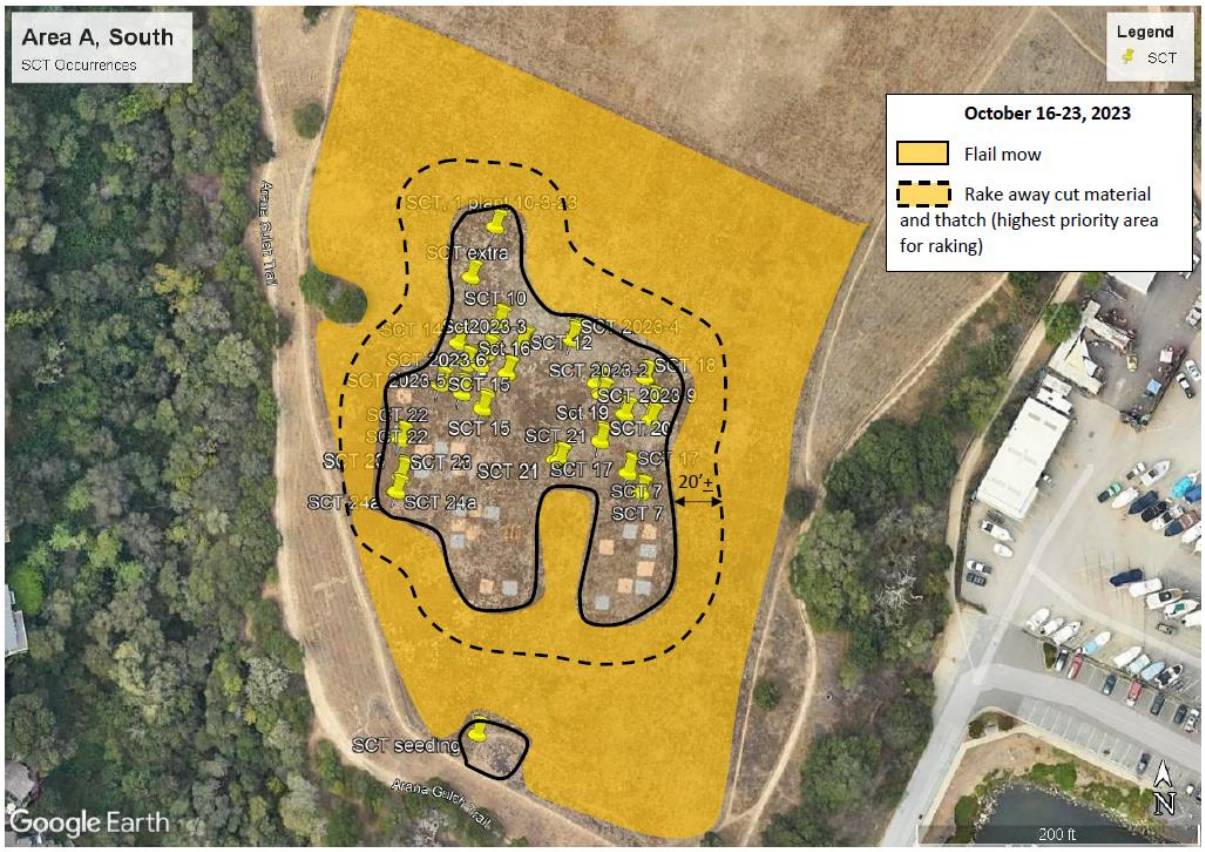


Figure 34. Mow and Rake Areas, Area A South, Fall 2023

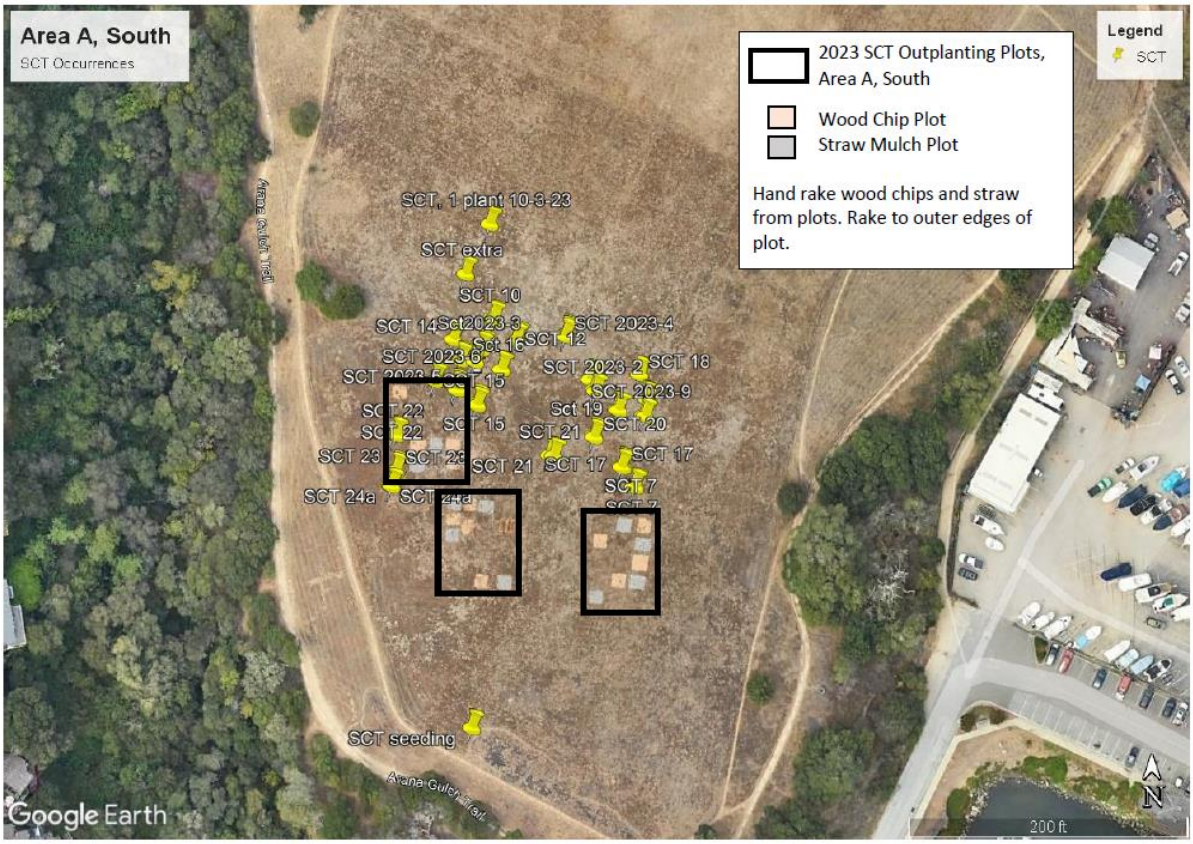


Figure 35. Hand Rake Plots in the 2023 Outplanting Areas, Area A South, Fall 2023

4. Area A, South: Flail mow one half of all SCT-occupied areas, including one 2023 macroplot, as shown in **Figure 36**. DO NOT RAKE. Area A, South: Allow cows into western side of SCT occupied areas to facilitate SCT seed/soil contract and seed dispersal and to experimentally compare grazing and mowing treatments. Confer with grazing operator about how this might be done (temporary electric fence?). Consider installing mineral block or molasses barrel to encourage cows to be within SCT-occupied area, as needed.
5. Area C SCT Plot. Allow cattle to access this area to stomp ground, increase seed/soil contact, and eat thatch and young grass growth. Monitor SCT seedling recruitment and remove cattle if significant browse/damage to SCT seedlings is observed.
6. Area A, South and Area C: Spread some on-site SCT seed heads/plants onto rakes unoccupied area outward of the 2023 plots to facilitate spread of the species.

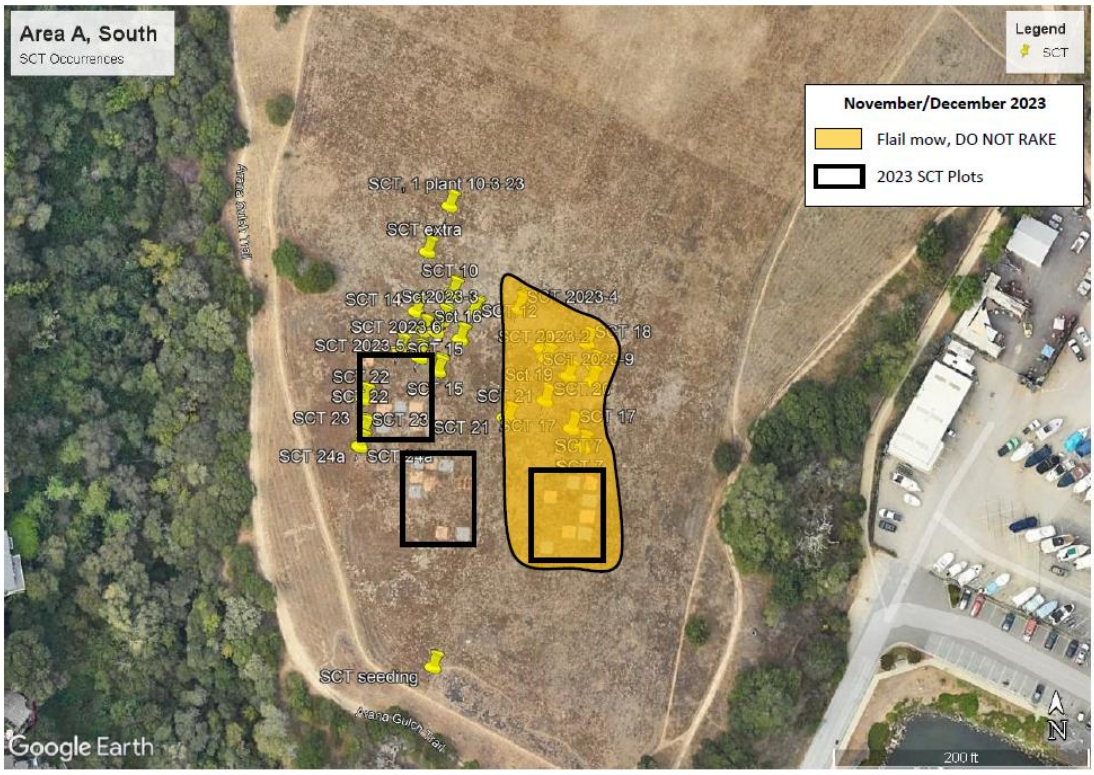


Figure 36. Areas Subject to Flail Mowing - Previous Year SCT and One 2023 Plot, Fall 2023

The City implemented the above management actions; however, due to contractual issues, the placement of cattle (including a cross-fence) proposed for Area A South was not implemented by December 31. The City intends to implement these measures in early 2024.

5.2.2. Outplanting of Native Grasses

Grass plugs (5 species) were installed in Area A South in February 2023 for grassland/prairie enhancement. **Table 11** displays the species and number of plants installed.

Table 11. Grass Plug Installation, Area A South, February 2023

Area	GPS	Species	# Installed	# Alive 10/23	% Survival
Plot 122	36.97425 -122.00074	*Danthonia californica*	98	66	67%
E side	36.97425 -122.99990	*Elymus glaucus*	72	51	71%
E side	36.97421 -122.00001	*Bromus carinatus*	66	41	62%
Wet plot	36.97465 -122.00061	*Deschampsia ceaspitosa*	70	65	93%
Wet plot	36.97459 -122.00047	*Hordeum brachyantherum*	94	0	0%
TOTAL			**400**	**223**	**56%**

Danthonia californica. Two plots in SCT Macroplot 122 received 98 plugs of *Danthonia californica.* 49 plants were installed in clusters in bare substrate and 49 plugs were installed in clusters amid year-old straw mulch. Plants were not irrigated. By 10/23/2023 there were 66 plants alive, yielding a survival rate of 67%. In the bare plot, plant survival was 51%; in the straw mulch plot survival was higher, at 84%.

Figure 37. *Danthonia* plugs, February 2023 and June 2023

Elymus glaucus. One 10x10-foot plot was created near the eastern fence to receive 72 *Elymus glaucus* plugs. Plot was weed-whipped and hoed prior to planting. Plugs were installed in clusters in SCT Plants were not irrigated. By 10/23/2023 there were 51 plants alive, yielding a survival rate of 71%.

Figure 38. *Elymus* plugs, February 2023 and October 2023

Bromus carinatus. One 10x10-foot plot was created near the eastern fence to receive 66 plugs. Plot was weed-whipped and hoed prior to planting. Plugs were installed in clusters; plants were not irrigated. By 10/23/2023 there were 41 plants alive, yielding a survival rate of 62%.

Figure 39. Bromus plugs, February 2023 and october 2023

Deschampsia ceaspitosa. One 10x10-foot plot was created in a low, seasonally moist spot in the central portion of Area A to receive 70 plugs. Plot was weed-whipped and hoed prior to planting. Plugs were installed in clusters; plants were not irrigated. By 10/23/2023 there were 65 plants alive, yielding a survival rate of 93%.

Figure 40. *Deschampsia* plugs, February 2023 and December 2023

Hordeum brachyantherum. One 10x10-foot plot was created in a low, seasonally moist spot in the central portion of Area A to receive 94 plugs. Plugs were installed in clusters; plants were not irrigated. By 10/23/2023 no plants were detected amid a dense growth on non-native ryegrass (*Festuca).* Survival was estimated at 0%.

Figure 41. *Hordeum* plugs, February 2023

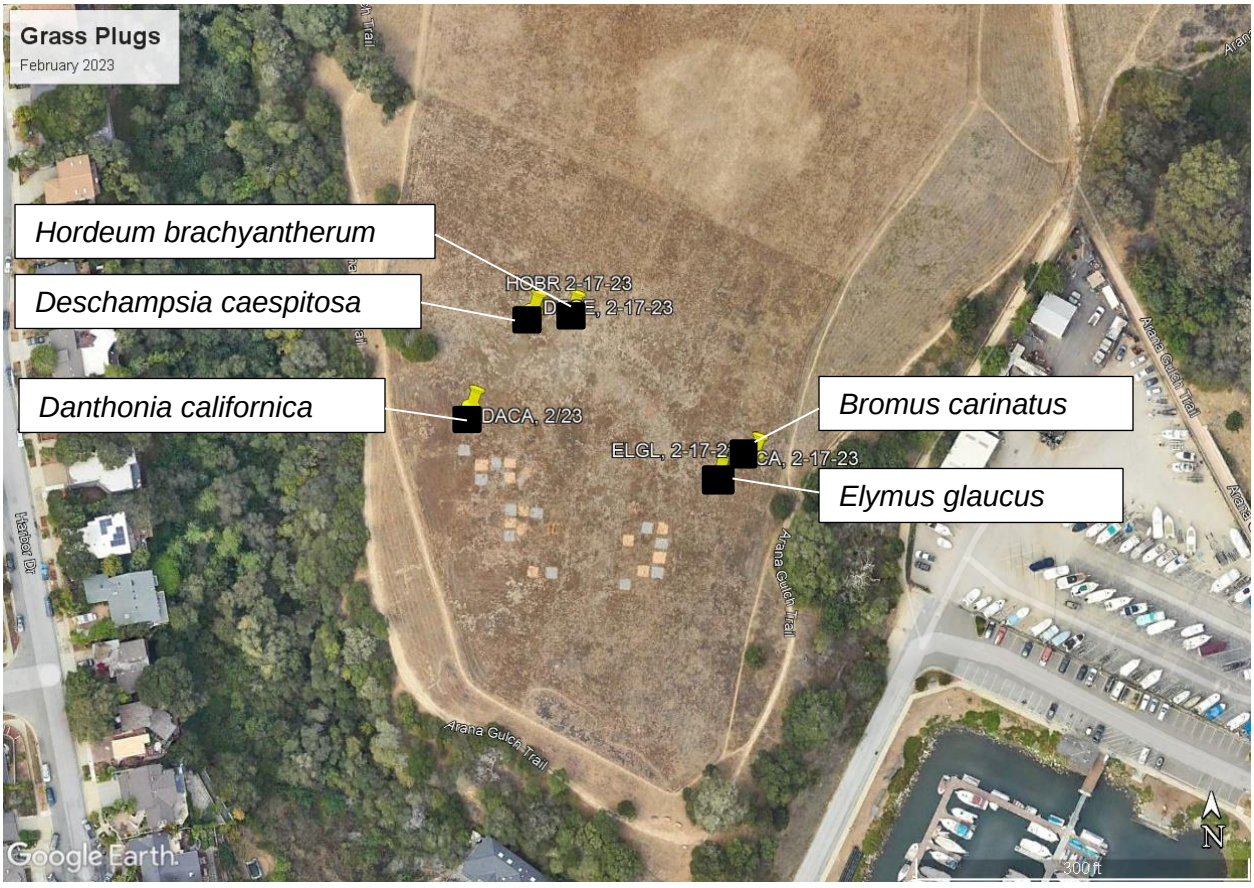


Figure 42. Location of Grass Plug Plantings, February 2023

5.2.2 Vegetation Assessment

5.2.2.1 Monitoring Methods

The 2023 vegetation assessment utilized the point intercept method on 25-meter transects to assess changes in plant species cover and ground cover. In spring (May), a total of 25 sample points per transect were recorded to obtain percent cover of each species encountered by the sampling rod. Ground cover (litter/thatch, bare, basal vegetation) was also recorded. The average height of the canopy layer was measured at the 6, 12, 18, and 24-meter marks using a plastic dinner plate threaded on a wire pin (recorded at the height where the plate comes to rest). Canopy height measurements were also taken along these transects in February and December to capture winter conditions for the current growing season. At each spring monitoring a photo is taken at the 0-meter end looking along the length of transect with a whiteboard held up at the 5-meter point labeled with the transect number and date. The spring season transect photos are included in **Appendix C**. In addition to the point intercept data, a search is conducted within a 5-meter belt transect (using the transect as the centerline) to record the presence of any plant species not encountered on the transect. This additional method is often used to capture uncommon or rare species and more fully characterize species richness.

Transect ends were initially marked with rebar posts fitted with metal rebar caps imprinted with the transect ID- however, by 2023 only a few markers remained visible. The GPS location of each end had been recorded along with the compass bearing of the transect from the 0-meter end and this GPS data was used to locate the transect points in 2023.

The original transects were set-up in 2013 and were located using a stratified approach to achieve a representative sample across the coastal prairie. In Area A, 11 transects were established, five were established in Area C, and four established in Area D, for a total of 20 transects. For several years, only four transects have been monitored in both Area C and D, due to the low species diversity and lack of native species. In coordination with discussions with the AMWG, the location of some transects was changed to better reflect vegetation patterns, particularly areas supporting native perennial grasses. In 2023, one transect in Area A North was moved to Area A South, and two additional transects were added in Area A South, as shown in **Figure 43.** In addition, a few transects were re-positioned to capture patches of perennial grass that have been missed in previous sampling. Transects AT 1-4 are now located in Area A North in an area designated as ‘annual grassland’. Transect AT 4 was moved to include part of the seasonal wetland that has been mapped for many years (shown in green on **Figure 43**). AT 9 was moved to Area A South. Transects AT 5-13 are in an area designated as coastal prairie. AT 6 and AT 9 were positioned to include two patches of California oatgrass (*Danthonia californica*), shown in blue on **Figure 43**. AT 12 and AT 13 were installed south of the SCT outplantings in an area with high cover by purple needle grass (*Stipa pulchra*).

For analysis, the transect is the sample unit and percent cover was calculated for each species encountered on the transect. The total number of species encountered on each transect was also calculated along with the percent ground cover of each category (only bare ground and litter are presented). Cover values were also summed on each transect by guild: exotic annual forb (EAF), exotic annual grass (EAG), exotic perennial forb (EPF), exotic perennial grass (EPG), native annual forb (NAF), native annual grass (NAG), native perennial forb (NPF), and native perennial grass (NPG). The mean cover values are presented with error bars constructed using one standard deviation from the mean.

Figure 43. Permanent Transect Placement in Area A North, Area A South and Areas C and D, May 2023

Note: The interior polygons represent native perennial grass patches (green=*Elymus triticoides* wetland, white= *Stipa pulchra*, blue= *Danthonia californica*.

Photo Monitoring. Photo points for long-term monitoring were established in April 2015. A total of 15 points are distributed throughout the coastal prairie with two additional points on the Arana Creek Causeway and two on Hagemann Bridge (**Figure 44**). All points are located at either an interpretative sign or a fence corner for easy reference. Four photos are taken per point in a clockwise order facing into the enclosure; Photo 1 looks straight ahead, Photo 2 is to the right, Photo 3 looks straight behind, and Photo 4 to the left. All photos can be taken in about one hour, preferably when the sun is high in the sky and casting few shadows. The two points taken on the causeway looking into Arana Creek give a general idea of conditions in the riparian area. The additional points located on Hagemann Gulch Bridge look out and down into the Gulch. One extra point is taken standing in front of the entry sign at Frederick Street in order to observe the recovery from the construction.

No photos were taken in 2023. Photos are scheduled to be retaken in spring 2024.

Figure 44. Location of Photo Points for Long-term Monitoring.

5.2.2.2 Monitoring Results

Precipitation Conditions. Table 12 presents monthly rainfall data for 2013 to 2023 as measured at the Delaveaga weather station, located just north of Arana Gulch. In most years, rainfall has been below the long-term average of 30 inches reported for the Santa Cruz area (Western Regional Climate Center). In 2023, there was significant rainfall from December through March and the total of 40.65 inches for the water year was above average.

Table 12. Monthly Rainfall (inches) at Station 104 (Delaveaga) for the 2013-2023 water years.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
2013	0.11	5.97	8.96	0.92	0.32	1.7	0.88	0.04	0.12	0.04	0.05	0.14	**19.25**
2014	0.06	0.31	0.12	0.02	3.16	1.4	0.45	0.04	0.05	0.16	0.02	0.96	**6.75**
2015	0	3.16	11.75	0	0.01	0	0	0.09	0.05	0.06	0.01	0	**15.13**
2016	0.04	3.38	5.36	12.92	0.17	0.31	0.72	0.24	0.03	0.06	0.13	0.07	**23.43**
2017	5.79	2.56	8.26	16	14.1	4.95	3.38	0.08	0.17	0.03	0.02	0.12	**55.46**
2018	0.07	2.85	0.17	6.11	0.3	6.67	1.33	0.04	0.04	0.04	0	0.04	**17.66**
2019	0.12	5	3.7	7.75	5.08	7.01	0.85	3.26	0.15	0	0.04	0.17	**33.13**
2020	0.01	2.78	10.76	2.89	0.01	3.3	2.98	1.52	0.04	0.08	0.04	0	**24.41**
2021	0	1	2.6	8.2	1.4	2.7	0.3	0.02	0.08	0.02	0.01	0.01	**16.34**
2022	5.54	2.18	9.7	0.74	0	1.17	1.81	0	0.18	0.02	0.03	0.98	**22.35**
2023	0	2.72	8.09	12.2	5.59	10.06	0.34	1.29	0.16	0.01	0.06	0.13	**40.65**

Source: California Department of Water Resources (DWR) California Irrigation Management and Information System (CIMIS) https://cimis.water.ca.gov/WSNReportCriteria.aspx).

Vegetation Assessment Results. The spring vegetation assessment was conducted on May 6-7th. As previously noted, the number of 25-meter permanent sampling transects in Area A South was increased to 9 (AT 5-13) and the number of transects in Area A North was decreased to 4 (AT 1-4). The 2023 data was compared to sampling date from 2021 and 2019 and to the baseline year of 2015. Comparisons with 2015 are not an ideal because it was an extremely dry year, as were the previous two years (see **Table 12**). Monitoring data from 2020 and 2022 are not comparable because they were focused on response to scraping and mapping of weeds and patches of native grass.

Canopy Height. The HMP Objective 3A is to reduce canopy height between the months of November thru April to 5 to 8 cm (2-3 in). This target is intended to increase the amount of light penetrating the ground and increase the ability of SCT seed to germinate.

Canopy height measurements in February 2023 were conducted when seven cows were in Areas C and D (open date between pastures). Although cattle had only been on site for a few days, average canopy height in Area C was 1.2 inches and 1.7 inches in Area D. These heights are within the HMP target zone. In Area A, grazing was allowed in Area A North, yet was excluded from Area A South due to the SCT outplanting. In February, grazing had not yet occurred in Area A North; however, the average canopy height was 3.74 inches (slightly above the HMP target). In Area A South, average canopy height was 3.25 inches (slightly above the HMP target). By May, after an above average rainfall season, significant vegetation growth has occurred and canopy height was above target in all areas. In Area A South canopy height averaged 20 inches. Canopy height averaged 21 inches in Area A North (**Table 13**).

Grassland management (mowing) was implemented in Area A South on May 8th, immediately following the monitoring. This mowing (use of rotary mower set at approximately six-inch mow height) reduced canopy height in this area. Two areas with purple needlegrass were excluded from the management mowing (see **Figure 43**).

Canopy heights were measured again in December 2023. Cattle had periodically grazed Area A North, and Areas C and D for approximately ten months. Average canopy height in Area C was 2.2 inches and 5.25 inches in Area D. Canopy height was within target for Area C; however, Area D was above target. In Area A North, the average canopy height was 5.75 inches (above the HMP target). In Area A South, average canopy height was 3.5 inches (slightly above the HMP target).

Table 13. Canopy Height Measurements, February, May, and December 2023 (inches)

	February 15	May 6	December 14
Area A South	3.25	20	3.5
Area A North	3.75	21	5.75
Area C	1.2	10	2.2
Area D	1.7	11	5.25

Bare Ground. Objective 3E is to increase the cover of bare ground. This objective continues to be met in Areas A and D, where the average cover of bare ground has increased steadily since 2015 to around 25% in A and 30% in D (**Figure 45**). In Area C, measured bare ground cover in 2015 was 21% and has remained similar, except for a large one-time increase in 2017. Bare ground cover in Area C was 28% in 2023.

Bare ground measurements were obtained in the SCT-occupied areas in Area A South in December 2023. Bare ground within eight 1-m^2 quadrats ranged from 5% to 70%; average value was 13.6% (see **Figure 46**). In additional to measuring bare ground, the quadrats found an average cover of 20% by mature SCT plants (range of 0% to 75%) and 11% cover by SCT seedlings (range of 0% to 60%). The remainder of the plant cover was provided by exotic annual grasses and forbs. Wood chips (present form 2023 and previous-year outplantings averaged 18.7% (range of 0% to 90%).

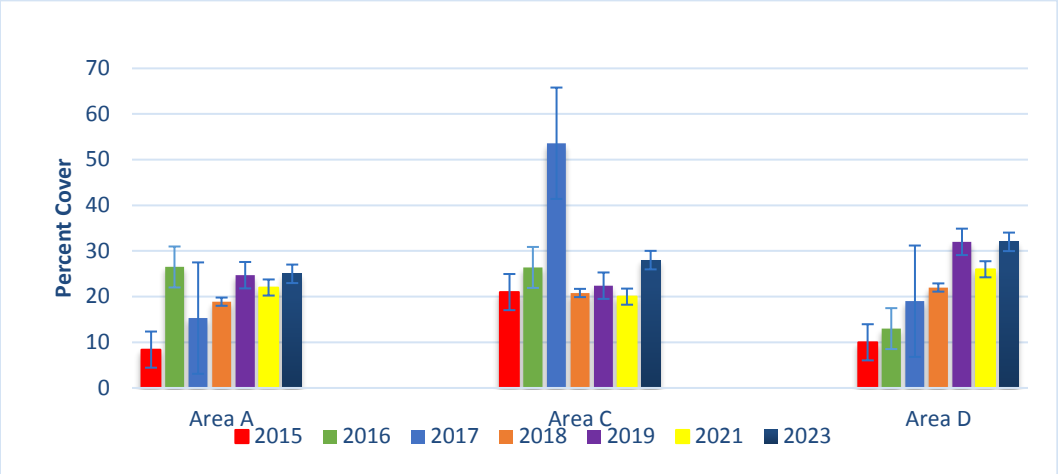


Figure 45. Mean Cover of Bare Ground in Areas A, C, and D, April or May , 2015 - 2023

Each error bar is constructed using 1 standard error from the mean.

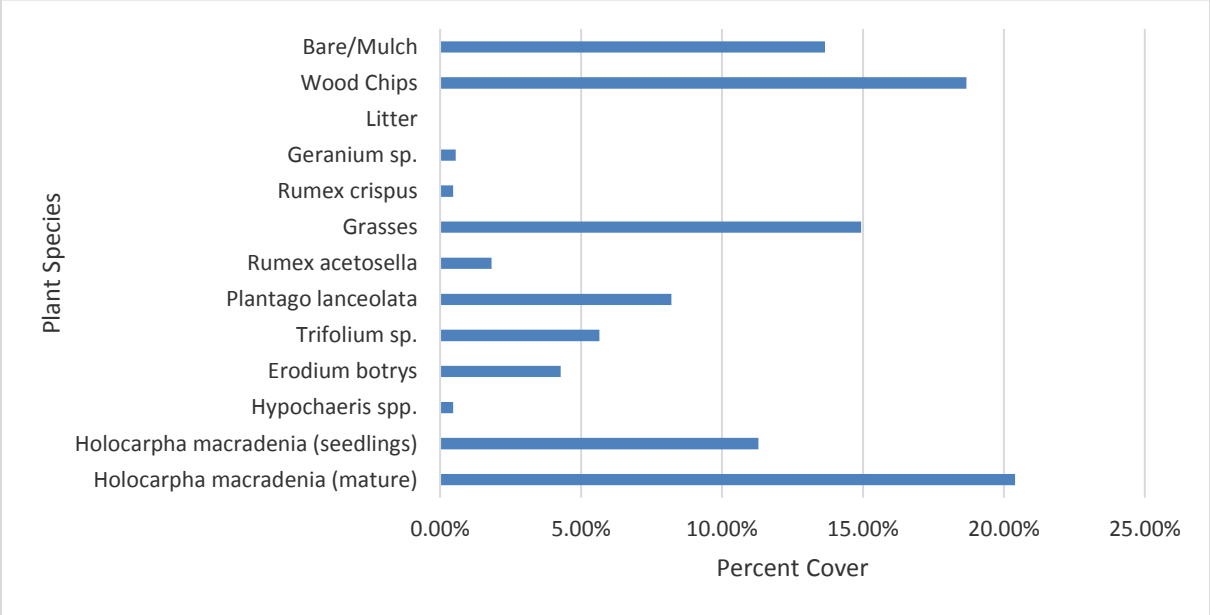


Figure 46. Mean Cover of Bare Ground and Plant Species in SCT-Occupied Areas of Area A South, December 2023

Vegetation Cover. Objective 3B is to reduce the cover of non-native species and Objective 3C is to increase the cover of native species. Since grazing began in 2015, non-native plant cover has not decreased the cover of native species has not increased in any of the three grazing Areas, as described below.

Area A. Within Area A South, exotic annual forbs (EAF) and exotic annual grasses (EAG) continue to dominate the vegetation (**Figure 47**). Compared to the 2015 baseline, the cover of

EAF has doubled. In contrast, cover of EAG has remained similar and ranged from 55 to 80%. Cover of exotic perennial forbs (EPF), comprised primarily of Italian thistle (*Carduus pycnocephalus*), has remained between 15 to 22% (not shown) because the City has periodically implemented mechanical control.

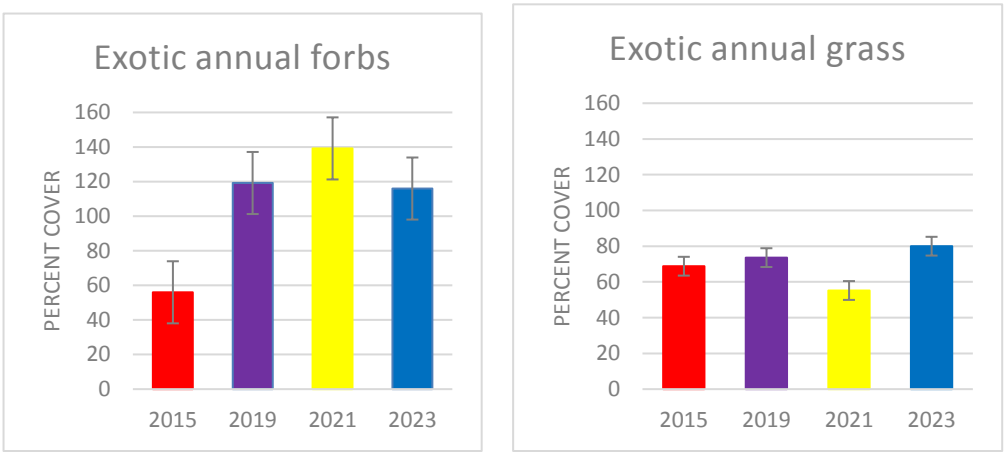


Figure 47. Mean Percent Cover of Non-native Plant Guilds in Area A South

Each error bar is constructed using 1 standard error from the mean.

The increase in EAF appears to be primarily driven by an increase in clovers (*Trifolium subterraneum* and *T. dubium*), which were absent prior to grazing and now comprise over 30% cover (**Figure 48**). Red-stem filaree (*Erodium cicutarium*) has been the most prevalent species in most years (except 2019), with cover remaining up around 50%. In 2019 to 2021, both smooth and rough cat's ear (*Hypochaeris glabra, H. radicata*) exploded in the prairie, but has since declined to 5%. Wild geranium (*Geranium dissectum)* cover more than doubled in 2023. The reason for these fluctuations is not clear.

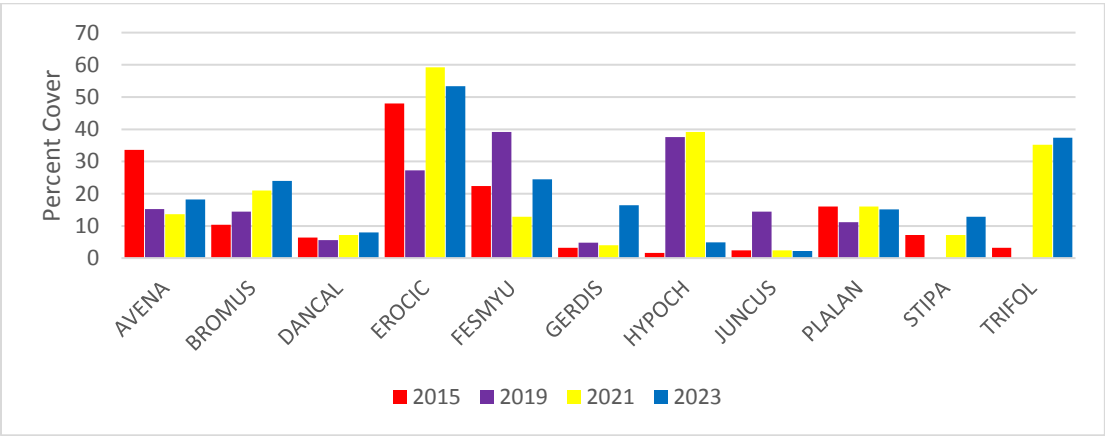


Figure 48. Mean Percent Cover of Selected Plant Species in Area A South

Each error bar is constructed using 1 standard error from the mean.

Figure 49 presents a graph of native perennial grass (NPG) cover within the prairie over time and a map of the transects with percent cover of native grasses. Since 2015, cover has remained around 20%. In 2023, total NPG cover averaged 25% across the 9 transects, with cover on individual transects ranging from 8 to 48%. In analysis prior to 2022, this level of native perennial grass cover in the coastal prairie was not recognized due to combining the transect data with that from the southern annual grassland of Area A. Native cover in the prairie is primarily purple needlegrass (*Stipa pulchra,)* followed by California oatgrass *(Danthonia californica)*. In 2023, the average cover of purple needlegrass almost doubled from 7 to 13% (see **Figure 49**). However, this increase most likely reflects the placement of two new transects in an area with high visible needlegrass cover, rather than a true increase (see **Figure 43**). Grazing has been excluded within the prairie since the installation of the SCT outplanting in 2020. Mowing has been implemented, but several patches of perennial grass have been excluded from the mowing. A main reason that new transects were installed was to better characterize native cover and include these patches of native grass that have been present for many years. Temporary fencing separating the pastures was installed in 2022 to allow for the differential management.

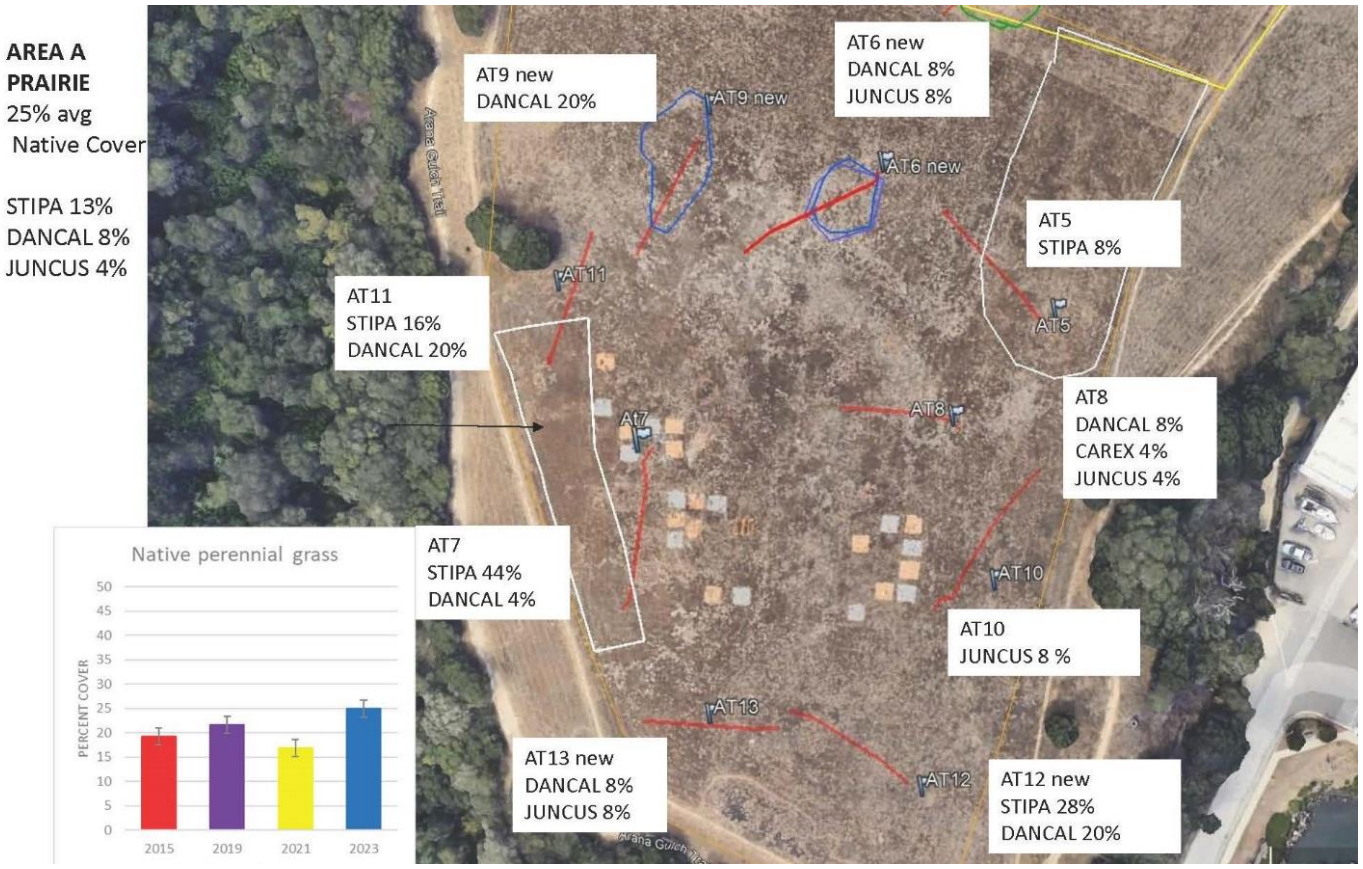


Figure 49. Mean Percent Cover of Native Grasses in Area A South

Within Area A North, the annual grassland, EAF cover has increased significantly over time (**Figure 50**). Non-native grass cover in the grassland has been around 100% most years, unlike the prairie where annual grass cover has remained below 80%. EPF cover has been less than 10% (not shown) and is comprised of common vetch and sheep sorrel.

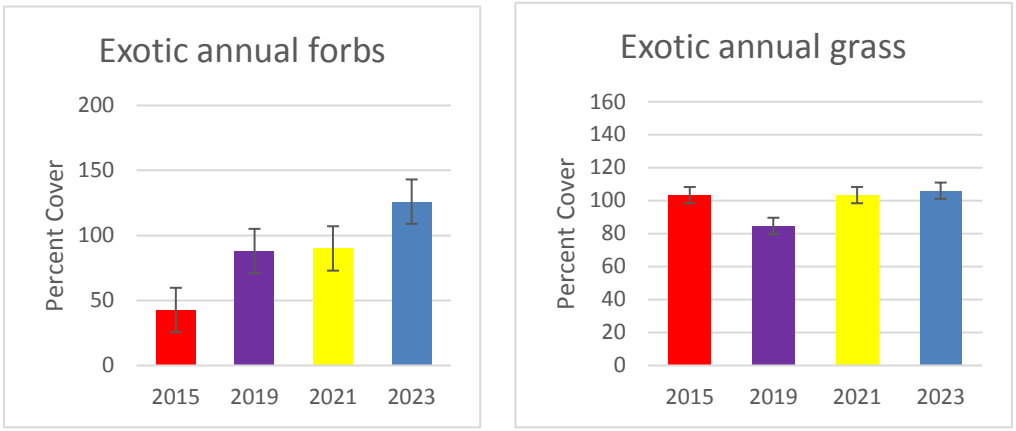


Figure 50. Mean Percent Cover of Non-native Plant Guilds in Area A North

Each error bar is constructed using 1 standard error from the mean.

In 2023, red-stem filaree was the dominant species Area A North, followed by rat-tail fescue (*Festuca myuros*). (**Figure 51**). Significant increases in filaree have driven the increase in EAF in the grassland, but clovers have stayed at very low levels. Cover of wild oat (*Avena fatua*) has declined since 2015, but rat-tail fescue has remained high. EPF cover has been limited to common vetch (*Vicia sp.)* California poppy has been detected within the grassland at low levels since 2015, and in 2023, two more native species were detected including spreading rush (*Juncus patens*) and Great Basin wildrye (*Elymus triticoides)*. This positive increase in native cover is the result of re-positioning one transect to include the wildrye mapped wetland area (see Figure 27). Greater cover of both species was expected on the transect, and it is likely that these species were under detected in the sampling.

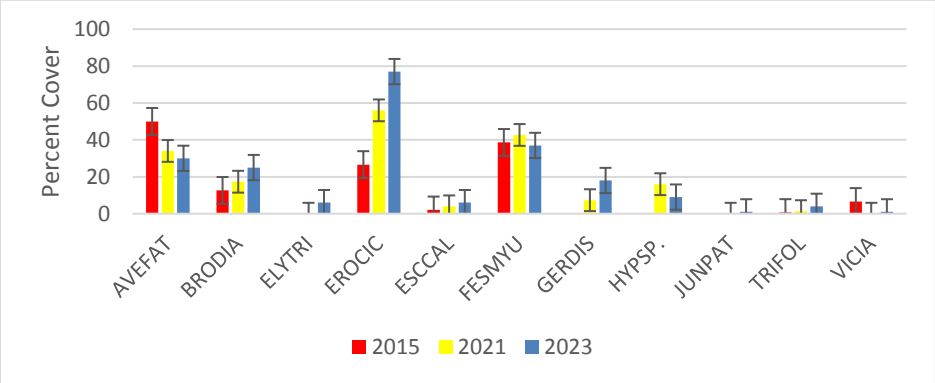


Figure 51. Mean Percent Cover of Select Plant Species in Area A North

Each error bar is constructed using 1 standard error from the mean.

In both Area A North and South, the modifications in the sampling transect design resulted in increases in the cover of native species (**Figure 52**). Average native cover is now at 13% in the grassland and 25% in the prairie.

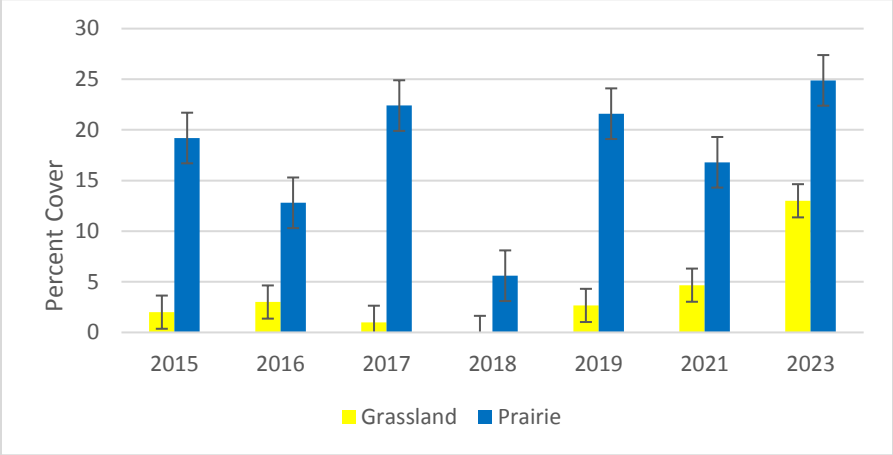


Figure 52. Mean Cover of Native Species in Area North (grassland) and Area A South (coastal pairie)

Each error bar is constructed using 1 standard error from the mean.

A recent interdisciplinary evaluation of long-term restoration outcomes on 37 restored coastal grasslands in California (Luong, J., Press, D., and K. Holl 2023) utilized a performance metric of a minimum of 25% native cover and five native species as the measure of restoration success. This metric was based on land managers reporting that statutory requirements typically require projects to achieve between 25 and 50% native cover. That study cited a recent review that found 20% native cover is a typical goal for working lands (Garibaldi et al., 2021). Although 25% cover may appear to be a low target, the classification of some native grasslands in California (i.e. *Stipa* grasslands) only requires 5% native cover (CNPS 2023). Because most California grasslands are highly invaded, achieving higher native cover is difficult. Luong et. al (2023) determined that a species richness target of 5 or more species was consistent with how projects are designed and monitored for statutory compliance. The AMWG may want to use this information as a starting point for refining restoration goals for the coastal prairie.

Within Area A, average total species richness within the coastal prairie has varied from 14 to 17 species (**Figure 53**) and only 7 to 11 species in the non-native annual grassland. The number of native species has remained below 5, with 1 to 3 in the prairie and less than 1 in the grassland (**Figure 54**).

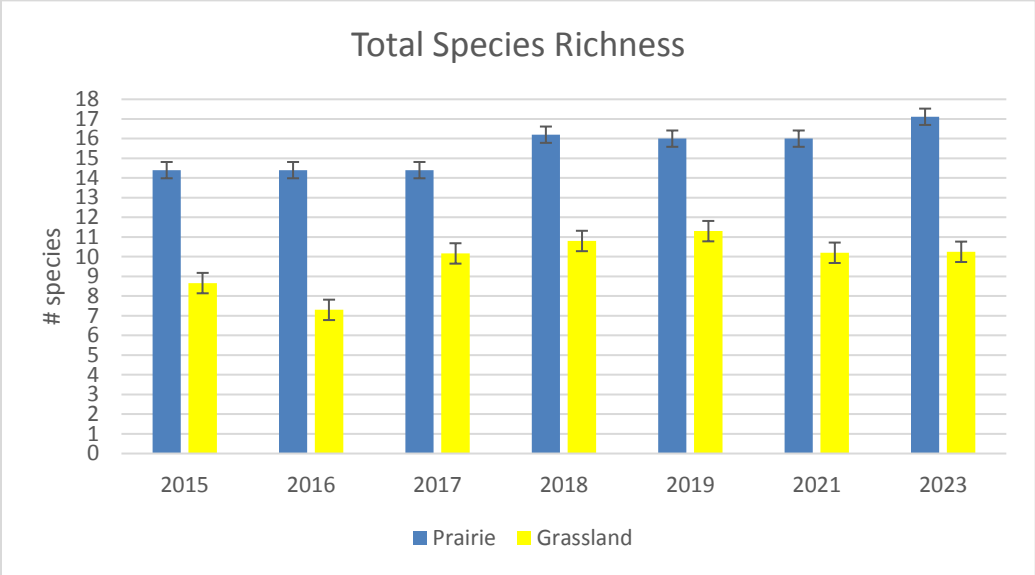


Figure 53. Mean Species Richnesss in Area A North (grassland) and Area A South (coastal prairie)

Each error bar is constructed using 1 standard error from the mean.

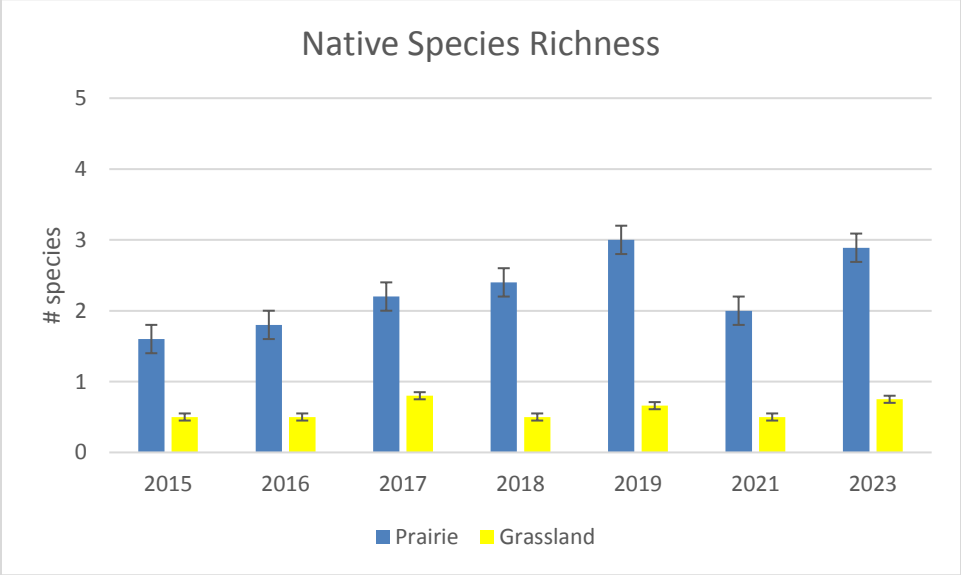


Figure 54. Mean Native Species Richness in Area A North (grassland) and Area A South (coastal prairie)

Each error bar is constructed using 1 standard error from the mean.

Area C. Area C remains dominated by non-native species. In contrast to the grassland in Area A, cover of EAG has increased from the 2015 baseline, but cover of EAF only increased for the first time this year (**Figure 55**). Cover of EPF has been primarily comprised of Italian thistle (*Carduus pycnocephalus*) and common vetch (*Vicia sativa)* and it has been reduced by half since 2015, due to increased management of Italian thistle, rather than grazing (**Figure 56**). Native species are still not present in measurable quantities

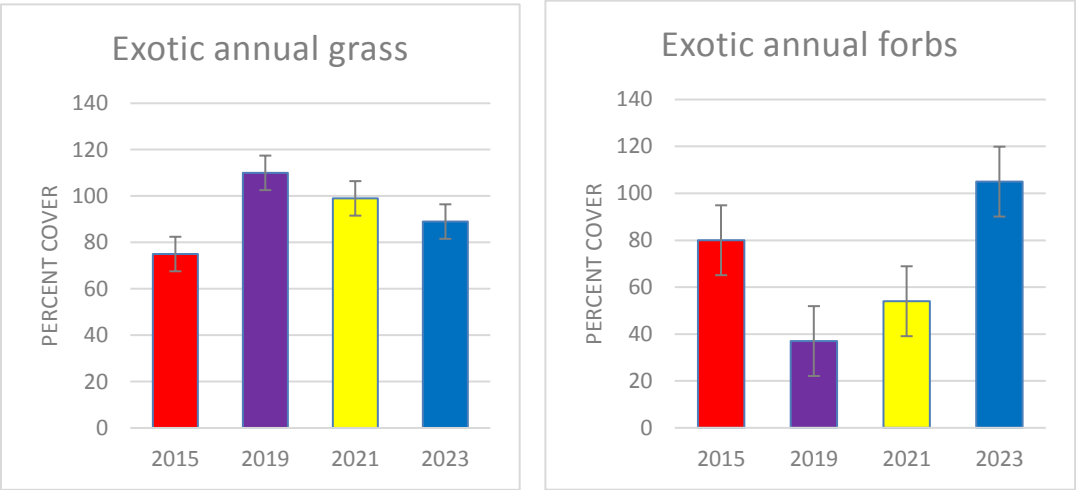


Figure 55. Mean Percent Cover of Two Plant Guilds in Area C

Each error bar is constructed using 1 standard error from the mean.

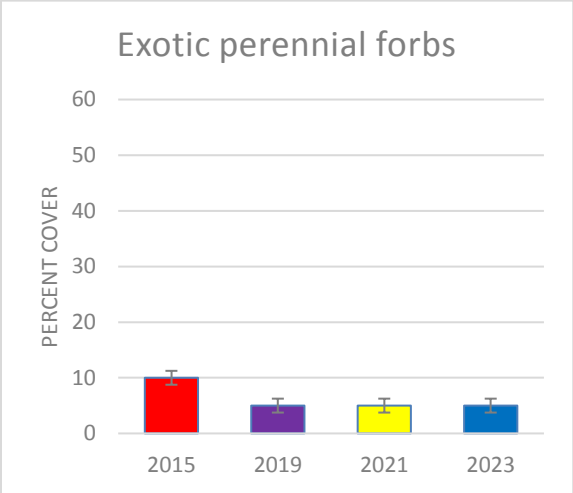


Figure 56. Mean percent Cover of One Plant Guild in Area C

Each error bar is constructed using 1 standard error from the mean.

Vegetation composition in Area C has shifted since grazing began in 2015. Prior to 2023, the most noticeable change was the disappearance of wild radish (*Raphanus sativa*) (**Figure 57**).

However, red-stem filaree exploded in 2023, increasing by almost four times. The high rainfall may have favored this species, as it also increased dramatically in Area D and the northern part of A. Rat-tail fescue remains a significant component and the thick litter/thatch layer it creates is likely an important factor in the low overall species diversity.

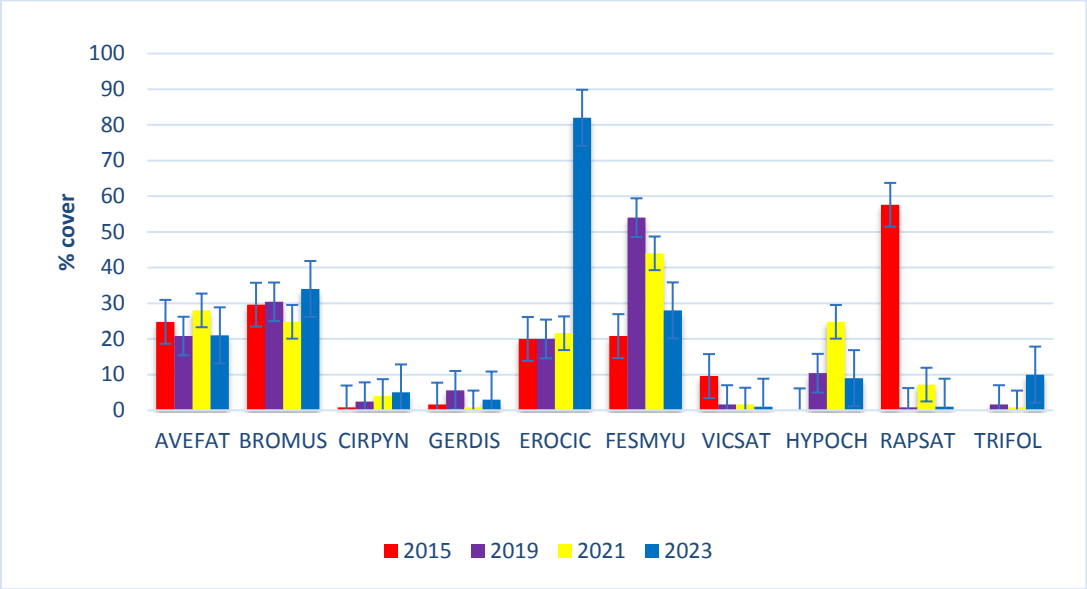


Figure 57. Mean Percent Cover of Sampled Plant Species in Area C

Each error bar is constructed using 1 standard error from the mean.

Species richness in Area C has increased since grazing began in 2015, and almost doubled by 2019 (**Figure 58**). However, all are non-native. Some of the initial increase was likely due to recovery from severe drought that occurred in 2013-2015. The number of species has remained at 10 for the last few years. Spreading rush is the only native species that has been detected in the sampling in Area C and is very sparsely distributed.

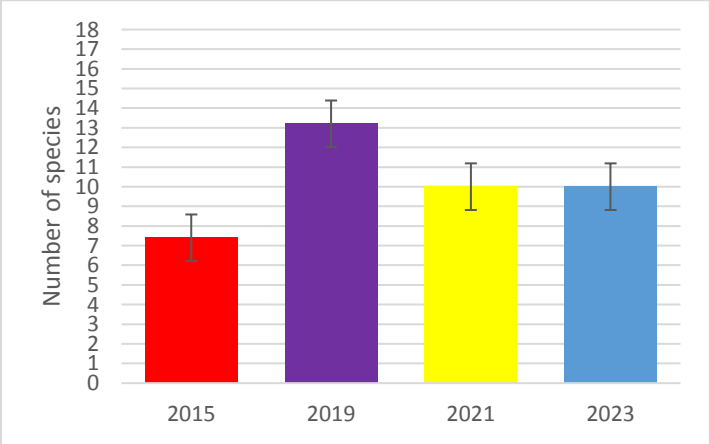


Figure 58. Mean Species Richness in Area C

Each error bar is constructed using 1 standard error from the mean.

Area D. Area D is dominated by non-native grass and forbs. EAG first declined in 2018 (not shown) and has stayed lower since 2019. Cover of EAF has fluctuated over the sampling period and was lower than the 2015 baseline until 2023 (**Figure 59**). In 2023, cover of red stem filaree doubled from what is was in 2021 (**Figure 60**). The sharp increase was also observed in Area C and A. Cover of EPF is mainly sheep's sorrel (*Rumex acetosella)* in Area D and it has remained at similar level. Velvet grass (*Holcus lanatus)* has decreased to a very low level from a high in 2019.

Sampled species richness in Area D has remained between 10 and 13 species across the years (not shown). Spreading rush is the only native species that has been measured on the point intercept transects.

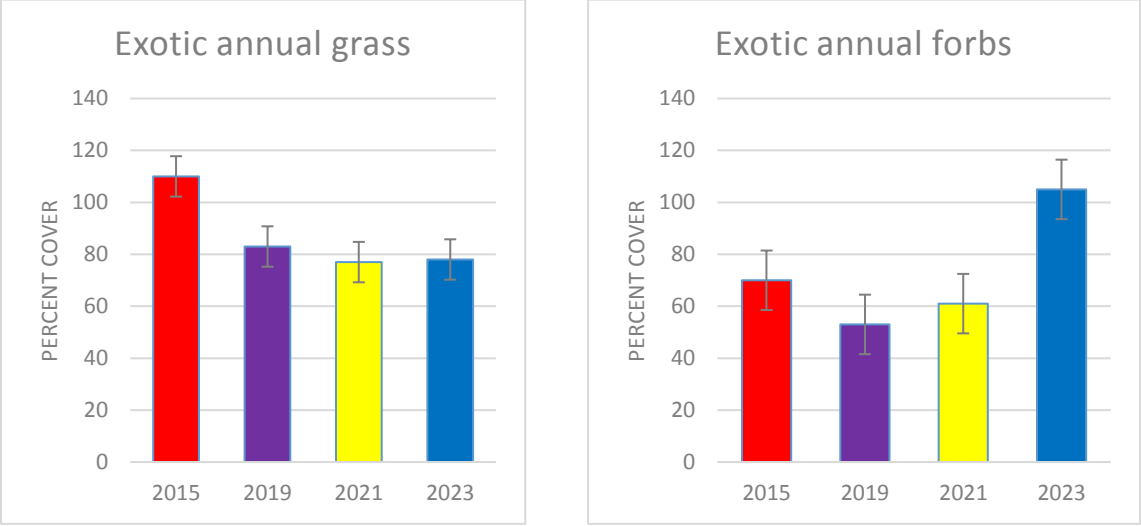


Figure 59. Mean Percent Cover of Two Plant Guils in Area D

Each error bar is constructed using 1 standard error from the mean.

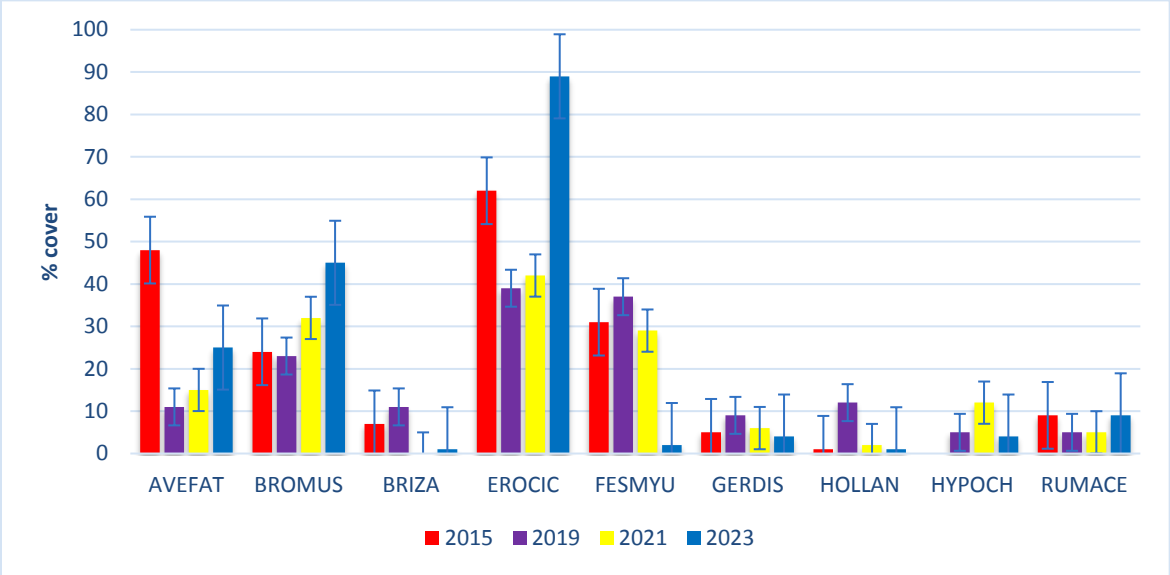


Figure 60. Mean Percent Cover of Select Plant Spécees in Area D

Each error bar is constructed using 1 standard error from the mean.

5.3 Grazing and Stocking Program

5.3.1 Implementation

The installation of cattle grazing infrastructure was completed in February 2015. The grazing enclosure includes about 18.75 acres (8.4 hectares), divided as follows: Area A = 15 acres (6 ha[9]); Area C = 4.1 acres (1.6 ha); and Area D = 2.1 acres (0.9 ha).

Although fences were installed in 2014, a ramp from Agnes Street to the holding coral and water hook-ups for the troughs were completed in February 2015. Large "Cattle Grazing Area" signs were installed at the three trail entrances; smaller signs were installed on the fence posts where trails are in close proximity to the grazing area. Additional signs indicating that the cattle graze to help restore the SCT were installed in February 2016. The City received input from the AMWG on the language for these signs. In 2017, a gate was added in Area C to facilitate movement of animals between areas A and C. In 2022, a cross-fence was installed in Area A to allow cattle grazing in just northern portion of the area. Fences, access gates, and other features to support cattle grazing were inspected and maintained throughout 2022.

[9] In 2021 and 2022 only the northern portion of Area was grazed.

The City's grazing contractor had cattle onsite from February 10, 2023 through December 31, 2023. The grazer used a cow/calf program. The HMP's original estimate for cattle was 2 to 6 cow calf pairs. However, it became evident during previous grazing years that this number of cattle was insufficient to keep up with the rate of grass growth. As an adaptive management action, the AMWG revised its recommendation to the City to provide the City and the rancher with more flexibility to increase the number of cattle at the site to keep pace with grass growth. The specific number of cattle present onsite throughout the 2023 grazing season are presented on **Table 14**.

As grazing occurred in 2023, the City conducted numerous observations of grazing operations, including the entry and exit of cattle from the site, conferring with the grazing operator, observations of feed and water troughs (regularly during the grazing season), recording residual dry matter (RDM) and adherence to BMPs (see Section 3.5.6 in HMP).

Table 14. Duration of Cattle Grazing, 2023

Duration	# of Cattle in Area A (north)	# of Cattle in Area C	# of Cattle in Area D	# of Cattle in Areas C & D (open gate)	# of Months Grazed
February 10 – April 13	-	-	-	5 cows	2.0
April 14	-	-	-	6 cows	0.03
April 14 – April 28	6	-	-	-	0.2
April 29 – May 17	-	-	-	6 cows 1 calf	0.4
May 18- June 1	-	-	-	7 cows 1 calf	0.4
June 1 – August 15	7 cows 1 calf	-	-	-	1.2
August 15 – September 1610	-	-	-	-	0
September 17 – November 16	-	-	-	2 cows	2.0
November 17 – December 6	-	-	-	2 cows 1 calf	0.6
December 7 – December 23	-	-	-	2 cows 1 yearling 1 6-mo. calf	0.5
December 24 - December 31	2 cows 1 yearling 1 6-mo. calf	-	-	-	0.2

[10] Grazer on vacation; all animals removed from site

5.3.2 Monitoring

Residual dry matter (RMD) is the amount of dry plant material left standing or on the ground from the previous year's growing season (Bartolome *et al*. 2006). RDM includes three components: 1) the current year's crop of palatable forage, 2) non-palatable plants, weeds, and the stubble of dry matter that is left behind when clipping and 3) thatch, which is dead plant material greater than one-year old. *A Mulch Manager's Guide for Monitoring Success* (Wildland Solutions 2008) provides practical information on how to assess RDM in a manner that is objective and directly related to management objectives for rangeland health. The RDM monitoring was conducted on October 3. Pursuant to the methodology outlined in *Guidelines for Residual Dry matter on Coastal and Foothill Rangelands in California* (UC Publication 8092 by J. Bartolome) the grazing areas were walked along random transects. Equipment consisted of a clip and weigh RDM kit from Wildland Solutions that included a 13.25" diameter circular hoop plot, a gram scale, and measuring bag. The RDM plot was randomly tossed and the vegetation was clipped and weighed. A photo was obtained of each plot before and after clipping; noting plot number, RDM level and date on dry erase board. The measuring bag was weighed empty, summer annual plants and any tree leaves were removed from the clip plot; old thatch was not evident and not included. Plants rooted in the plot were clipped as close to the ground as possible, clippings were placed in the bag, weighed and recorded (subtracting weight of the bag). The weight of the clippings was converted to pounds per acre (grams clipped x 100 = lbs./acre RDM).

Clipping and weighing RDM plots was used to calibrate visual estimates of three RDM levels corresponding to an RDM objective of 500-650 lbs./acre (exceeds, meets, or below). Once the observer's eyes were calibrated, it was possible to assess the RDM level without a clip plot. Locations where RDM levels were assessed as well as edges of mapped boundaries were recorded with GPS waypoints.

The results were plotted onto an aerial photo to create an RDM zone map, based on GPS points mapped onto most recent Google Earth imagery available, and polygons created. The RDM zone map, portraying the following RDM levels, provides a sufficient level of detail for aiding management and cattle grazing decisions:

BLUE:	Highest RDM (exceeds objective (>650 lbs./acre)
GREEN:	Middle RDM (meets objective (500-650 lbs. per acre)
RED:	Lowest RDM, below objective (<500 lbs./acre)

5.3.3 Results

Within the grazed areas (northern portion of Area A, Area C, and D) RDM levels were equally reflected by red (<500 lbs./acre), green RDM (500 - 650 lbs./acre), and blue RDM (>650 lbs./acre) zones, which reflects the effects of seasonal grazing that occurred between February and December 2023, as well as the amount of biomass produced in the above-average rainfall year. At most locations, thatch was not evident as cattle ingested the current

and previous year's growth. All areas had higher RDM levels compared to 2022, which is likely attributable to the abundant plant growth in 2023.

Figure 61 exhibits the RDM map for all grazed areas (A, C, and D). **Figures 62, 63** and **64** show clip plots with highest RDM (>650 lbs./acre), middle RDM (500-650 lb./acre) and lowest RDM (<500 lbs./acre), respectively.

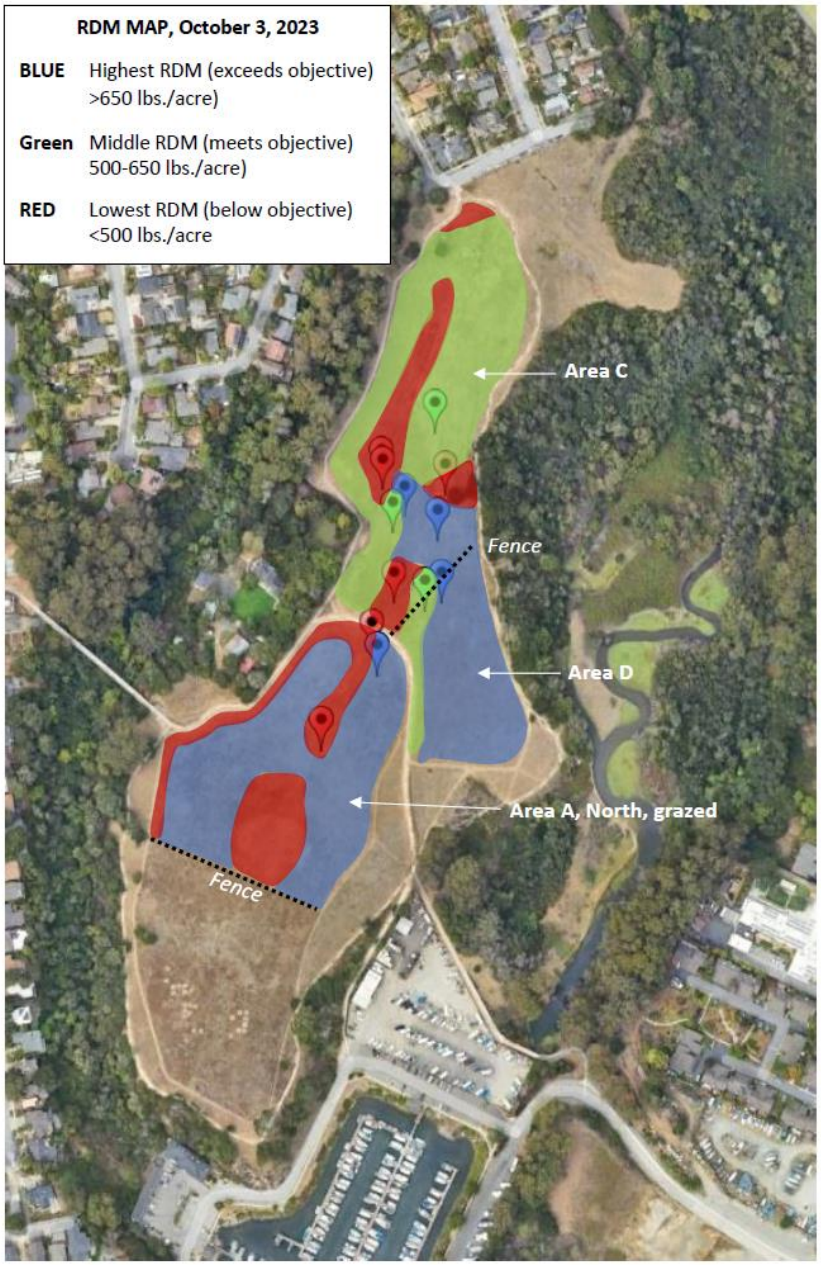


Figure 61. RDM Map for Grazing Areas, October 2023

Figure 62. Clip Plot of Highest RDM (Blue), October 2023

Figure 63. Clip Plot of Middle RDM (Green), October 2023

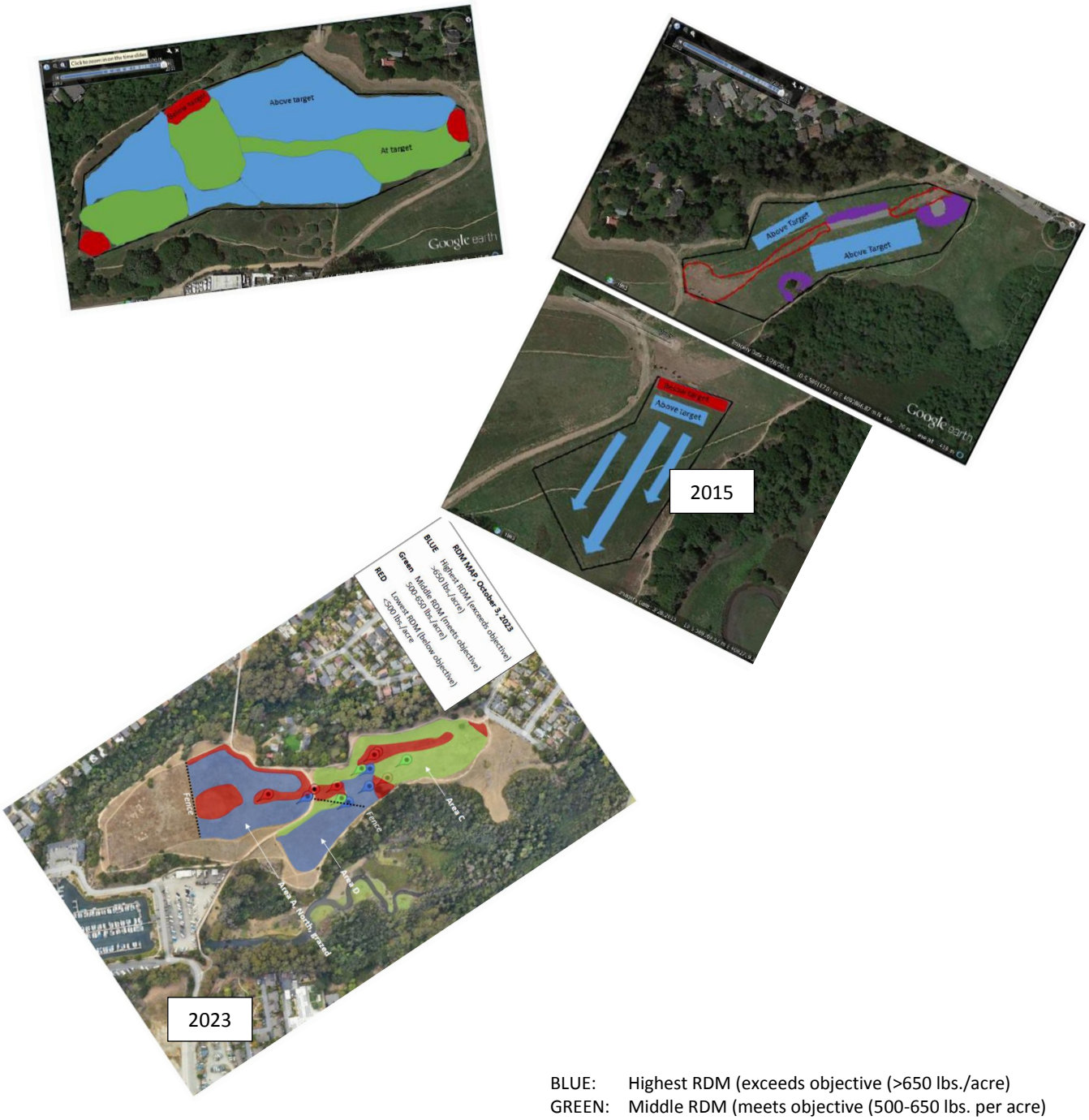
Figure 64. Clip Plot of Lowest RDM (Red), October 2023

5.3.4 Discussion

In 2023, cattle grazing reduced canopy height in the northern portion of Area A and Areas C and D during months the cattle were on site (February 10 through December 21). Grazing canopy height in mid-February averaged 3.5 inches in Area A North, 1.2 inches in Area C and 1.7" in Area D. Height measurements were taken approximately a few days after cattle were brought onto the site. The canopy height in all areas was below or within the desired target range for the SCT germination and emergence period (i.e., 2-3.5"). Cattle grazing was sufficient in keeping the canopy height low. Similar to previous years, once grazing was initiated, the cattle reduced biomass across the grassland and in the process also increased bare ground. Non-native species remained dominant with very high cover. RDM levels decreased in most of the grazed areas between 2015 and 2023. A comparison of RDM levels between 2015 and 2025 is presented in **Figure 65**.

There were fewer areas of low and middle RDM zones (red and green) in 2023 than 2022 and this is likely due to the high rainfall year and abundant plant growth. For example, there is more middle RDM (green) zones area in Area C in 2023, which were red in 2022. The amount of red RDM was also reduced in Area A North. Blue RDM levels were recorded in Area D, which were green in 2022. Despite the higher RDM levels for most areas in 2023, there has been a reduction in biomass, canopy height, and RDM across the grassland since 2015. This represents positive progress in improving vegetation conditions as well as reflecting changes in land management actions. As the Arana Gulch grasslands have been highly disturbed for well over one hundred years, returning the grassland and prairie to reference conditions, if possible, will take many more years.

Figure 65. RDM – Comparison of 2015 and 2023 Measurements



BLUE: Highest RDM (exceeds objective (>650 lbs./acre)
GREEN: Middle RDM (meets objective (500-650 lbs. per acre)
RED: Lowest RDM, below objective (<500 lbs./acre)

5.4 Invasive Weed Work Plan

5.4.1 Management Actions

In 2015 the City mapped the invasive plants within this management area and prepared an Invasive Weed Work Plan (IWWP). In 2016, the City filled a park maintenance position with dedicated hours for Arana Gulch. The IWWP outlined methods for the removal and control of invasive, non-native plant species in the management area. Species addressed in the plan include: Italian thistle (*Carduus pycnocephalus)*, bull thistle (*Cirsium vulgare)*, poison hemlock (*Conium maculatum)*, cotoneaster (*Cotoneaster sp.)*, Bermuda grass (*Cynodon dactylon)*, French broom (*Genista monspessulana)*, English ivy (*Hedera helix)*, velvet grass (*Holcus lanatus)*, Harding grass (*Phalaris aquatica)*, *Prunus sp.*, pyracantha (*Pyracantha sp.)*, wild radish (*Raphanus sativa)*, Himalayan blackberry (*Rubus ameniacus)*, and milk thistle (*Silybum marianum).* The IWWP is presented in the Year 2 Annual Report, Appendix B.

In 2023, the City and volunteer groups removed invasive plant species from the delineated grassland area. Thickets of Himalayan blackberry, Italian thistle, and milk thistle were mowed or weed-whipped Control actions for thistles in the IWWP, specify that when seed heads of thistles are observed, they are cut and disposed of off-site. Thistles (*Cirsium, Silybum,* and *Carduus spp.)* were previously widespread on site and control efforts have significantly reduced cover of these species.

5.5 HMP Performance Evaluation

The purpose of the detailed vegetation monitoring is to assess progress toward meeting the goals and interim success criteria specified in the HMP.

- Goal 1: Increase the abundance and distribution of the SCT population.
- Goal 2: Restore a proper disturbance regime with the reintroduction of grazing.
- Goal 3: Minimize the detrimental effects of high non-native cover and restore coastal prairie species diversity and habitat function.
- Goal 4: Increase the size of the SCT seed bank to a level that will ensure a high probability of persistence for 100 years, or in perpetuity.

The HMP made the assumption that an introduction of grazing in 2015 would create site conditions conducive to increasing the abundance and distribution of SCT (Goal 1) by providing a disturbance regime needed for the species. While the grazing program has successfully reduced average canopy heights and increased bare ground, it has not reduced cover of non-native plants or increased native species richness or cover (Goal 3), nor increase the abundance and distribution of SCT (Goal 1) of its seed bank (Goal 4). The grazing release in Area A South in 2021 has, in fact, allowed for an increase in cover by native

perennial grasses of California oatgrass and purple needlegrass (*Stipa pulchra)*. The large stands of these grasses are avoided during the season spring mowing in Area A south allowing for good growth and seed set of these species. Recent research on restored prairies in the central coast documented reference data on native plant cover and species richness. Using this reference data, the Area A South grassland/prairie has met a definition of a restored functioning coastal prairie system as specified by Goal 3.

The lack of natural recruitment of SCT on site following years of cattle grazing confirmed the depletion of the SCT and other native species seedbank, indicating that the SCT population could be at or near some unknown threshold of extirpation at the site. Due to these concern on species extirpation, in 2021 management actions were refocused to species recovery through re-establishment of a viable soil seedbank. In 2021 an outplanting program was developed to introduce SCT seed to the site to meet Goals 1 and 4. Due to the initial success of SCT plant propagation and outplanting in 2021, the outplanting program was repeated in 2022 and 2023. The program has successfully re-introduced SCT plants and seed into the ecosystem, resulting in two generations of natural SCT plant recruitment. To date, a hundred thousand or more SCT seeds have been introduced to the site to recreate/rebuild a SCT soil seedbank (Goal 4). Goal 4 is to maintain a viable SCT population, with an objective (1A) to increase the number of aboveground SCT to at least the 2006 level (348 plants) in the first year after the return of grazing (i.e., summer 2016) (Objective 1A). Although no SCT were observed in the first year after grazing (2022), the 2021-2023 outplanting program have resulted in hundreds of SCT plants on site, exceeding the 2006 level of 348 plants. In 2023 1,899 SCT plants occur on site. These plants represent current year outplants (798 plants, 42% of population) as well as SCT plants arising from viable seed in the soil seedbank (i.e., in historic colony sites and previously-planted areas (1,101 plants, 58% of population). The HMP objective to increase the population above the 2006 level has been attained for last two years (2022 and 2023).

A second HMP objective (1B) is to expand the distribution of SCT beyond Tarplant Area A within three years. In 2021, 2022 and again in 2023, SCT were installed in Area C within a cattle exclosure. Although seed was released into the soil from these plantings, there was no natural recruitment of SCT plants from these outplantings. In 2023 76 SCT plants survived from the years outplanting, contributing approximately 3,040 seeds into soil seedbank. Management actions were implemented to encourage natural recruitment, including fall mowing and cattle-grazing/activity. Continued SCT outplantings in Areas C is recommended for 2024. The City entered a fourth agreement with UCSC Greenhouses to propagate SCT plants for outplanting in Apreas A and C in 2024.

The HMP has a goal to maintain a genetically and demographically viable soil seed bank in perpetuity (Goal 4), with an objective to increase the density of viable ray achenes in the soil seed bank from the baseline (first 3 years) and conduct assessments at 5-year intervals (Objective 4A). As discussed in the Year 2 (2015) Annual Report, a baseline seed bank

density study was conducted by Dr. Bainbridge in 2014 /2015 that demonstrated a 100-fold decline from data collected in 1999. Additional soil seed bank density analysis has not been conducted. Such a study may be warranted after several years of outplanting such that an updated seed bank density can be documented.

To maintain a viable seed bank and to guard against an unexpected stochastic event, SCT seed was collected from the site in 2018 (seed from 25 flower heads collected from 267 plants) and deposited at the UCSC Greenhouse for long-term seed storage. Under an agreement with the City and UCSC, approximately 100,000 additional seeds were produced through a seed bulking effort This seed increase is one tool to maintain a genetically and a demographically viable seed bank, which could be used at a later date to enhance the soil seed bank.

A goal of the 2021-2023 SCT outplanting program was to further increase SCT seed input into the soil seedbank. The seedbank consists of both the disk and ray seeds. The disk seeds can germinate within a year of release whereas the ray seeds may not germinate for several years. The *Germination Study: Dormancy in Ray Achenes of Holocarpha macradenia* (Childress, 2023) found the average viability of the ray achenes at 40% and under field conditions, scarification of the ray achene seed costs and/or the seed's exposure to light, may be the most likely triggers for germination. Although it is not known how many viable disk and ray seeds are produced per plant, an estimated 115,000 SCT flowerheads, with possibly a million or more seeds, have been released into Area A South and a portion of Area C from the 2021, 2022, and 2023 outplantings, thus contributing to the HMP goal.

The HMP has three goals that apply to the coastal prairie and are not specific to the SCT (which is addressed in the previous section). Goal 2 seeks to maintain a functioning coastal prairie through the reintroduction of grazing and the resultant disturbance regime. Objective 2A identifies implementation of the grazing program by 2014 and Objective 2B requires that the grassland achieve residual dry matter (RDM) measurements within a range appropriate for SCT growth. Seasonal grazing was continued in the northern portion of Area A, Area C and Area D in 2023 and many areas of the grazed areas were in the red and green RDM range, thus, meeting Objectives 2A and 2B. The City elected to continue another year of not grazing the southern portion of Area A in 2023 to accommodate the continued SCT outplanting program, as the outplantings would have been adversely affected by cattle activity. The southern portion of Area A was mowed once in the spring and once in the fall as an alternative grassland/prairie management action.

Observations and BMP implementation monitoring of the grazing program in the northern portion of Area A and Areas C and D were implemented concurrent with grazing. The protocol for monitoring of the grazing program in 2023 are outlined in the HMP and include observations of feed and water troughs (3 times during grazing), adherence to BMPs (see Section 3.5.6 in HMP), and documenting residual dry matter (once a year in September or

October). The following BMPs, as identified in the HMP[11] , were implemented and monitored:

- Temporary fencing was not needed around the seasonal wetland within Area A or its 50-foot buffer, as no adverse impact from cattle grazing was observed in this area in 2023.
- Water troughs were placed adjacent to grazing area gates and away from the top of steep slopes; the troughs were located outside of sensitive areas (occupied SCT areas/seasonal wetland). No supplemental feed was used in 2023.
- The 2023 grazing season was in an above average rainfall year and the number of animals on site did not result in any erosion. There was no significant volume of cattle waste due to the relatively low number of animals on site during the grazing season.
- The City and the grazing contractor conducted regular visual inspections of fence lines to ensure cattle remained within the designated grazing area in 2023. There were no incidents of cut fence lines during the grazing season. The City and the grazing contractor monitored the fences during the grazing season; at no time did any cattle escape the grazing area.
- During rainfall events, the City conducted visual inspections (by foot) to document whether there was any rilling or other erosion within and from the grazing area. No erosion issues were detected in 2023. There was no need to install erosion control measures, such as straw wattles, to prevent any accelerated or channelized runoff toward steep slopes.
- The grazing contractor avoided motorized vehicle use during rainy season/soil saturation.

The observations of SCT in 2023 occurred in the southern portion of Area A and a small fenced portion of Area C. Area A was not subject to grazing in 2023. The small fenced portion of Area C with SCT outplantings was open to cattle grazing in November and December 2023.

5.5.1 Status of SCT Recovery, Years 1-10

At the conclusion of the 10th year of implementation of the HMP, it can be shown that the SCT population has achieved the HMP threshold of 348 plants. This threshold has taken many years and pathways and its continued success is not assured without continued human intervention and site management.

As presented in **Table 15,** the first five years of HMP implementation were focused on grassland management (through cattle grazing) to create suitable habitat conditions for SCT

[11] See page 68 (Section 3.5.6) of Arana Gulch HMP.

seed germination and plant growth. By Year 6 it was determined that the extant seedbank was too depleted and continuing the grazing program, by itself, was not going to meet the required HMP goals for the species. Habitat management actions were then re-focused on species recovery. Recovery actions included on-site seed collection, seed increase, plant propagation, experimental SCT outplantings, and experimental direct seeding. These actions were implemented over a period of four years, resulting in over 3,000 SCT plants installed and one plot hand-seeded. By the end of 2023, approximately 4,000 SCT plants had flowered at Arana Gulch, comprised of 798 plants from the current-year outplanting and 1,101 plants from natural seed recruitment in previously-planted plots and historic areas.

These early stages of SCT recovery have been successful; however, many habitat management questions remain. The next stage of species recovery needs to determine the management that can maintain and/or increase both the SCT population and its areal extent into the future. There are questions on optimum SCT seedbank density and viability, optimum grassland management techniques, as well as the need for long-term seed collection, plant propagation, outplanting, and direct seeding.

Population Maintenance Seedbank Density

- Determine if planting container-grown SCT is a viable method to increase population and maintain/increase soil seedbank.
- What is required seedbank density for long-term preservation of SCT on site; how often should SCT outplanting occur to reach desired seedbank density?
- How much seed production is needed each year to maintain desired seedbank density?

Grassland Management for SCT

- Effect of mowing/grazing on SCT population, including how many above-ground SCT plants are needed to maintain (or increase) SCT population, taking into account herbivory and/or plant/seed losses
- Amount of bare ground needed in winter for SCT seed germination
- Optimum cropping height for SCT to increase branching and subsequent flower and seed production
- Evaluate vectors for seed dispersal and SCT establishing outside of planted plots.

Table 15. Status of SCT Recovery, Years 1-10

Year	Action	Rationale	Results and Recommendations
Years 1-5 (2014-19)	Seasonal grazing, Jan – July (typical)	HMP premise was that there was viable SCT seed in the soil seedbank and that grazing would be suitable management to create soil disturbance and reduce weed cover to stimulate germination of the soil seedbank.	Grazing had no obvious effect on expression of extant SCT seedbank, as SCT occurrences were limited to old, pre-grazed scrape plots. Determination was made that extant seedbank is too depleted for species to recover with just grazing management. In Year 5, it was determined that re-introduction of SCT seed into the habitat is required for species recovery.
Years 5-6 (2018-19)	Collection of on-site SCT seed	Seed increase at UCSC Greenhouses for later outplanting to re-introduce SCT seed into the system	Collection of 24 seed heads from extant plants. Successful seed increase, generating approximately 10,000 seeds, in storage at UCSC Greenhouses. In Year 6, decision was made to conduct experimental SCT plant propagation for outplanting in Year 7.
Year 7 (2020)	Experimental Greenhouse Propagation and Outplanting of SCT	Successful growth of SCT in nursery. Experimental outplanting of 28 SCT Plugs in Area C	Survival of 6 SCT; approx. 200 flowerheads (FH) produces with seed released onto site (Area C). Decision made to increase SCT plant propagation and outplanting for Year 8, using stored seed.
Year 8 (2021)	Nursery Propagation and Experimental Outplanting of SCT	Propagation and outplanting of 1,000 SCT plugs in Areas A, C, and D. Macro-plots used to evaluate various methods of mulch, with and without grazing, and control	60% survival of outplantings in Area A and C; 0% survival in Area D; approx. 52,000 FH with seeds released in Area A and Area C. No natural recruitment of SCT in previous year outplanting site (Area C). Decision made to repeat SCT plant propagation and outplanting for Year 9, using stored seed.
Year 9 (2022)	Nursery Propagation and Experimental Outplanting of SCT Experimental Mowing of Previously Year Plots (Area A)	Outplanting of 1,400 SCT Plugs in Areas A and C, using macro-plots to evaluate various methods of mulch and control. No grazing. Experimental seeding in Area A. Previous year plots in Area A subject to seasonal mowing February – May.	20% survival of outplantings in Area A And Area C; approx. 15,000 FH and seeds released in Area A and Area C. Natural recruitment of SCT in previous year outplanting plots in Area A (1,500 SCT; approx. 4,500 flowerheads with seed released). Mowing caused branching and more flower/seed production on SCT plants tall enough to cut. Decision made to repeat SCT plant propagation and outplanting for Year 10, using stored seed.
Year 10 (2023)	Nursery Propagation and Outplanting of SCT Mowing of Portion of Previously Year Plots (Area A)	Outplanting of 1,091 SCT Plugs in Areas A and C, using wood chip and straw mulch plots. No grazing. Previous year plots subject to seasonal	88% survival of outplantings in Area A (874 plants); 81% survival of outplantings in Area C (76 plants); approx. 34,980 flowerheads and seeds released in Area A and 3,040 flowerheads released in Area C from outplanting.

Year	Action	Rationale	Results and Recommendations
	Allow fall season grazing in Area C cattle exclosure	mowing February-May and fall season mowing	Natural recruitment of SCT in previous year outplanting plots in Area A, reflecting F1 and F2 generations and recruitment of SCT in historic natural areas and an experimental seeding plot (958 SCT; approx. 10,518 flowerheads with seed released). Spring season mowing caused branching and more flower/seed production on SCT plants tall enough to cut. Experimental fall season mowing of half of SCT population in Area A South. Flail-mowing and raking of non-SCT occupied areas in Area A South for habitat management. Decision made to repeat SCT plant propagation and outplanting for Year 11, using stored seed.
Year 11 (2024)	Nursery Propagation and Outplanting of SCT (scheduled) Mowing of Portion of Previously Year Plots (Area A) (Scheduled) Allow grazing in Area C	Outplanting of 1,000 SCT Plugs in Areas A and C, using wood chip plots. Seasonal grazing with cross-fence in Area A South. Previous year plots subject to seasonal mowing February-May and fall season mowing	To be reported in Year 11 (2024) report.

Table 16. Biological Variables Monitored in Coastal Prairie/Tarplant Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Interim Target Date	Year 10 (2023) Results	Objective Met?
Goal 1. Maintain a viable SCT population at Arana Gulch						
Objective 1A. Increase number of aboveground SCT to at least the 2006 level by 2015 (Note: 2006=348 plants in Area A)	# of above ground SCT plants	Yearly in Aug./Sept.	Increase	2014	1,823 SCT in Area A, including 2023 outplantings and natural recruited plants 76 SCT in Area C	Yes
Objective 1B. Expand the distribution of SCT beyond Area A within 3 years (Note: Year 3 = 2017)	Distribution of SCT plants	Yearly in Aug./Sept.	Expansion	2017	76 SCT outplantings survived in Area C in 2023	Yes
Goal 2. Reintroduce grazing to restore a disturbance regime that maintains functioning coastal prairie						
Objective 2A. Implement the Grazing Program by 2014	2A.1 Observation of feed and water troughs	3x during grazing	Stable	2015	City monitored water troughs	Yes
	2.A.2 BMP implementation monitoring	3x during grazing	Stable	2015	City monitoring plant height and other BMPS through grazing season	Yes, BMPs were implemented
Objective 2B. Maintain RDM within a range that allows SCT to complete its lifecycle and protects coastal prairie grassland from erosion (700-1,500 lbs./acre)	Residual dry matter (RDM)	Yearly in Sept./Oct.	Maintain within range	2017	RDM measured in October; some areas in C and D were at target	Yes, some areas were above target
Goal 3. Minimize detrimental effects of high non-native plant cover and restore coastal prairie species diversity and habitat function						
Objective 3A. Reduce canopy height during the basal rosette stage for SCT (Nov. –	Average canopy height	3x during growing season	Reduction	2015	Canopy heights were at or near target in February, in all; canopy heights were above target in May;	Partially, cattle grazing reduced canopy height in northern portion of Area A and Areas C and D.

Objective	Variable	Measurement Frequency	Desired Direction of Change	Interim Target Date	Year 10 (2023) Results	Objective Met?
April) from the baseline level to 2-3 inches[12] by 2015					however, Area A South and Area C were within target by December.	
Objective 3Bi. Reduce cover of non-native species in the coastal prairie from the baseline to one more representative of a reference functioning coastal prairie system by 2020	Percent cover of non-native plants	Yearly at peak growth in April	Reduction	2020	Non-native plant species dominate the grassland.	Cattle grazing has altered non-native composition but non-native species dominate the grassland.
Objective 3Bii. Cover of native perennial grasses (NPG) increases from baseline levels to one more representative of a reference intact coastal prairie system"	Percent cover of native perennial grasses	Yearly at peak growth in April	Increase	2020	Grazing exclusion in Area A South appeared to allow several NPG species to flourish. Average native cover is at 13% in Area A North and 25% in Area A South.	No, cover of NPG remains low in Areas C and D; however, Area A North and South have higher cover values. A mowing regime in Area A South has retained native plant cover; an outplanting of native grasses in Area A South was implemented in 2023.
Objective 3C. Increase cover of native species from baseline levels to one more representative of a reference functioning	Percent cover of native plants	Yearly at peak growth in April	Increase	2020	Cover of native species in Areas A North in 13% and 25% in Area A South and is within ranges of restored coastal prairie as documented by J Luong.	No, cover of native species has not increased significantly in Areas C and D; however, native plants are more likely to be encountered in Area

[12] AMWG reduced threshold from 0.5 m (1.6 feet) to 2-3 inches in January 2015

Objective	Variable	Measurement Frequency	Desired Direction of Change	Interim Target Date	Year 10 (2023) Results	Objective Met?
coastal prairie system by 2020.					Cover in Area C and Area D remains at <1%.	A; Area A South meets objective.
Objective 3D. Increase native species richness from baseline levels to one more representative of a reference functioning coastal prairie system by 2020.	Native species richness	Yearly at peak growth in April	Increase	2020	In Area A, South total species richness varied from 14 to 17 species; naïve species richness varied from 7 to 11 species. In Area C and D the number of native species has remained below 5 (typically 1).	Partially; in Area A species richness is greater as more transects were established to better represent the area.
Objective 3E. Increase cover of bare ground in the coastal prairie from baseline level to a level that enables SCT plants to complete their lifecycle by 2015.	Percent bare ground	3x during growing season	Increase	2015	Grazing was excluded in Area A South. Bare ground in SCT occupied areas in December was 14%.	Yes, a trend of increased bare ground has been detected in Area A South.
	Permanent photo points with GPS location and compass direction	Before, during and post construction and then yearly at peak growth	Improving	2015	Photo points established in April 2015, approximately 8 weeks after initiation of cattle grazing.	No photo points were taken in spring 2023
Goal 4. Maintain a genetically and demographically viable soil seed bank in perpetuity.						
Objective 4A. Increase the density of viable ray achenes in the soil seed bank from baseline in the first 3 years	Seed bank density (#of viable ray achenes)	Every 5 years	Increase	2015	No viable seed in Areas B and C; unlikely to have viable seed in Area D; viable seed in Area A and C from outplantings	Seedbank not reassessed; however, recruitment from the multi-year SCT outplanting has occurred in Area A

5.6 Proposed Actions for 2024

The following actions and expected timing are proposed for 2024:

- Continue the cattle grazing program in Area A North and in Areas C and D, beginning in January 2023, with grazing extending to June/July, depending upon presence of SCT flowers and forage. Consider implementing interim grassland management actions (i.e., focused mowing or other management) in winter if cattle grazing is delayed and canopy height levels are above the target objective of 2-3 inches (5-8 cm) between the months of November thru April. Evaluate need to mow in fall to reduce canopy height.
- Implement cattle grazing program in western portion of Area A South, beginning in January 2023, with grazing extending to March or April, depending upon growth of SCT; remove cattle if significant browse/damage occurs to emerging SCT plants.
- Implement mowing in Area A South concurrent with implementation of the 2024 SCT outplanting program. Periodically mow grassland to keep canopy height below 10 inches, with the goals of removing seed heads of non-native grasses.
- Monitor grazing operation and implement the HMP-designated BMPs (see Section 3.5.6 in HMP and bullet list above) (January– June/July).
- Mow delineated areas outside the grazing areas (May/June). Conduct pre-mowing surveys for breeding birds and locally unique flora.
- Continue to implement invasive plant species control as per the IWWP, focusing on removal/control of the following species:
    - Himalaya blackberry (*Rubus ameniacus)*
    - Cotoneaster *(Cotoneaster sp.)*
    - French broom (*Genista monspessulana)*
    - Velvet grass (*Holcus lanatus)*
    - Thistles (*Cirsium sp., Carduus sp., Silybum marianum)*
    - Medusa head (*Elymus caput-medusae)*
    - Stinkwort (*Dittrichia graveolens)*
- Consider using soil sampling test data evaluate soil deficiencies that may affect the growth of SCT and other native plant species.
- Review results of prior outplanting plots for SCT seed expression. Consider additional research to address questions on population maintenance and seedbank density.
- Conduct outplantings of SCT seedlings in January/February 2024, using plants grown at UCSC Greenhouses.
- Consider continued outplanting of native grass plugs in Area A to increase native plant cover, pending availability of planting stock.
- Conduct census for SCT and monitor plant cover at occupied sites.
- Collect SCT seed if there are more than 50 plants; store seed for seed increase, storage, and possible out-planting, if needed.

- Monitor plant cover, canopy height, species richness, and bare ground at permanent transects and compare data to previous years and HMP desired direction of change (April/May).
- Document canopy height three times a year: February, April/May, and December.
- Document RDM in September/October.
- Document amount of bare ground in SCT occupied areas in December (SCT germination period).
- Evaluate and update, as needed, the draft sub-management area map and develop/finalize specific performance targets for percent cover of native species, nonnative species and bare ground, and species richness for coastal prairie that will be used to determine whether HMP objectives have been met, based on recent studies. In the absence of acceptable data on reference coastal prairies, the AMWG may use these three years of baseline data and a first year of monitoring data under grazing in April 2016 to begin refining the objectives under Goal 3.
- Document site conditions from the permanent photo-points.

6. Hagemann Gulch Riparian Woodland Management Area

Bridge and trail construction were completed in 2014 and erosion control and wildlife protection measures were implemented, consistent with Goal 3 of the HMP. Historic "Rose of Castille" bushes were relocated to City Hall in 2013, consistent with Goal 5 of the HMP. A riparian revegetation plan was prepared and approved by CDFW to compensate for impacts of the bridge project. Mapping and identification of invasive, non-native plant species was completed in 2017.

6.1 Management Actions

6.1.1 Integrated Pest Management (IPM)

Over two days in December 2023 the City and volunteers (Earth Stewards) did weed control (removal of Himalaya berry and English ivy) along the Marsh Vista Trail. The extent of invasive plant species was mapped in the management area in 2017 as shown in **Figure 68.**

6.1.2 Fire Hazard

The City Fire Department, through a State Coastal Conservancy Grant, implemented shaded fuel break management actions along The Prairie Loop Trail and other areas in September 2023. Understory vegetation, as well as tree limbs, within an approximately 30-foot wide swath adjacent to the trail was cut and removed. Tree limbs were trimmed up to 8 feet in height. A treated area along the Prairie Loop Trail is depicted in **Figure 66.** All of the work areas are shown on **Figure 67.**

Figure 66. Area along Prairie Loop Trail Subject to Fire Hazard Rduction Work

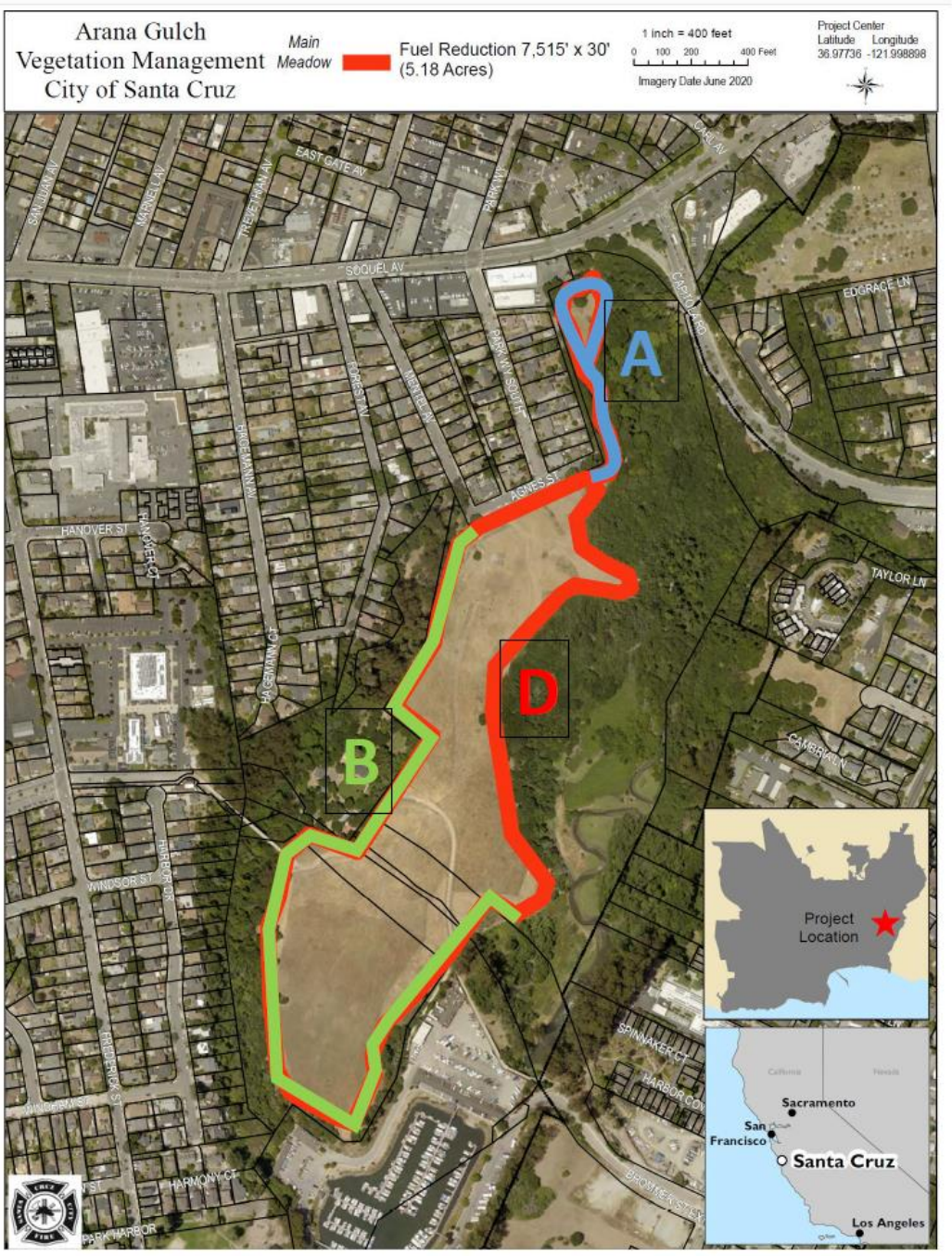


Figure 67. Vegetation Managment Areas for Fuel Reduction, 2023

6.1.3 Wildlife Protection

If necessary, prior to the implementation of vegetation management actions, surveys were conducted for nesting birds by qualified biologist. A pre-construction bird nest survey was conducted prior to the fuel management work described in 6.1.3, above; no active nests were detected in the work area.

6.1.4 Appropriate Uses

In 2023, the City monitored visitor use activities in this area. Police and City maintenance staff periodically patrolled open space activities in and around the gulch for transient encampments and other illegal activities. Encampments were removed as needed.

Figure 68. Invasive Plant Species Mapped in Hagemann Gulch Management Area in 2017

6.2 Monitoring and Performance Evaluation

6.2.1 Monitoring Methods and Results

No actions.

6.2.2 Evaluation of HMP Goals

Table 18 presents a summary of the biological variables monitored, the Year 10 (2023) values, and the desired direction of change.

The HMP has a goal to seek funding to develop an integrated pest management (IPM) plan to reduce the understory of invasive non-native species in Hagemann Gulch (Goal 1, Objectives 1A, 1B, and 1C). Invasive plant species, primarily French broom, were removed from the fuel management work area along the Prairie View Trail, concurrent with the Fire Departments shaded fuel management work.

Goal 2 (Objective 2A) of the HMP for this management area identifies the need to reduce the fire hazard within the gulch. The objectives include reducing the cover of woody thickets (comprised of invasive, non-native species) and prioritize the removal of eucalyptus trees, as feasible. Construction of the multi-use bridge resulted in the removal of a several eucalyptus trees near the western abutment and from the central gulch; however, several large stands of eucalyptus trees remain. As noted above, the City began implementation of the IPM plan for the removal of the woody invasive plant species, consistent with this objective.

Protection of wildlife habitat features is a goal of the HMP (Goal 3). This goal and it associated objectives were met concurrent with construction of the trail and the bridge over Hagemann Gulch in 2014. Objective 3A requires the identification and protection of San Francisco dusky-footed woodrats with the bridge construction zone (within 25m of the bridge). No woodrat nests/houses were documented within the construction zone. No further action is required; however, the City will continue to search for nests when work is performed in the area. Objective 3B requires monitoring for sensitive bird and bat roots and/or nests occurring within 25m of the Hagemann Gulch bridge, with monitoring and protection of such resources for 3-5 years post-construction. The 2013 bat survey found that the trees in the area provide only foliage roosting habitat. No cavities or crevices were found to support sensitive bat roosts. As the baseline is zero, no additional monitoring is required; however, the City could elect to monitor bat roosts to document if there is an increase in bat roosting after the trail and bridge project. Similarly, the 2014 nesting bird survey was negative for sensitive bird nesting. As the baseline is zero, no additional monitoring is required; however, the City could elect to monitor the area for sensitive bird nesting to document if there is an increase in such nesting after the trail and bridge project. These objectives are no longer applicable as part of the plan.

Goal 4 for this management area requires observing uses in Hagemann Gulch after trail and bridge construction and to determine if there are changes in use from site improvements. In

2023 police periodically patrolled the greenbelt to detect appropriate and inappropriate uses; off-leash dog use and periodic illegal encampments were noted in/around the bridge and other areas in/around the gulch. Objective 4A has been met.

Goal 5 of the HMP is to preserve the "Rose of Castille" bushes located near the Hagemann Gulch bridge construction area. To preserve these shrubs, the City elected to relocate them to City Hall in 2013, in consultation with the City Arborist. The shrubs are in excellent condition and Objectives 5A and B have been met.

6.3 Proposed Actions for 2024

The following actions and expected timing are proposed for 2024:

- Monitor appropriate uses within Hagemann Gulch through periodic police patrols (January– December 2024).
- Continue to remove and control invasive, non-native plant species within the management area, as resources allow.
- Monitor encroachment of invasive, non-native plant species within the shaded fuel management work area and implement control measures as needed.

Table 17. Biological Variables Monitored in Hagemann Gulch Riparian Woodland Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 10 (2023) Results	Objective Met?
Goal 1. Seek funding to develop an integrated pest management (IPM) plan to reduce the understory of invasive non-native species in Hagemann Gulch					
Objective 1A. Use a combination of methods to reduce the cover of non-native invasive woody plant thickets from baseline levels in the first year.	Non-native invasive woody plant cover	Before and after every removal effort	Decrease	Eucalyptus trees removed near western bridge abutment and along bridge sightline	Partial compliance; some eucalyptus trees removed but some stands remain on City property
Objective 1B. Monitor re-sprouting of removed vegetation and recruitment of new seedling on a regular basis, for at least 5 years after initial removal efforts.	Re-sprout and seedling emergence of target weeds	After every removal effort	Decrease	Minor re-sprouting of eucalyptus branches from trees limbed for the bridge placement	Yes, re-sprouts were monitored; re-sprouts included in IPM plan that was developed in 2017
Objective 1C. If passive restoration is not adequately controlling erosion, use revegetation with appropriate native species or other cultural methods to limit the amount of exposed soil and the potential for re-infestation and erosion.	Area of exposed soil (bare ground)	After every removal effort	Decrease	No action; no erosion detected	Yes, no erosion has been detected; no actions needed at this time
Goal 2. Reduce the fire hazard within Hagemann Gulch					
Objective 2A. Reduce the cover of woody thickets as per Objective 1A to reduce overall fire risk.	Non-native invasive woody plant cover	Before and after every removal effort	Decrease	City Fire Department implemented a	Partial compliance; non-native thickets have been controlled within the

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 10 (2023) Results	Objective Met?
				shaded fuel management plan along Prairie Loop Trail	shaded fuel management area along Prairie Loop Trail
Objective 2B. Prioritize the removal of eucalyptus trees where feasible.	Area occupied by eucalyptus	After every removal effort	Decrease	Eucalyptus trees removed near western bridge abutment and along bridge sightline	Partial compliance; some eucalyptus trees removed but some stands remain on City property
Goal 3. Protect wildlife habitat features in Hagemann Gulch					
Objective 3A. The number of SF dusky-footed woodrat nests occurring within Hagemann Gulch bridge construction zone will be identified and the nests protected.	Number of SF dusky-footed woodrat nests within 25m of Hagemann Bridge construction zone	Yearly, if observed prior to construction.	Stable	None detected within construction area Hagemann Gulch bridge; unknown number within 25m of bridge	N/A. No nests were identified prior to construction
Objective 3B. Monitoring for sensitive bird and bat roosts and/or nests occurring within 25 m of the Hagemann Gulch bridge construction zone will be identified and protected and continued for 3-5 years post-construction.	Sensitive bird or bat detections within 25m of Hagemann Bridge construction zone	Yearly, if observed prior to construction.	Stable	None detected within 25m Hagemann Gulch bridge	N/A. No nests were identified prior to construction

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 10 (2023) Results	Objective Met?
Goal 4. Increase appropriate uses in Hagemann Gulch					
Objective 4A. Observe the condition of all improvements at least 4 times per year in the first 3 years and at least twice a year thereafter.	Observation of infrastructure conditions	4x per year	Stable	Stable	Park staff periodically inspected the area in 2023; issues of illegal encampments were documented in close proximity to the bridge
Goal 5. Preserve the "Rose of Castille" historic roses					
Objective 5A. Relocation of the roses will occur only if no other alternative is feasible for development of the Hagemann Gulch Bridge. Any relocation will be done in the vicinity of the existing trees, in consultation with the City Arborist.	Presence of Rose of Castile	Yearly in June/July	Stable	Shrubs relocated to City Hall	Yes, roses were located to City Hall to ensure regular maintenance and care
Objective 5B. Address the public education benefits of identifying the Rose of Castille and providing interpretative panels.	Presence of Rose of Castile	Yearly in June/July	Stable	Decision was made.	Staff determined that identifying them would expose them to potential theft and vandalism. No additional action is necessary.

7. Arana Gulch Creek Riparian Woodland and Wetland Management Area

The Arana Gulch Multi-Use Trail including the causeway over Arana Gulch Creek was completed in 2014. This construction project required the implementation of erosion control, wildlife protection measures prior to construction, and revegetation of areas near the causeway consistent with construction permit conditions. Riparian revegetation was implemented in 2015.

7.1 Management Actions

7.1.1 Trail and Causeway Construction Project

In 2014, the City prepared a riparian revegetation plan which was reviewed by the AMWG and approved by CDFW to compensate for impacts to native trees and shrubs by the causeway construction. Three areas were designated for revegetation. In 2014, Area A, the slope by the causeway, was hydroseeded with sterile seed as per the CDFW-approved revegetation plan. Twenty dormant willow cuttings were installed at the toe of the slope in December 2014. In Area B, located near the northwestern causeway abutment, 40 creeping wild rye (*Elymus triticoides)* were planted (March 2015). In Area C, a flat area north of the causeway, was planted with 40 creeping wild rye (*Elymus triticoides)*, 16 California rose (*Rosa californica)*, 16 mugwort (*Artemisia douglasiana)*, and 3 coast live oak (*Quercus agrifolia)* were planted (March 2015). The plantings were installed by City staff and volunteers recruited by the RDCSCC. The City maintained these plantings, implementing periodic weeding and hand-watering; however, plant survival of the willows in Area A was low and the area was replanted in winter 2016. Plant survival of the creeping wild rye was low in Area B; therefore, the City elected to install additional native shrubs in Area C, where growing conditions were considered to be better. Roses for the Hagemann Gulch Bridge project were also planted in this area. Additional willow pole cuttings (25) were installed along the slope above Arana Creek to replace previous plantings that died.

7.1.2 Wildlife Protection

Prior to construction of the Arana Gulch Multi-Use Trail, measures were implemented to avoid impacts to wildlife. These measures were completed in 2014. No additional management actions were implemented in 2023.

7.1.3 Integrated Pest Management (IPM)

In 2014 and 2015, mapping of invasive weeds within this management area was initiated. The mapping is to guide future management activities for species removal/ control. The approximate size, density of plants (dense, moderate, and sparse) and the location of each non-native invasive species patch was documented using GPS and mapped on aerial photos. A map of data collected, and updated in 2019, is presented in **Figure 70A-D**.

Invasive non-native plant species documented to date in the management area include: (*Acacia spp.)*, perennial pepperweed (*Lepidium latifolium*), eupatorium (*Ageratina adenophora)*, ice plant (*Carpobrotus edulis)*, Italian thistle (*Carduus pycnocephalus)*, bull thistle (*Cirsium vulgare)*, jubata grass (*Cortederia jubata)*, cotoneaster (*Cotoneaster sp.*), Bermuda grass (*Cynodon dactylon*), eucalyptus (*Eucalyptus sp.)*, French broom(*Genista monspessulana*), English ivy (*Hedera helix*), velvet grass (*Holcus lanatus*), Himalayan blackberry (*Rubus ameniacus*), thornless blackberry (*Rubus ulmifolius)*, spiderwort (*Tradescantia fluminensis)*, and periwinkle (*Vinca major)*.

In 2023, the City continued closure of the ad-hoc path along Arana Creek to discourage public access to the natural area. Clean-ups from illegal camping activities were performed to remove trash and waste, primarily from the woodland areas. In some instances, vegetation was removed to improve the line-of-sight from the public right-of-way into the area, deterring illegal activity and improving law enforcement patrolling and monitoring. Extensive trash and waste removal occurred near the intersection of Capitola Road and Soquel Drive. Unfortunately, the activities necessitated more staff time and resources to be diverted to daily trash and waste removal.

In December 2023, the City removed a large patch of ice plant (*Carpobrotus sp.)* (mapped as CAED 4, 5, and 6 on **Figure 70B**) from the marsh plain on Arana Creek. Using a boat to access the marsh plain, work crews removed several bags of ice plant. This work area is depicted in **Figure 69**.

Figure 69. Iceplant Removed from Marsh Plain in December 2023

Arana Gulch Greenbelt – Location of Invasive Plant Species in Arana Creek Management Area
April, 2015 - Sheet 1 of 4

Figure 70A. Location of Invasive Plant Species within Arana Gulch Creek Riparian Woodland and Wetland Management Area

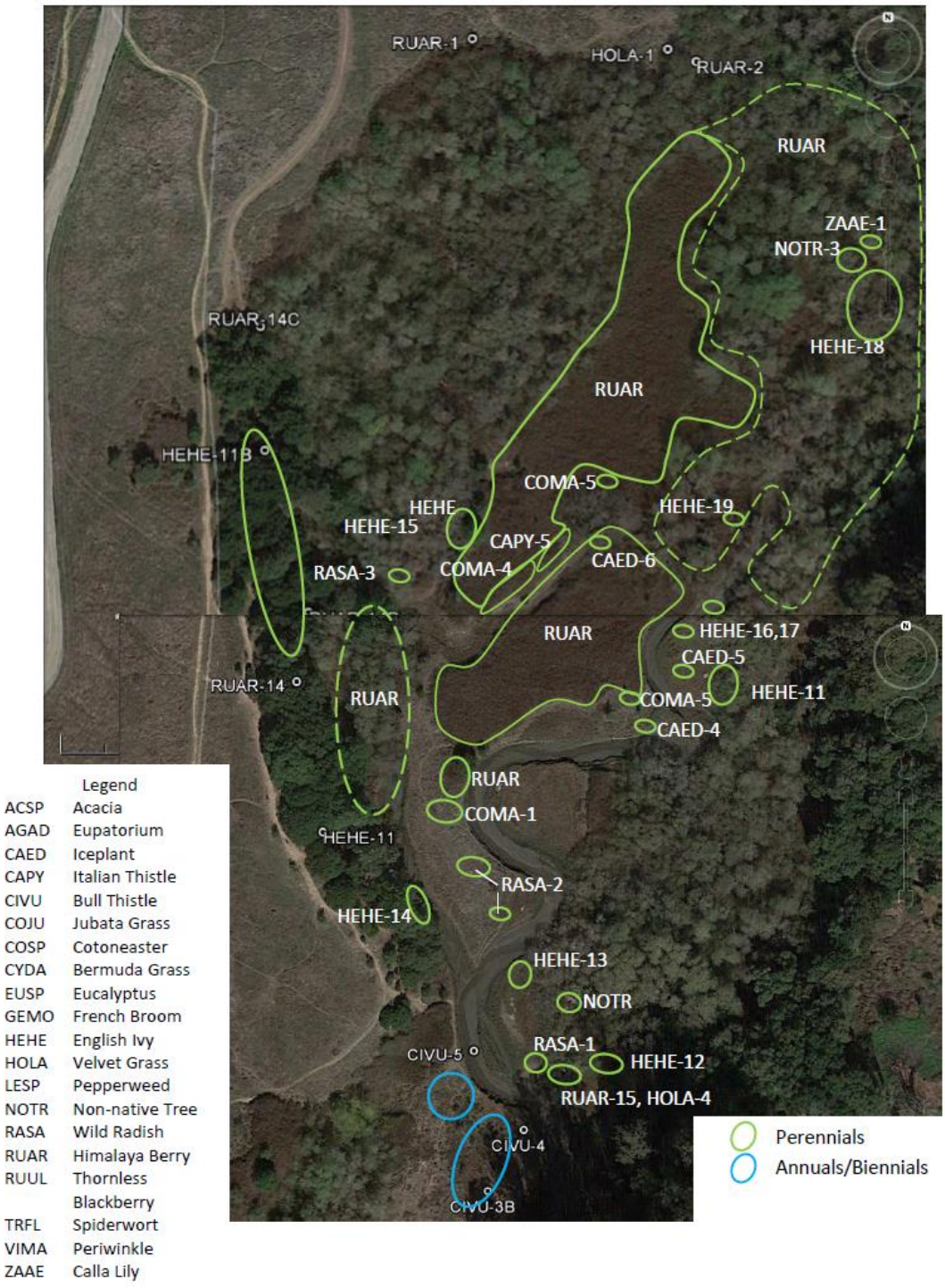


Figure 70B. Location of Invasive Plant Species within Arana Gulch Creek Riparian Woodland and Wetland Management Area

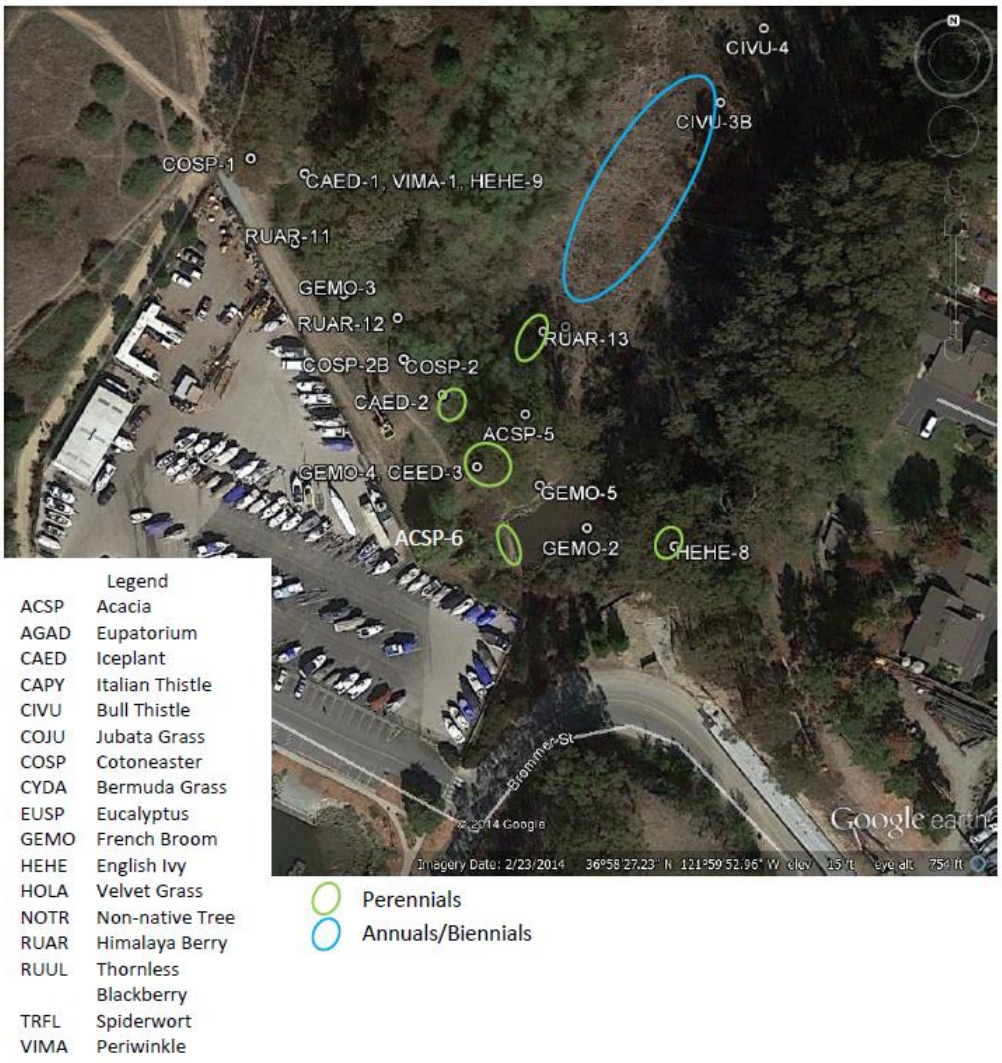


Figure 70C. Location of invasive plant species within Arana Gulch Creek Riparian Woodland and Wetland Management Area

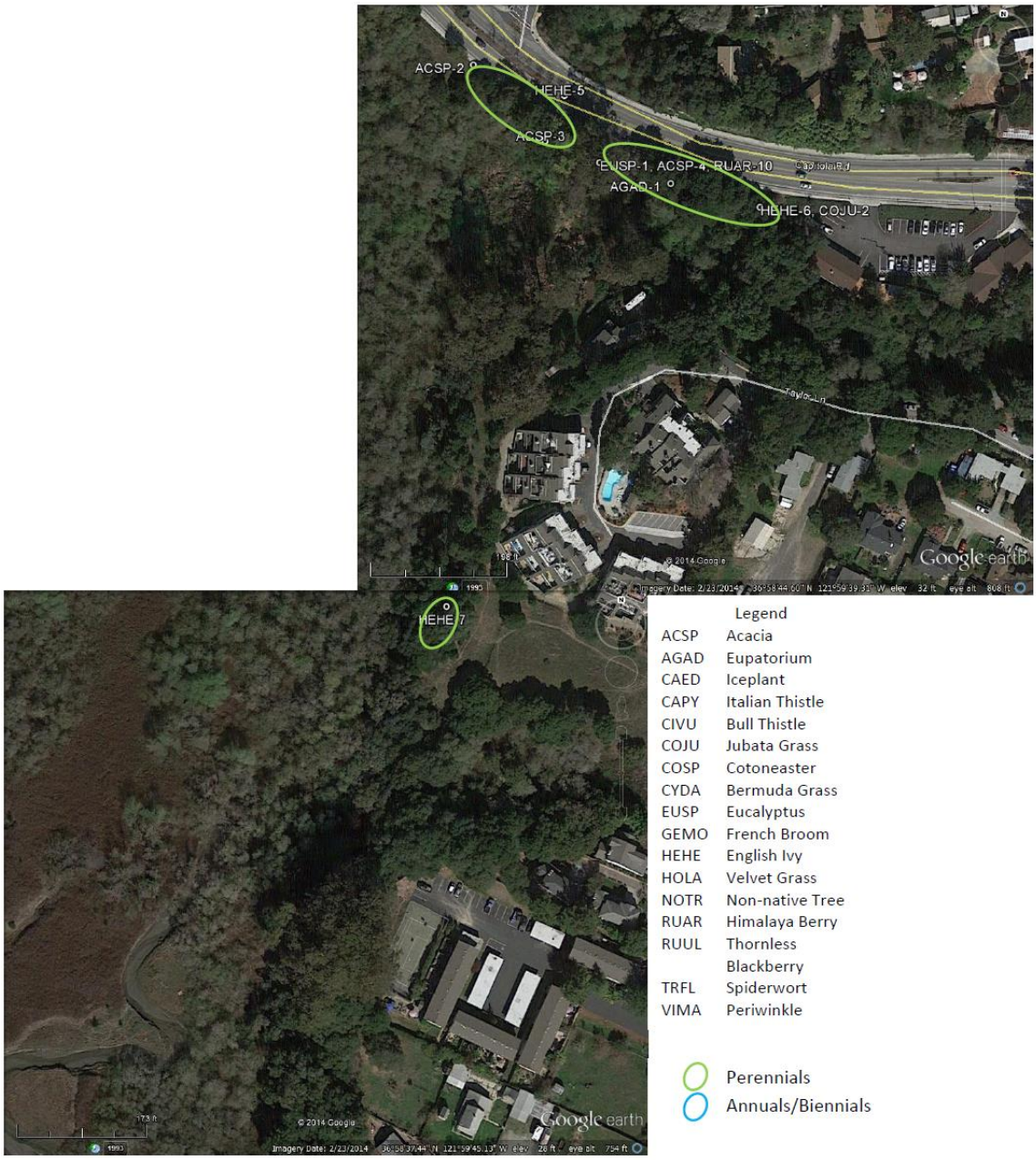


Figure 70D. Location of invasive plant species within Arana Gulch Creek Riparian Woodland and Wetland Management Area

7.1.4 Coordination with the RCDSCC

No actions between the City and the RCDSCC were conducted in 2022.

7.2 Monitoring and Performance Evaluation

7.2.1 Monitoring Methods

No monitoring was performed in 2023. Monitoring of the riparian revegetation areas was completed in 2020 (5-years).

7.2.2 Monitoring Results

None.

7.2.3 Evaluation of HMP Goals

Table 18 presents a summary of the biological variables monitored, the Year 10 (2023) values, and the desired direction of change.

The HMP has a goal to seek funding to reduce sediment and improve steelhead conditions within the Arana Gulch watershed (Goal 1 of HMP), a goal to stabilize the tidal reach of Arana Gulch Creek (Goal 2), and to restore the eroded gully on the greenbelt (Goal 3). To meet this goal, the City has conferred with the RCDSCC in previous years to discuss management activities within the watershed and within the greenbelt property. There was no active coordination in 2021.

Goal 4 is to develop an integrated pest management (IPM) plan to reduce the understory of invasive non-native species in the management area (Goal 4). The City continued to make progress on this task by removing occurrences of invasive, non-native plant species growing within the management area in compliance with goals of the HMP.

7.3 Proposed Actions for 2024

The following actions and expected timing are proposed for 2024:

- Be available to engage with the RCDSCC on their watershed and greenbelt projects, as proposed by the RCDSCC. (January– December 2024).
- Continue to remove and control occurrences of invasive, non-native plant species within the management area, as resources allow.

Table 18. Biological Variables Monitored in Arana Gulch Creek Riparian Woodland and Wetland Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 10 (2023) Results	Objective Met?
Goal 1. Reduce sedimentation and improve steelhead habitat conditions within the Arana Creek watershed					
Objective 1A. High priority sediment-related projects identified in the Arana Creek watershed enhancement plan area implemented.	# of completed sediment-related projects with the RCDSCC	Yearly	Increase	No action.	No
Objective 1B. High priority steelhead habitat improvements identified in the Arana Creek watershed enhancement plan area implemented.	# of completed steelhead habitat improvement projects with the RCDSCC	Yearly	Increase	No action.	No
Goal 2. Stabilize the tidal reach of Arana Gulch Creek					
Objective 2A. Engage the RCDSCC Arana Gulch Working Group staff to attend targeted AMWG meetings to identify possible solutions for the tidal reach of Arana Gulch Creek.	RCDSCC attendance at AMWG meetings	Yearly	Increase	No action.	Yes. City will continue to coordinate with RCDSCC to meet goals, as projects are proposed
Objective 2B. Work with the RCDSCC staff to obtain funding to design and implement a bank restoration project that reduced head cutting and bank erosion	Funding level for the tidal reach restoration	Yearly	Obtain/increase	No action.	No

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 10 (2023) Results	Objective Met?
along the tidal reach of Arana Gulch Creek.					
Goal 3. Restore the eroded Greenbelt Gully					
Objective 3A. Work with the RCDSCC staff to pursue funding for the Greenbelt Gully restoration project.	Funding level for the Greenbelt Gully project	Yearly	Obtain/increase	No action.	No
Goal 4. Seek funding to develop an integrated pest management (IPM) plan to reduce the understory of non-native species in the Arana Gulch Creek Management Area					
Objective 4A. Remove and reduce the cover of non-native invasive species in the riparian woodland relative to baseline conditions including: black acacia found near the culverts, dense thickets of Himalayan berry, scattered French broom, tall white top, and periwinkle.	Non-native invasive woody plant cover	Yearly	Decrease	Himalaya berry removed from near the Marsh Vista Trail; ice plant removed from marsh plain of Arana Creek	Partial, invasive, non-native plant species continue to be removed and controlled
Goal 5. Provide education opportunities and increase appropriate uses					
Objective 5A. Observe the condition of all improvements at least 4 times per year in the first 3 years and at least twice a year thereafter.	Observation of infrastructure conditions	4x per year	Stable	Conditions were monitored.	First year of monitoring was 2015

8. Conclusions from Year 10 and Recommendations for Year 11 (2024)

8.1 Conclusions from 2023

The City continued implementation of the HMP in 2023 (Year 10). Actions were conducted in all of the management areas. Cattle were grazed in the grassland in Area A North, and Areas C and D for SCT and overall grassland management. Area A South was mowed for grassland/prairie management. A 3rd year of SCT outplantings was implemented, with 1,091 SCT plants installed in Area A South and Area C (cattle exclosure). The 874 surviving SCT outplantings in Areas A South produced over 34,000 flowerheads with their seeds released into the soil seedbank. In addition, seed deposited from the 2021 and 2022 outplantings produced 949 SCT plants, with over 10,000 flowerheads, with their seed released into the soil seedbank. There was effective and efficient coordination between the City and the AMWG in 2023 as management actions and monitoring protocols were discussed. The City communicated with users of the greenbelt on the cattle-grazing and provided police patrols to encourage/enforce regulations and deter vandalism and illegal camping.

8.1.1. Coastal Prairie/Santa Cruz Tarplant Management Area

Within the Coastal Prairie/SCT Management Area cattle grazing occurred in Area A North and Areas C and D from February 10 through December 31. Implementing cattle grazing is in compliance with the HMP. Grazing was successful in maintaining the desired February canopy height in these areas. Periodic mowing was used in Area A South for SCT and grassland management; the mowing was compatible with the SCT outplanting actions and seed dispersal objectives. Monitoring of plant cover and residual dry matter was implemented and some objectives were met in some areas for these variables. Objectives of the HMP relating to improving the coastal prairie to a more functioning system have been met in Area A South, but not in other areas. The addition of more monitoring transects in Area A South was successful in capturing the coastal prairie plant composition and distribution in this area. Grassland management actions were also implemented outside of the Areas A, C, and D grazing areas. Mowing of the perimeter grasslands was conducted in May and June. Management of these grassland areas is required under the HMP; therefore, the City is in compliance with the HMP.

A census of SCT was conducted in 2023. Thirteen SCT plants were documented from historic SCT colony sites in Area A South. A total of 1,823 SCT plants were documented in Area A South and 76 SCT in Area C (cattle exclosure). The HMP objective of reaching 348 plants was met in 2023.

8.1.2. Hagemann Gulch Riparian Woodland and Arana Gulch Creek Riparian Woodland and Wetland Management Areas

Management actions were conducted in the Arana Creek Riparian Woodland and Wetland Management Area and the Hagemann Gulch Riparian Woodland Management Area in 2023, by way of police patrols, City staff actions to monitor visitor uses, and City crew and volunteer actions to remove invasive, non-native plant species.

8.1.3. Adaptive Management and Public Outreach

The City engaged with the AMWG in 2023 through field and web-based meetings in two meetings (April and November) as well as via email correspondence. The City received input from the AMWG on management actions and implemented the requested management actions. The City maintained a web page on the City's website for public outreach and responded to comments from the public and the AMWG on ways the site could be improved. These actions were in compliance with the HMP.

8.1.4 Schedule and Budgeting

The City established a line item in their operating budget for Arana Gulch and allocated funds for fiscal year July 1, 2022 to June 30, 2023 and fiscal year July 1, 2023 to June 30, 2024. The City established a maintenance position for the greenbelt, which became effective in January 2016. Establishing funding for management actions is in compliance with the HMP.

8.2 Recommendations for 2024

The City will discuss with the AMWG recommendations for management actions for 2024 at a minimum of two meetings in 2024. These meetings may be field and/or virtual (web-based) meetings. The AMWG will provide input to the City on actions based on management priorities. The following summary of actions is preliminary and may be revised based on input from the AMWG and available funding.

8.2.1 Coastal Prairie/Santa Cruz Tarplant Management Area

HMP activities for 2024 (Year 11) is the continuation of seasonal cattle grazing within portions of the prairie/grassland. The City will continue to implement the Stocking and Work Program in Area A North and Areas C and D. Cattle may be used for prairie and SCT management purposes in Area A South. Periodic grassland mowing will occur in the southern portion of Area A, concurrent with implementation of the SCT outplanting actions. Management activities will include monitoring plant composition, plant cover and residual dry matter (RDM) within the grazed areas, grassland conditions along the permanent transects, documenting conditions from the permanent photo-stations, and continuing to remove and control high-priority invasive, non-native plant species. The City will consider implementing additional management actions if cattle grazing is delayed and canopy height exceeds the height limits established for the period November through April.

The City will also continue to implement seasonal mowing outside the grazing fences that are to be retained as grassland. A census of the SCT will be conducted in summer/early fall 2024. Naturally-occurring colonies, as well as survival of the 2024 SCT outplanting plots, will be censused. Seed collection of SCT may occur depending on the SCT population and prior approval from CDFW. Plants grown at UCSC Greenhouses are scheduled to be installed within management areas in February 2024. The City will consider implementing additional management actions to encourage SCT seed expression.

As stated in Chapter 5, the early stages of SCT recovery have been successful; however, many habitat management questions remain. The next stage of species recovery needs to determine the management that can maintain and/or increase both the SCT population and its areal extent into the future. There are questions on optimum SCT seedbank density and viability, optimum grassland management techniques, as well as the need for long-term seed collection, plant propagation, outplanting, and direct seeding.

Population Maintenance Seedbank Density

- What is required seedbank density for long-term preservation of SCT on site; how often should SCT outplanting occur to reach desired seedbank density?
- How much seed production is needed each year to maintain desired seedbank density?

Grassland Management for SCT

- Effect of mowing/grazing on SCT population, including how many above-ground SCT plants are needed to maintain (or increase) SCT population, taking into account herbivory and/or plant/seed losses
- Amount of bare ground needed in winter for SCT seed germination
- Optimum cropping height for SCT to increase branching and subsequent flower and seed production
- Evaluate vectors for seed dispersal and SCT establishing outside of planted plots.

8.2.2 Hagemann Gulch Riparian Woodland Management Area

HMP activities identified for 2024 (Year 11) will be to monitor appropriate uses within the gulch concurrent with public use of the trail and bridge. City police will monitor use as per their regular patrol duties within the greenbelt. Invasive plant control measures will be continued, pending funding and staffing.

8.2.3 Arana Gulch Creek Riparian Woodland and Wetland Management Area

HMP activities identified for 2024 (Year 11) will be continued removal and control of invasive, non-native plant species.

8.2.4 AMWG and Public Outreach

In 2024 the City will continue to confer with the AMWG on adaptive habitat management activities throughout the year through scheduled meetings and group email correspondence.

The AMWG will provide recommendations to the City on management priorities, grazing monitoring and public outreach. The City will solicit input from the public on HMP actions through the City webpage and through public input at the scheduled AMWG meetings.

8.2.5 Schedule and Budgeting

Table 19 presents a schedule for the HMP actions scheduled for 2024. The City has allocated funds for fiscal year July 1, 2023 to June 30, 2024 and funding for fiscal year July 1, 2024 to June 30, 2025.

Table 19. Timeline for Habitat Management Actions Proposed for Year 11 (2024)

	2024												2025
Task	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
Coastal Prairie/Santa Cruz Tarplant Management													
Objective1. Santa Cruz tarplant census, measure plant cover and soil moisture; document bare ground (Nov/Dec); outplantings of grown SCT; seed collection.													
Objective 2. Monitor grazing program and variables; implement other grassland management actions (mowing), as needed to control grass height.	✶												
Objective 3. Monitor baseline condition and photo points													
Hagemann Gulch Riparian Woodland Management													
Objectives 1 and 2. Implement IPM Plan and reduce fire hazard													
Arana Gulch Creek Riparian Woodland and Wetland Management													
Objectives 1, 2, and 3. Collaborate with RCDSCC													
Objective 4. Implement removal/control of invasive													

	2024												2025
Task	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
non-native woody plant species and target weeds													
Objective 5. Infrastructure monitoring[13]													
Adaptive Management													
Objective 1. Conduct AMWG meetings													
Prepare Yearly Monitoring Report													
✶ Initiate grassland management actions if cattle grazing does not meet canopy height targets between November and April													

[13] Includes riparian revegetation and implementing year-long maintenance and monitoring.

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Appendix A AMWG Meeting Minutes, 2023

NOTE: Please see the separate Appendix document

A-1: AMWG Meeting Minutes for:

April 18, 2023
November 7, 2023

Appendix B Photo Monitoring

NOTE: Please see the separate Appendix document