Arana Gulch Habitat Management Plan
City of Santa Cruz

Year 5 (2018) 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)

February 15, 2019

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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 and 2016; these actions are described in the Year 1 (2014), Year 2 (2015), Year 3 (2016), and Year 4 (2017) Annual Reports. Actions implemented in Year 5 (2018) are described in this report. The AMWG provided input to the City during the implementation of the Year 5 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 5 (2018), the City continued to focus on improving the habitat 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. SCT seed was collected on-site in summer 2018; under an agreement between the City and the University of California, Santa Cruz (UCSC), the seed will be used to grow plants for seed increase (and future out-planting) and for long-term seed storage. Purple needlegrass seed was collected in summer 2018 and a seeding plot was established in November to increase on-site native plant cover. In addition, the City employed the services of staff, volunteers, and a restoration work crew to remove and control invasive weeds in the Arana Gulch Creek and Hageman Gulch Management Areas. All of these actions taken by the City are to continue progress to meet the HMP objectives. The habitat management activities undertaken in 2018 are summarized below.

Master Plan Improvements

Master plan improvements in 2018 included improvements to the Coastal Prairie Loop Trail. An eroded section of trail was repaired. The Arana Gulch Multi-Use Trail and the Agnes Street Connector Trail, completed in 2013 and 2014, respectively, as well as the Marsh Vista Trail were maintained in 2018.

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. City staff maintained these plantings throughout 2018.

Summary of Coastal Prairie/Santa Cruz Tarplant Management Area Activities

Management actions in Year 5 included seasonal grazing and seasonal mowing. As per a grazing contract and Stocking and Work Program prepared in 2014, the City continued to contract with a local rancher for seasonal grazing. Cattle grazing commenced on January 11 and extended to June 6, 2018. Additional activities in this management area included monitoring plant composition, plant cover, canopy height, and residual dry matter (RDM) within grazed areas, implementing removal/control of invasive weed infestations, and documenting site conditions at previously established permanent photo stations. Cattle-rubbing posts that were installed in 2016, were monitored to see if cattle congregation created bare areas for SCT; a small area of bare ground was found around these posts. Areas where gravel was removed from Area C in December 2016 were monitored for native plant recovery; widely spaced coast tarweed (*Deinandra corymbosa)* continue to colonize these areas in 2018.

Prairie site conditions were documented in April 2018 with plant species composition and cover values recorded at permanent transects. Photo-documentation was also conducted in April. Documentation of the Year 5 conditions, using permanent transects was done in compliance with the HMP. In coordination with the AMWG, sub-management areas were identified to reflect the various plant species composition, as well as presence/absence of SCT, that may direct future management and monitoring. Canopy heights were measured in February, May, and August. Additionally, residual dry matter was assessed in October. The data was collected amid a slightly below average rainfall season.

As per guidelines in the HMP, seasonal mowing was conducted for grassland/prairie areas located outside the grazing fences between January and December (Tarplant Area B) and in June and July (all other areas) to reduce the canopy height of the non-native grasses and forbs to benefit the coastal prairie species diversity and habitat function. A flail mower was used. 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 ensure to maintain some tall grass for birds to hide and nesting as per

recommendations from the Santa Cruz Bird Club. Colonies of native plants were flagged so mowing could avoid these occurrences.

A census of SCT was conducted in summer 2018; 267 SCT plants were found, an increase from 0 plants in 2017 and an increase from 35 plants in 2016. Increasing the SCT population to above the 2006 population level of 349 plants[1] is an HMP goal. The population was recorded at 18 plants in 2013, 4 plants in 2014, and 0 plants in 2015. The 267 SSCT plants in 2018 is still below the HMP target. The areas where SCT were observed in 2018 were subject to cattle grazing. To date, site management has not resulted in the number of SCT meeting the HMP goal; however, there were sufficient number of SCT plants to allow collection of SCT seed. In September, 25 flowering heads, representing 5% of seed output (measured as 5% of flowering heads) were collected. Under an agreement between the City and the University of California, Santa Cruz (UCSC), the seed was delivered to the UCSC Greenhouse. The seed will be used to grow plants for seed increase (for future out-planting) and for long-term seed storage. In September, plant species composition and plant cover in areas supporting SCT was recorded to aid in habitat management. Seven 1-meter square quadrats were established at four SCT subcolonies within Area A; the data found a dominance of exotic annual forbs and exotic annual grasses. Cover by SCT was 8% (all plots).

In December 2018, the City received a research permit from CDFW to collect soil samples from areas that currently or historically support(ed) SCT. Twenty-six soil samples were obtained from Areas A, C, and D and sent to a soil lab for nutrient analysis. The soil nutrient analysis was received and the data was compared to soil data from 2013. Available nitrogen (N) and phosphorus (P) decreased from 2013 to 2018. Soil pH slightly declined. The soil has high levels of manganese (Mn) and iron (Fe).

In compliance with the HMP and an Invasive Weed Work Plan (IWWP) prepared for the management area, City staff continued to remove occurrences of invasive, non-native plant species within the central prairie/grassland. The City continued to remove cotoneaster, Himalaya blackberry, and English ivy from the prairie and removed basal rosettes and flowering stalks from thistles. A large patch of cotoneaster, located near the harbor entrance trail and the Coastal Prairie Loop Trail that was removed in June 2017 was re-treated in 2018.

The City coordinated with the Natural History Museum and, in July 2018, conducted an educational tour with the public to discuss the endangered SCT and plants and animal in the open space. There were 20 participants.

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

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

Pursuant to a survey that mapped occurrences of invasive, non-native plant species within the Hagemann Gulch Riparian Woodland and Arana Gulch Creek Riparian Woodland and Wetland Management Areas, City staff and a contracted work crew removed and controlled occurrences of non-native, invasive weeds in both management area in Year 5. In summer, a contracted work crew controlled large expanses of English ivy (including ivy in the oak trees), French broom, cotoneaster, acacia, pyracantha, and eucalyptus from the management areas. City staff removed patches of ice plant near Arana Creek. The City continued closure of the ad-hoc path along Arana Creek to discourage public access in the natural area. Straw wattles and straw were maintained at the northern end of the trail to reduce the amount of run-off from the Coastal Loop Trail entering Arana Creek.

The Natural History Museum's Earth Steward's Program, a program to teach youth environmental restoration job skills, had two work days with approximately 15 students who helped remove invasive plants from the Hagemann Gulch Riparian Woodland Management 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.

Management Activities Proposed for 2019 (Year 6)

The following management actions are identified for 2019:

- Continue seasonal cattle grazing within the prairie/SCT management area, as per the approved grazing contract and Stocking and Work Program. Additional activities in this management area include monitoring plant composition, plant cover and residual dry matter (RDM) within grazed areas, implementing removal/control of invasive weed infestations, and documenting site conditions at the permanent photo stations.

- Consider implementing interim grassland management actions (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 November/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. In addition, soil salvage areas created near Area C will be monitored for any expression of SCT.

- A census of SCT will be conducted in summer 2019. 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. Consider monitoring soil moisture at occupied SCT sites from summer to winter.

- The City will 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.

- The City will continue to work with the AMWG to form recommendations for improving trail sections to improve walkability and deter new trails from forming.

- The City will continue to confer with the Resource Conservation District (RCD) on Arana Creek watershed management, including measures to reduce erosion and sediment entry into the watershed. The City provides funds to the RCD to apply for grant opportunities to implement erosion control projects.

- The City will continue to confer with the AMWG on adaptive habitat management activities in 2019 through periodic meetings and group email correspondence. The tentative schedule is to hold AMWG meetings in January and June 2019.

- The City will continue to coordinate with the Natural History Museum and conduct educational tours on restoration activities. The Earth Steward's Program will continue to utilize Arana Gulch to teach students environmental restoration job skills. Other opportunities to coordinate with organizations and/or researchers will also be explored.

- The AMWG will finalize recommendations for aligning targets for the prairie, grassland, mixed, and SC tarplant areas.

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 5 (2018) due to the urgency to revitalize the SCT population. The population of SCT at Arana Gulch has varied greatly in response to previous management actions; in some years the population increased and in some years, it dramatically decreased. In 2018, the SCT population increased from 0 plants in 2017 to 267 in 2018. This positive outcome is attributed to site management actions, wherein grass cover has been reduced and more bare ground for SCT seed germination has been created.

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 2018, the AMWG provided input to the City during 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 5th annual report since adoption of the HMP and many objectives of the plan have not yet been realized as the long-term habitat management effort is still in its early stages. 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, and Year 4 [2017] Annual Report) 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 Project Purpose and Report Organization

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 2018 which is considered to be Year 5 pursuant to actions outlined in the HMP and the CDFW 2081(a) permit. The results of a CDFW Research permit received for soil testing in December 2018 are also included in this Year 5 (2018) Annual Report.

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 6 (2019) 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], and Year 4 [2017]) 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 2018. Two meetings were held with the AMWG in 2018; the minutes from the February 16th meeting and August 29th 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 group is currently soliciting resource professionals for additional membership.

The AMWG provided input to the City on habitat management activities within Arana Gulch throughout 2018. 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, interest in soil testing, desire for SCT seed collection, SCT seed storage and increase/out-planting, the desire for recording plant species composition and cover data for SCT-occupied areas, and the size and location of a native grass seeding plot.

3.2 Public Outreach

In 2018 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 2018.

The AMWG 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.

In preparation of the beginning of the grazing season in January 2018, City staff and park rangers spent time on site to discuss the grazing program and the importance of keeping dogs on-leash when they encountered violators of the rule. The City continued to provide a brochure at the entrances to the greenbelt informing the public of why grazing was being implemented and listing safety tips for human/dog and cattle interactions. The brochure was also posted on the City webpage. 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. When cattle were on site in 2018 (January through June), City staff and park rangers provided information to the public on the grazing program through park brochures

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

and on-site conversations. The City coordinated with the Natural History Museum and, in July 2018, conducted an educational tour with the public to discuss the SCT, restoration activities, and overall plant and animal life in the open space.

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 2018, two meetings were held with the AMWG (February and August) 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 the AMWG in 2014. The City and the AMWG began to re-visit prioritization of the HMP management actions in 2018, but this task was not completed. This task will be continued in 2019 and, if completed, the results of this prioritization will be included in the 2019 annual report.

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 (80%) 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 2018, such as seasonal grazing 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 Santa Cruz tarplant with an objective of increasing the number of aboveground SCT to at least the 2006 level (348 plants) by 2016 (first year after grazing). Although management actions are being implemented to increase the number of aboveground SCT, the project has not met this target; however, 267 SCT were observed on site in 2018, which is approaching the goal. 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.

The third adaptive management goal is to develop educational opportunities within Arana Gulch, with efforts to conserve and restore its rare resources. 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 2018, and whether the actions were in compliance with the HMP.

Table 1. Monitoring of Adaptive Management Variables

Objective and Variable	Actions in Year 5 (2018)	Year 5 (2018) 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.	Meeting held February 16th and August 29th	Meeting minutes presented in Appendix A	Yes, two meetings in 2018. Email correspondence was conducted with AMWG members periodically in 2018
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, 2017 to June 30, 2018 and July 1, 2018 to June 30, 2019	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	Data from studies and monitoring were considered by City and AMWG during management decisions	Yes, monitoring of biological variables were conducted as outlined in the HMP. Trends in biological variables were also documented. Management actions were implemented to reach desired variables for SCT (not reached in timescale) and coastal prairie by 2020
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.	City received research permit from CDFW to conduct soil analysis	Soil samples taken in December 2018; data not yet available	Yes, when additional research items are identified, the KMQ framework will continue to be used
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 throughout 2018 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 constructed in 2014. The Marsh Vista Trail, a pedestrian trail located along the east side of Arana Creek, was constructed in 2013. Activities associated with Master Plan improvements are described in this section. The schedule of when master plan improvements were implemented is provided in each section below.

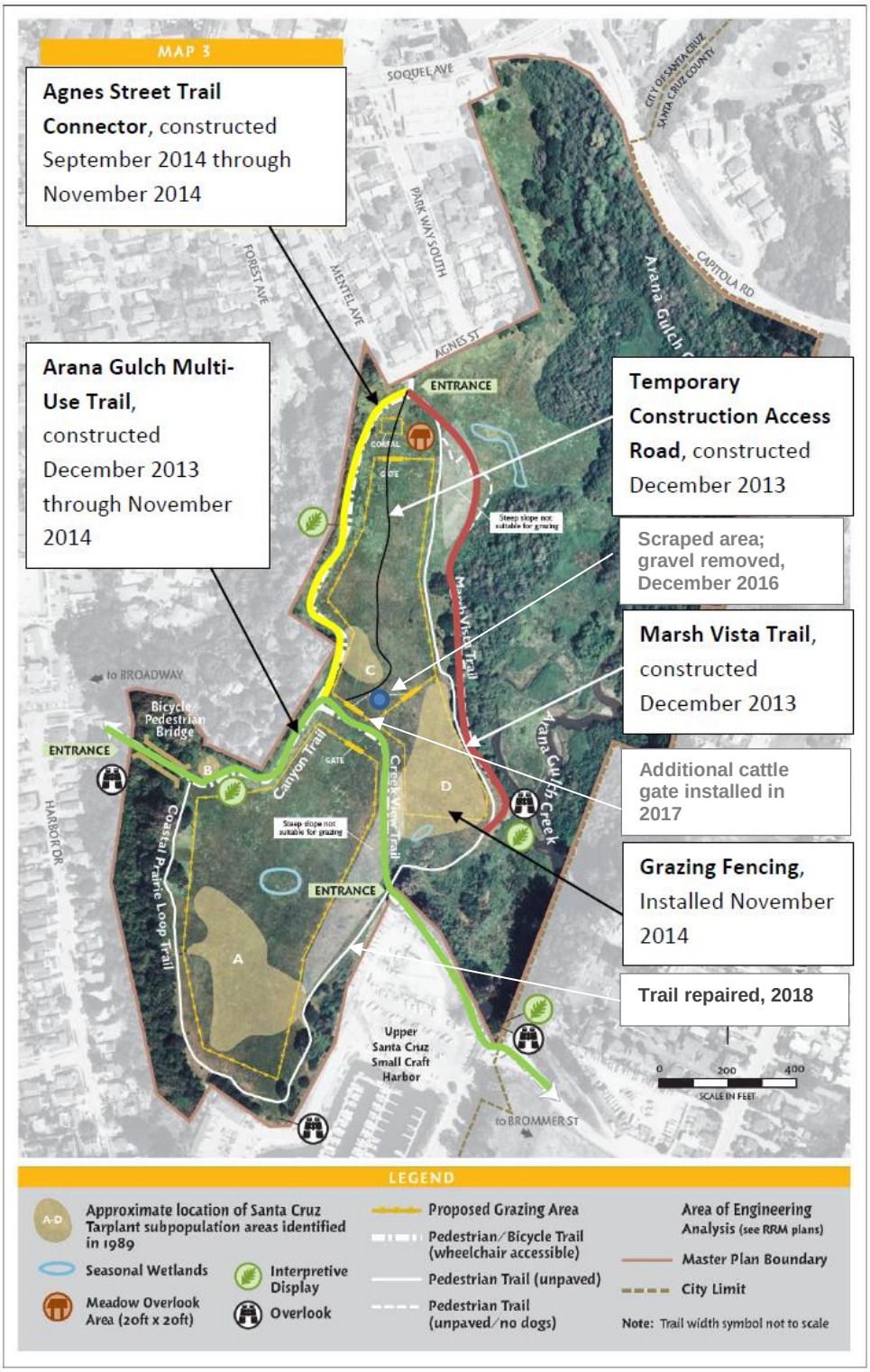
4.1 Multi-Use Trail Construction Areas

A temporary construction access road was used in 2013 and 2014 during trail construction. The area was allowed to naturally revegetate from the existing soil seed bank. The access way is contained within Grazing Area C and was subject to periodic cattle grazing from January through June 2018. Coast tarweed (*Deinandra corymbosa)* colonized this area and surrounding areas. Repairs were made to the Coastal Loop Trail in 2018, as depicted in **Figure 2**. The location of this trail and other master plan improvements is presented in **Figure 3**.

Areas subject to hydromulch and hydroseeding for erosion control as part of trail construction were observed in 2018. No erosion was noted in these areas and no additional seeding was conducted in 2018. An area with construction-related gravel was scraped in December 2016 to remove the gravel; the topsoil was retained and re-scattered in place. The location of the scraped area is depicted in **Figure 3.** Coast tarweed (*Deinandra corymbosa)* was observed in this treated area in 2018.

Figure 2. Repairs to Coastal Loop Trail, 2018

Figure 3. Master Plan improvements, 2013 - 2018



4.2 Multi-Use Trail Soil Salvage Adjacent to Mapped Tarplant Areas

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. The location of the salvage and receiver sites is depicted on **Figures 4 and 5**, respectively.

In 2018, native and non-native plants continued to occupy the Tarplant Area D receiver site, similar to previous year observations. Native species observed included coast tarweed (*Deinandra corymbosa)* and California poppy (*Eschscholzia californica)* as well as non-native species include oats (*Avena spp.)*, cat's ear (*Hypochaeris sp.)*, filaree (*Erodium sp.)*, wild radish (*Raphanus sativus)*, ryegrass (*Festuca perennis)*, and ripgut brome (*Bromus diandrus)*. No SCT was documented from this receiver site in 2018.

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 was salvaged and spread onto areas southwest and northwest of Tarplant Area C. The two receiver areas encompass approximately 2,900 square feet (see **Figure 4**). Details on the soil salvage and soil depths within this placement area are presented in the Year 1 (2015) Annual Report. The location of the receiver sites, as well as data from the November 2014 soil sampling are shown in **Figure 5**.

Figure 4. Location of multi-use trail soil salvage sites, 2013 and 2014

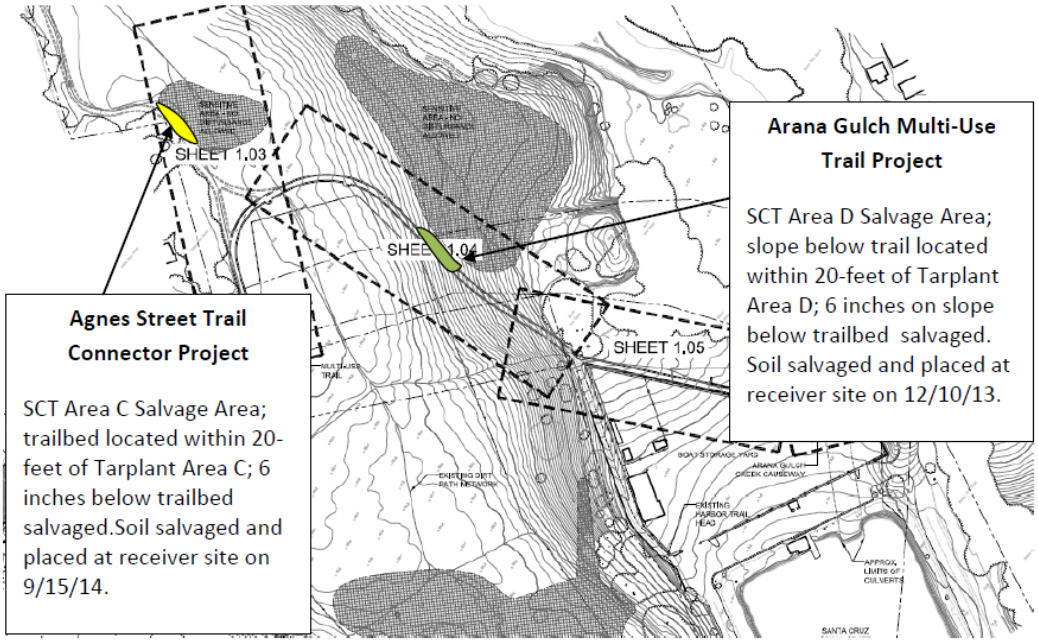
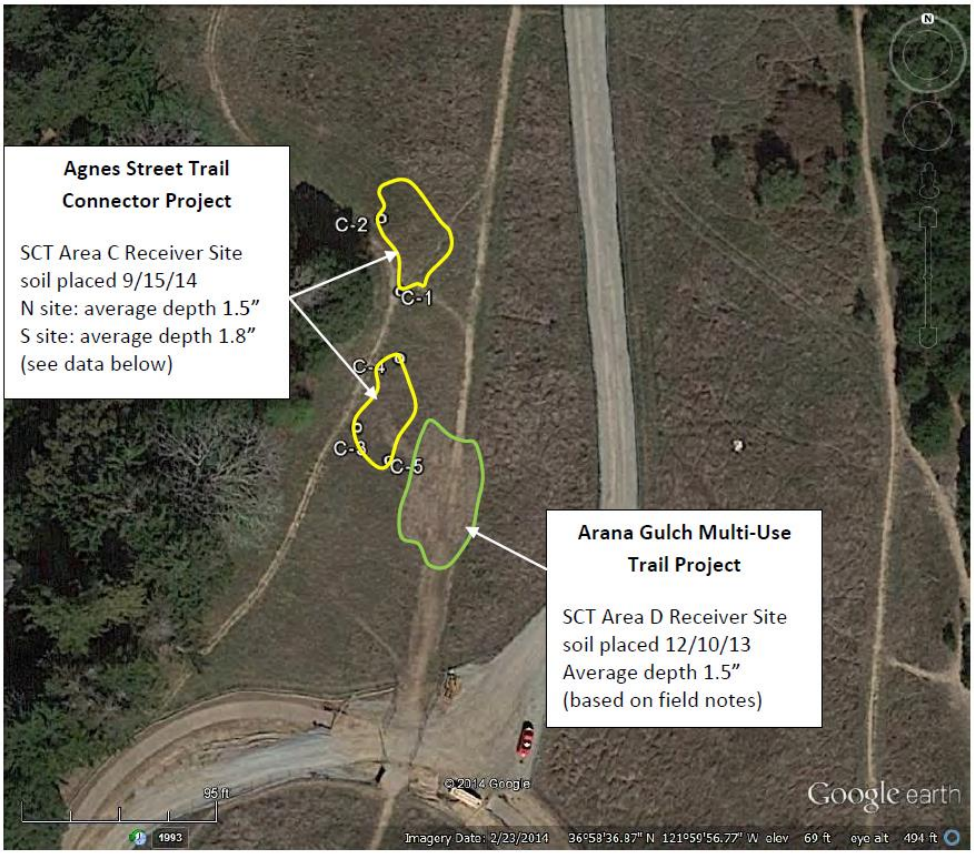


Figure 5. Multi-Use trail soil receiver sites on aerial photo, 2013 and 2014



In 2018, native and non-native plants continue to occupy the Tarplant Area C receiver site. Native species observed included coast tarweed (*Deinandra corymbosa)*. Species typical to the adjacent grassland occur at the site, including hare barley (*Hordeum murinum ssp. leporinum)*, cat's ear (*Hypochaeris sp.)*, filaree (*Erodium sp.)*, and ryegrass (*Festuca perennis)*. No SCT was documented from the receiver site in 2018.

4.3 Natural Recruitment of Native Plants along Multi-Use Trails

The construction of the multi-use trails included removal of soil under the trail's footprint in preparation for trail materials, base rock, and the pervious surface. The excavated soil was taken off-site. Areas in close proximity to the paved trail (i.e., areas within the designated, fenced construction work area) were also disturbed. In spring and summer 2017, field observations of the Arana Gulch Multi-Use trail (east-west trail) construction area documented the presence of naturally establishing native and non-native plant species within the disturbed soil areas. Individuals of the native coast tarweed (*Deinandra corymbosa)* colonized the edge of the trail construction zone; however, over time trail use and soil compaction has occurred and the area appears less suitable for plant growth. Some coast tarweed still persists along the trail. Other plant species also naturally established in the construction area include several weedy, non-native species, such as wild oats (*Avena spp.)* and wild radish (*Raphanus sativa)*. No SCT were observed in these areas in 2018.

Poor drainage along the edge of the 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 monitored these areas during winter 2017/18 and found that they continue to be effective.

4.4 Grazing Infrastructure and Stocking Program

Cattle infrastructure include fences, access gates, water line/water troughs and a temporary holding corral near Agnes Street. In January, per an agreement for cattle grazing with a local cattle rancher, cattle were brought onto the site as per the HMP Grazing Program and Stocking and Work Program. See Section 5.3 for more information on the 2018 cattle grazing program. 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).

5. Habitat Management and Monitoring - Coastal Prairie/Santa Cruz Tarplant Management Area

Activities within this management area are summarized in the following section and include actions as outlined in Section 3.0 of the HMP as well as adaptive management actions recommended by the AMWG. Management actions in 2018 included grazing, perimeter mowing, monitoring of grazing actions, monitoring for SCT, collection of SCT seed, collection and planting of native grass seed, and invasive weed control. City staff implemented most of these tasks. A log of maintenance actions is presented in **Appendix B.** The AMWG is in the process of collecting data on nearby coastal prairie reference sites that may be useful in developing performance criteria for percent cover of native and non-native plants, species richness, and percent cover that is bare ground that will be relevant to site conditions at Arana Gulch. These criteria will be applied to sub-management areas that have been identified. It is anticipated that these criteria will be developed in 2019 by the AMWG and CC and will be used to assess future performance of the coastal prairie at Arana Gulch.

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 SCT population and is one of only 13 populations found in Santa Cruz County (USFWS, 2015). However, the population of SCT has declined precipitously over the last two decades. 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). Each section concludes with a monitoring and performance evaluation of progress toward meeting the goals and objectives outlined in Section 3.0 of the HMP. Proposed actions for 2019 are discussed in Section 5.5.

5.1 Santa Cruz Tarplant

Several management actions for Santa Cruz Tarplant (SCT) were implemented in 2018, as described below.

5.1.1 Management Actions

Management actions for the Santa Cruz Tarplant (SCT) consisted of seasonal grazing of the Areas A, C and D (and surrounding grassland) and seasonal mowing of Area B. Areas A, C, and D were grazed between January 11 and June 6, 2018. Further details on the grazing program can be found in Section 5.3. Area B was mowed or weed-whipped approximately every 2-3 weeks from January through June each time the grass grew more than 8 inches in height. No mowing occurred in July, then the area was mowed in mid-August, September, and October. Raking of grass clippings was not conducted in 2018.

5.1.2 Monitoring and Results

A primary focus for this management area is the recovery of the SCT. The population of SCT at Arana Gulch has declined over the last two decades[5]. 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**). These area designations have remained in use.

5.1.2.1 Census. A census for SCT was conducted by Kathleen Lyons, with Noah Downing. The survey followed guidelines from *Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities* (CDFG, 2009), *CNPS Botanical Survey Guidelines* (CNPS, 2001), and *Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed and Candidate Species* (UFWS (1996). Field surveys to determine the presence/absence of SCT were conducted in June, July, August, and September 2018. This survey period coincided with the blooming period of SCT. A reference population at the Santa Cruz Armory was field checked on June 5; plants at this location were in flower which suggested that the species could be flowering and detected within Arana Gulch. Surveys were conducted by walking the grassland (includes Tarplant Area A, B, C, and D) over multiple days. Meandering walking surveys, which are parallel walking routes spaced 25-50 feet apart, were conducted to detect SCT. Survey days were June 5 and 15, July 2 and 24, August 17, and September 10 and 24 totally 12 survey hours. As per protocol, if a SCT was observed a waypoint would be taken with a handheld Global Positioning System (Garmin 60sce) that would record the plant's patch location. If found, the protocol includes recording patch size, plant height, branching, flowering status, and number of flowering heads per plant. A map showing the survey route(s) is presented in **Appendix C (Item C-1).**

Two hundred and sixty-seven (267) SCT were documented onsite in 2018. This is an increase from 0 plants in 2017 and an increase from 35 plants in 2016, 0 plants in 2015 and 4 plants in 2014. The survey was conducted in a below average rainfall year (17.66 inches), which followed an above-average rainfall year (2017/18) and three seasons of grazing (grazing in winter/spring seasons of 2015, 2016, and 2017).

SCT were found in five patches, all in Area A. **Table 2** presents the number of plants in each patch, the size of the patch, average plant height, and number of flowering heads. **Figure 6** displays the distribution of SCT in 2018. **Figure 7** displays the location of the 2018 plants compared to the historical distribution of the species on site. **Figure 8** displays the population trends at the site from 1996 to 2018.

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

Table 2. SCT Census Results, 2018

Area	Patch #	Size of Patch	Number of SCT[3]	Average Height (in.)	Average Number of Flower Heads	Total Number of Flower Heads
Area A						
	C1[1, 3]	25' x 30'	232	3.14"	2/plant	428
	C2[2, 4]	1' x 1'	1	6.0"	6/plant	6
	C3[2, 3]	2' x 3'	13	2.15"	1.5/plant	19
	C4[1, 4]	3' x 3'	20	2.6"	2/plant	44
	C5[3]	1' x 1'	1	4.0"	2/plant	2
Area A Total			267			499
Area B	-	-	0			
Area C	-	-	0			
Area D	-	-	0			

[1] Colony located at former scrape plot (scrape plot done in October 2011)
[2] Colony located on west side of Area [3] Census conducted on July 24 and August 17, 2018
[4] Census on August 17, 2018

Figure 6. Distribution of SCT, 2018

Figure 7. Distribution of SCT in 2018 and historic occurrence data, 2018

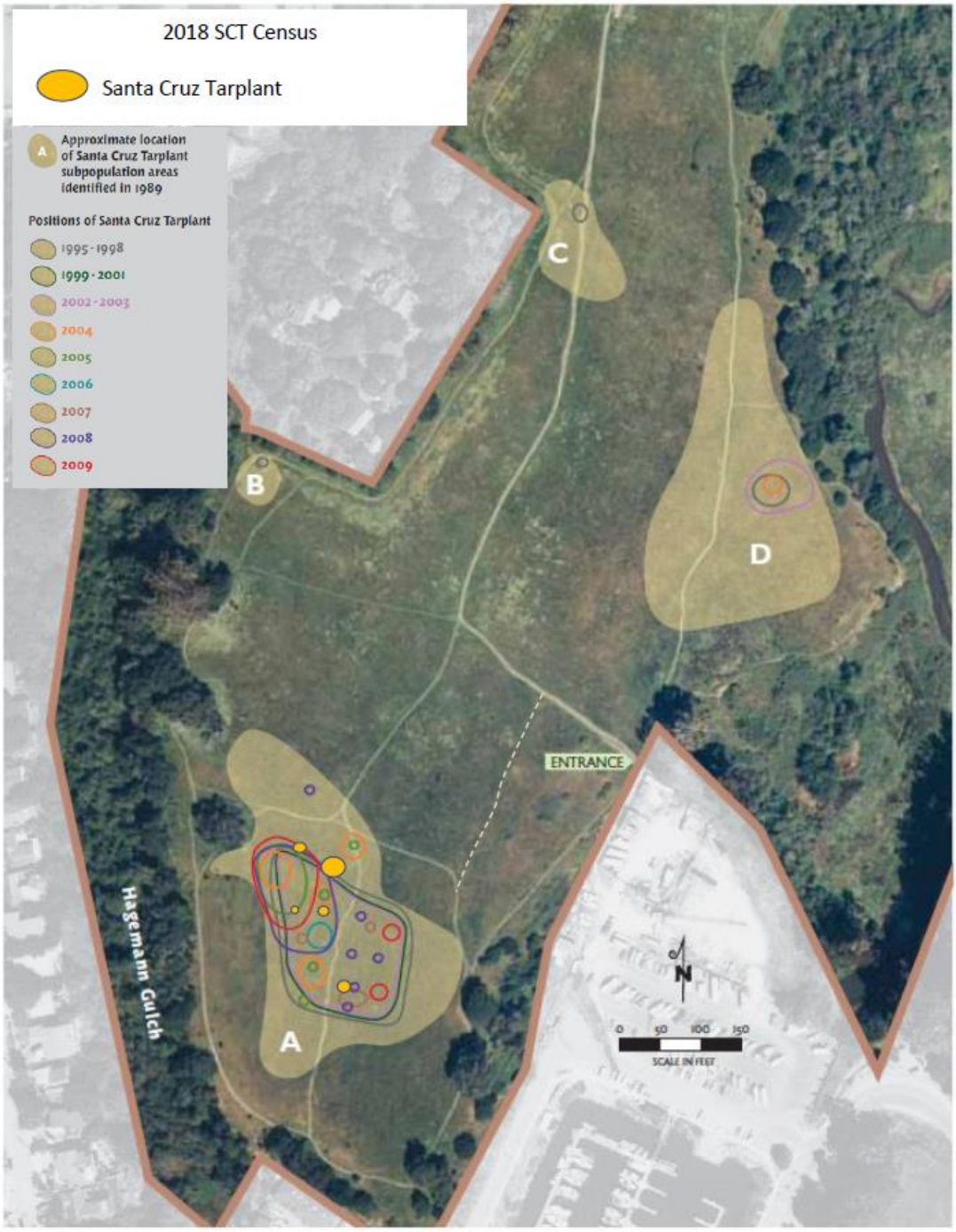
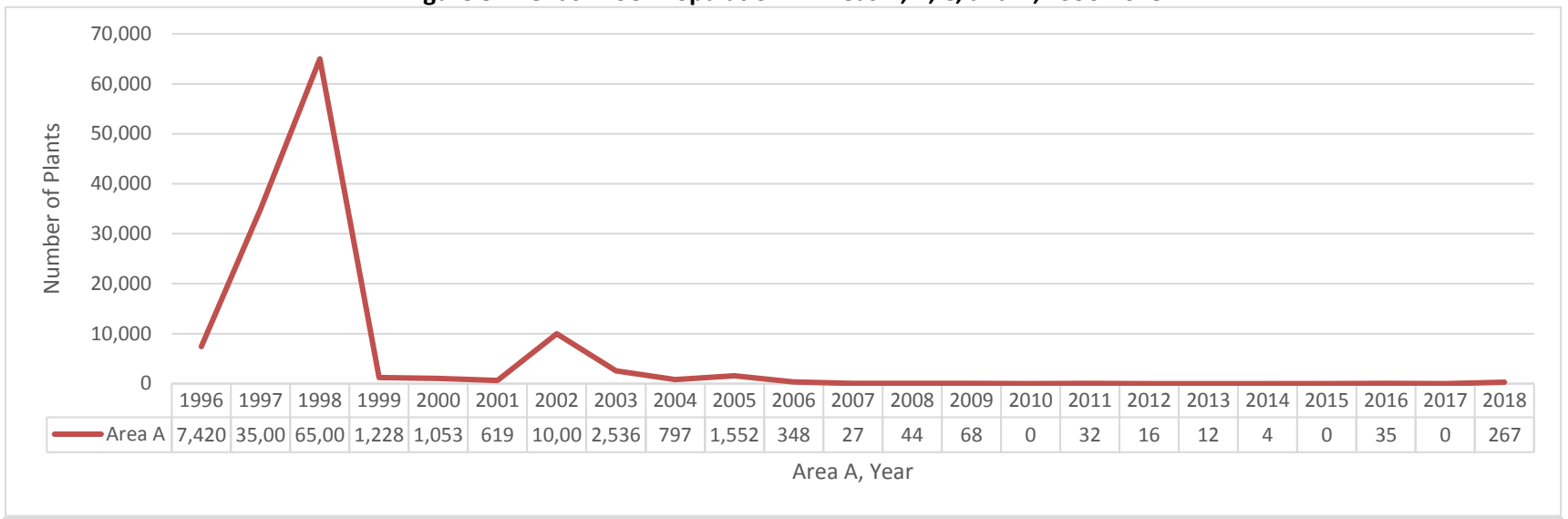
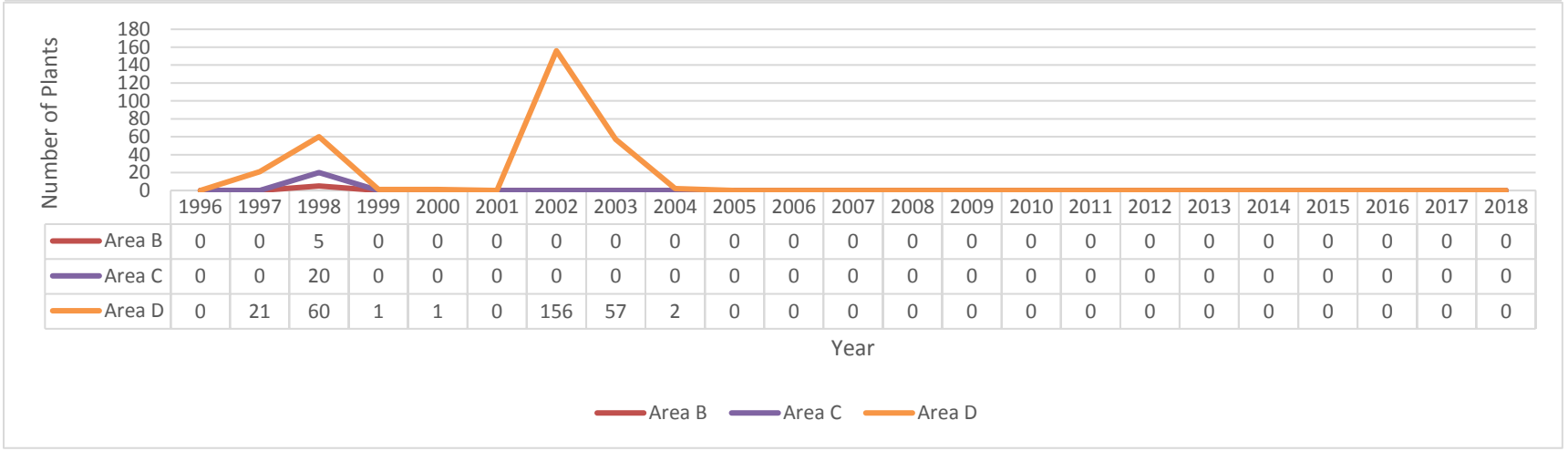


Figure 8. Trends in SCT Population in Areas A, B, C, and D, 1996-2018



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Area A	7,420	35,00	65,00	1,228	1,053	619	10,00	2,536	797	1,552	348	27	44	68	0	32	16	12	4	0	35	0	267



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Area B	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area C	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Area D	0	21	60	1	1	0	156	57	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

5.1.2.2 Seed Collection. SCT seed was collected from the site in September 2018. As per conditions of the City's 2081 permit with CDFW, no more than 5% of seed was collected. Of the 267 SCT plants, 499 flower heads were counted; therefore, 25 flower heads were collected. The flower heads were collected from four patches and from different plants. The SCT seeds were teased from the flower heads, yielding 270 seeds (UCSC Greenhouses, pers. comm.). This material was deposited at the UCSC Greenhouse for contract-growing and long-term seed storage. Under an agreement with the City and UCSC, a portion of the seed will be grown into mature plants for seed increase purposes and/or out planting on-site in 2019.

5.1.2.3 Plant Cover at SCT Patches. Plant cover and species composition was documented at four of the five SCT patches in September 2018. Seven 1-meter square quadrats were used to visually assess absolute plant cover, litter, cattle dung, and bare ground. Plant cover averages 83%. Most plant cover was provided by exotic annual grasses (EAG), primarily ryegrass (*Festuca perennis)* (26%) and rattail fescue (*Festuca myuros)* (7%). Exotic annual forbs (EAF) were dominated by filaree (*Erodium botrys)* (18%) and cat's ear (*Hypochaeris sp.)* (8%). Cover by native species included SCT (8%), blue-eyed grass (*Sisyrinchium bellum)* (0.1%) and California rose (*Rosa californica)* (0.1%). Litter and cow dung each provided 4% cover. Bare ground represented 10%. This information is portrayed in **Figure 9**. A photo of one quadrat sample is presented in **Figure 10**. Photo-documentation of SCT habitat within Area A, between 2011 and 2018 is present in **Appendix C (Item C-2)**.

Figure 9. Mean percent cover of plant guilds and other features at SCT-occupied areas, September 2018

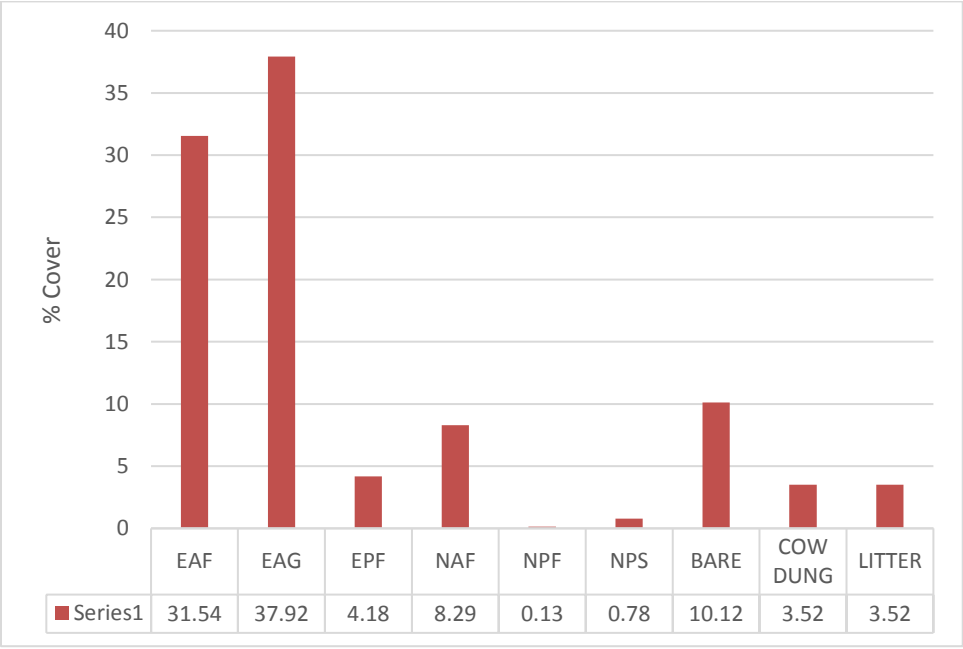


Figure 10. Quadrat sample at SCT Patch C-1, September 2018

5.1.3 HMP Performance Evaluation

The HMP has a goal to maintain a viable SCT population, with objectives to increase the number of above ground SCT to at least the 2006 level (348 plants) in the first year after the return of grazing (i.e., summer 2016) (Objective 1A). As 267 SCT were observed in 2018, the project is approaching this goal; however, it has not yet been attained.

The seasonal cattle grazing that occurred over the past three years (2015/2016/2017) appears to have improved growing conditions for SCT in that the amount of bare ground increased and residual dry matter reduced; and in 2018, coupled with favorable rainfall and temperatures, SCT seed was able to successfully germinate and produce mature, seed-producing plants in 2018. Ground conditions in 2018 were similar to those in 2017; however, in 2017 there was heavy rainfall in January and February, and coupled with cool weather, these conditions may have adversely affected SCT germination and growth in that year.

The HMP has an objective to expand the distribution of SCT beyond Tarplant Area A within three years (Objective 1B). As SCT were only found in Area A in 2018, Objective 1B was not met this year. The 2015-2018 cattle grazing occurred in Tarplant Areas A, C, and D; however, if the seedbank is depleted it could take several years for expansion to occur. Under an agreement with the City and UCSC, a portion of the SCT seed collected from Area A in 2018 will be grown into mature plants for seed increase purposes and/or out planting on-site in 2019, which could include out-plantings in Areas B, C, and/or D.

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) to assessments done every 5 years (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. Future analyses of soil seed bank density will be compared to this baseline to determine compliance with this objective. To maintain a viable seed bank and to guard against an unexpected stochastic event, SCT seed collected from the site in 2018 (seed from 25 flower heads) was deposited at the UCSC Greenhouse for long-term seed storage. Under an agreement with the City and UCSC, collected/grown seed will be routinely stored for species recovery purposes. The stored seed 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.

5.2 Grassland/Coastal Prairie

5.2.1 Management Actions

5.2.1.1 Grassland Mowing. Grassland mowing occurred outside the grazing fences within areas delineated to remain as grassland. The grassland area to be maintained includes all areas within the grazing fences and areas extending to the drip line of the adjacent woodland, as depicted in **Figure 11**. Perimeter fuel break mowing was also identified along the trails.

The City flail-mowed (to approximately 4" height) Tarplant Area B between March and June and again in August - October. The remainder of the site was mowed in June. Mowing was conducted for grassland management purposes (i.e., reduce cover by non-native plants) and also for perimeter fuel break purposes. (Note: Please refer to Section 5.3 for the grazing management).

Using previous year recommendations from the AMWG, perimeter mowing occurred once a year in late May or early 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 on June 5th. No breeding birds were detected in the areas subject to mowing; however, several colonies of locally unique plants along the Coastal Loop Trail were flagged such that mowing would avoid these areas. Plant species flagged include soap plant (*Chlorogalum pomeridianum)*, Mariposa lily (*Calochortus luteus)*, pretty face (*Tritelia ixiodes)*, and California poppy (*Eschscholzia californica)*. The pre-mowing survey results are presented in **Appendix C (Item C-3).** At the time of the June mowing, grass height was estimated to range 1-4 feet, based on pre-mowing visual observations. Flail mowing was conducted as close to bare ground as possible. Areas subject to mowing are depicted on **Figure 12**. Mowing outside the Area D grazing fence is depicted in **Figure 13**.

Figure 11. Delineated grassland, April 2015

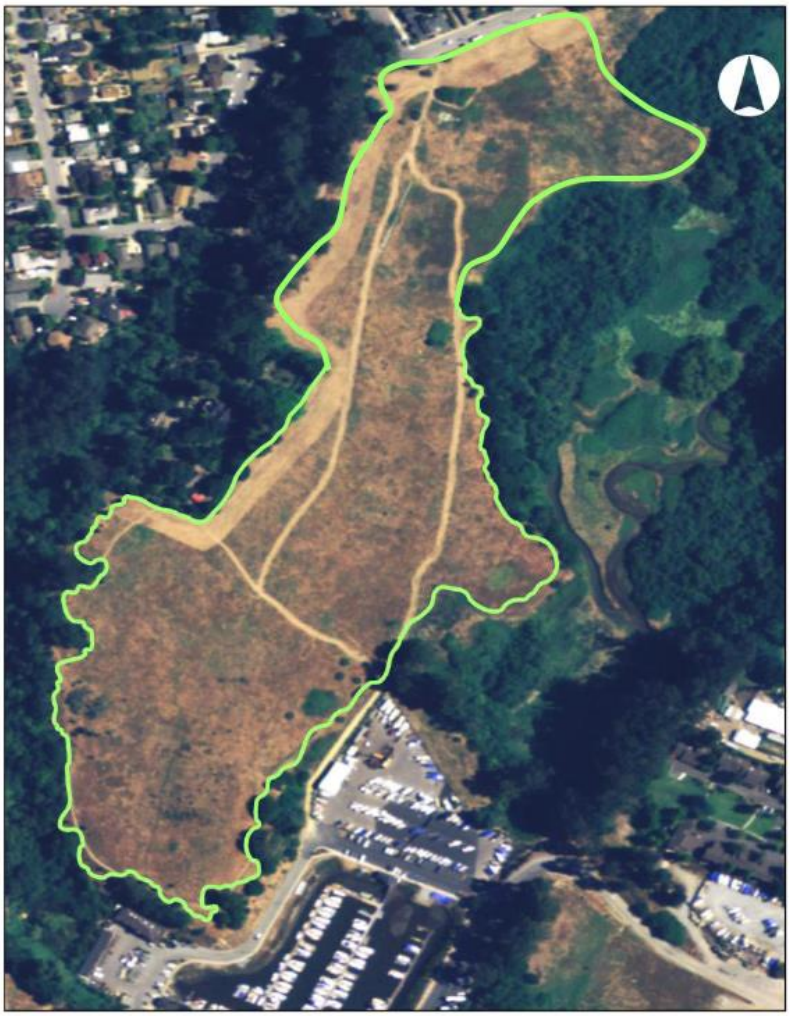


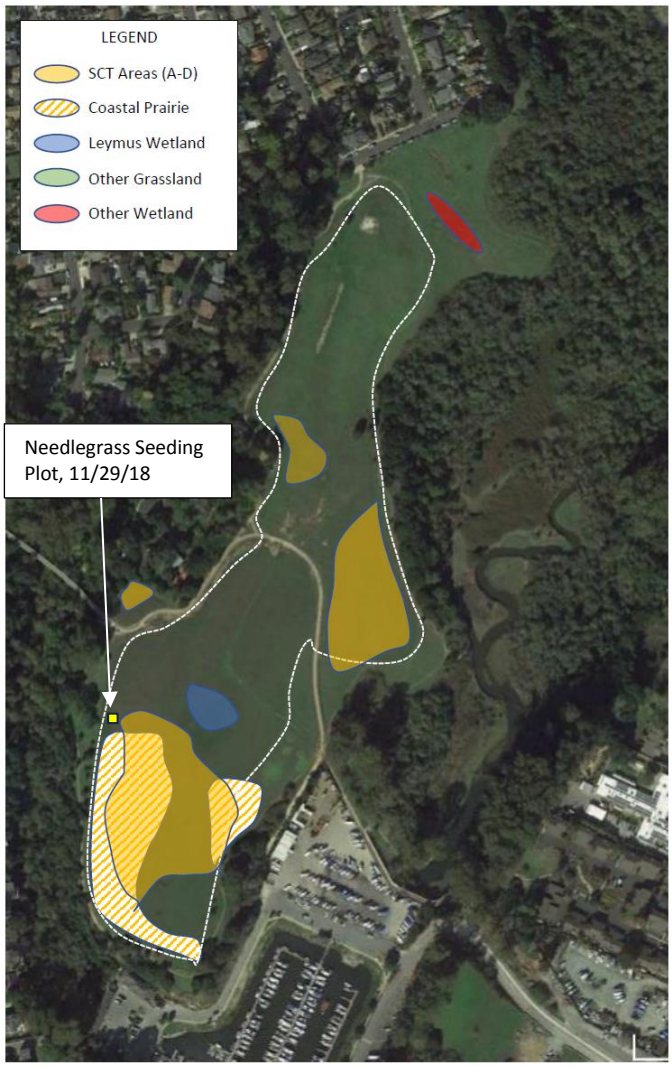
Figure 12. Areas Mowed in 2018

Figure 13. Grassland mowing, June 2018

5.2.1.2 Invasive Plant Removal. In 2018 the City continued to remove woody plant species from the delineated grassland area. Occurrences of cotoneaster *(Cotoneaster sp.)* and Himalaya blackberry *(Rubus ameniacus)* continued to be removed/controlled. In 2018, sprouts of cotoneaster and blackberry were re-treated. A thicket of cotoneaster and Himalaya berry (*Rubus ameniacus)* between the Coastal Prairie Loop Trail and the harbor that was removed in June 2017 was re-treated. The City prevented most thistles from the grazing areas and along the Coastal Prairie Loop Trail from setting seed. This required multiple shovel cutting, weed-whipping, and weed-eating work days from February through September.

In 2017 a grassland sub-management area map was prepared. The map is presented as **Figure 14**.

Figure 14. Sub-management areas in grassland (updated draft)



5.1.2.3 Needlegrass Seeding. In late May and June, seed from purple needlegrass (*Stipa pulchra)* was collected from on-site plants. Approximately 1 pound of seed (with chaff) was collected. Seed was stored in a large paper bag, in a cool, dry condition. No seed pre-treatment was done (USDA, 2010). On November 29th, a 15'x15' plot was established in grazing Area A for seeding of the collected seed. The site was selected due to its close proximity to an established area of needlegrass grassland. The site was raked to remove the existing grass thatch and hoed to reveal bare soil. *Stipa* seed (including chaff and awns) was hand-broadcast onto the site then lightly raked in to improve soil-to-seed contact. The awns were left on to allow it to naturally drill into the ground. Seed was applied at a rate of approximately 25 seed per ¼ meter plot. Seed from 20 seed heads of gumplant (*Grindelia stricta)* growing nearby were also hand broadcast onto the prepared seedbed. The location of the seeded plot is depicted on **Figure 14**. **Figure 15** displays the seeded area.

Figure 15. Seeding purple needlegrass into plot in Area A, November 2018

5.2.2 Vegetation Assessment

The CDP requires annual assessment of the vegetation in the grassland/coastal prairie until the interim success criteria specified in the HMP are met, with continued monitoring every three years, thereafter. Goal 3 of the HMP is to 'Minimize the detrimental effects of high non-native annual grass cover and restore coastal prairie species diversity and habitat function.' There are 5 interim success criteria (Objectives A-E) that address parameters important to the functioning of the coastal prairie and SCT competitive ability including canopy height (A), cover of non-native species (B), cover of native species (C), species richness (D), and bare ground (E). The purpose of the assessment is to characterize vegetation and ground cover conditions in areas that are being grazed under guidance of the Grazing and Stocking Program, discussed in the next section (5.3). These data provide a quantitative evaluation of changes in vegetation condition over time in response to grazing and are useful in informing management actions described in the previous section (5.2.1.) The monitoring methods and results are described below and progress in meeting the specific goals and objectives of the HMP is discussed in the last part of this section (5.2.3)

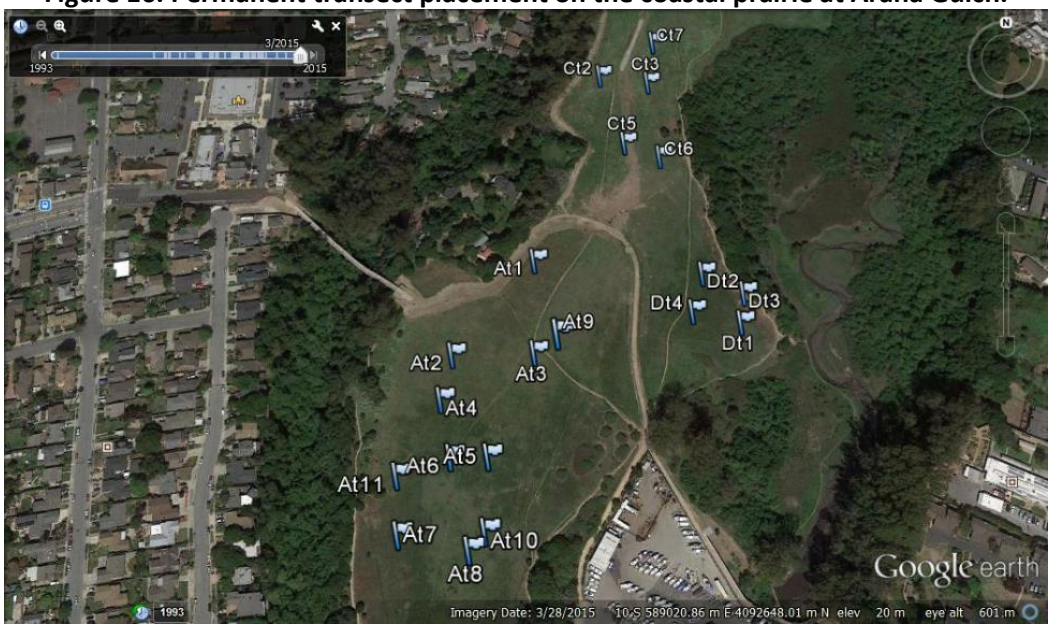
5.2.2.1 Monitoring Methods. The first baseline assessment of vegetation and ground cover conditions in the grassland was conducted in June 2013. Subsequent monitoring has been conducted in April or May of 2014-2018. The spring vegetation assessment has utilized the point intercept method on 25-meter transects to assess changes in plant species cover and ground cover. A total of 25 sample points per transect are recorded to obtain percent cover of each species encountered by the sampling rod. Ground cover (litter, bare, gopher disturbance, basal vegetation, rock) is also recorded. The average height of the canopy layer is measured at the 6, 12, 18, and 24-meter marks using a plastic dinner plate threaded on a wire pin wherein plant height is recorded where the plate comes to rest. Each year 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 transect photos are included in **Appendix C (Item C-3)**. 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 have been permanently marked with rebar posts one half inch in diameter pounded into the ground and fitted with metal rebar caps imprinted with the transect ID. The GPS location of each end has been recorded along with the compass bearing of the transect from the 0-meter end. Many of the rebar and caps have been damaged by mowing (in 2013 and 2014) or by cattle or burrowing animal since the first installation in 2013. Some have been replaced multiple times, but a few have not. The sample points are located each year using GPS and a metal detector.

During the monitoring set-up in 2013, transects were located using a stratified approach with satellite imagery from Google Earth to get a representative sample across the coastal prairie. 11 transects were established in Area A, 5 in Area C, and 4 in Area D, for a total of 20

transects, as shown in **Figure 16**. Preliminary data was collected and a power analysis was conducted using a statistical power calculator (http://www.dssresearch.com/toolkit/sscalc/size_a1.asp DSS Research) to determine the number of transects needed in each enclosure in order to assess a 5% change in percent cover at an 80% power level (with $\beta = 0.2$ and $\alpha = 0.1$, based on standard practice).

Figure 16. Permanent transect placement on the coastal prairie at Arana Gulch.



In 2018, the spring vegetation assessment and photo monitoring was conducted on April 23-25 and canopy height measurements were taken in February, April, and August to capture winter, spring, and summer conditions. Statistical tests were performed using JMP version 14 software (SAS). 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).

Data were tested for normality and equality of variance required of ANOVA using multiple tests with a significance level at p=0.05. When data were normal, change in percent cover was examined using ANOVA with a Tukey's honest significant differences post-hoc test. For non-normal data, a Wilcoxon test was used (called a Kruskall-Wallis test if there are more than two groups). If the variances of the canopy height data were unequal across years, a Welch's test was used. The mean cover values are presented with error bars constructed using one standard deviation from the mean.

Photo Monitoring. Photo points for long-term monitoring were established in April 2015. A total of 15 points were distributed throughout the coastal prairie with two additional points on the Arana Creek Causeway and two on Hagemann Bridge (**Figure 17**). All points were located at either an interpretative sign or a fence corner for easy reference. Four photos were 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 included the revegetation area on the east bank above the culverts. The additional points located on Hagemann Gulch Bridge were taken from both sides of the bridge with a view straight out and looking down into the Gulch. One extra point was taken standing in front of the entry sign at Frederick Street in order to observe the recovery from master plan improvements/ construction activity. Photos are in **Appendix C (Item C-4)**.

Figure 17. Location of photo points for long-term monitoring established at Arana Gulch.

5.2.2.2 Monitoring Results

Precipitation Conditions. During the sampling years, rainfall has been below the long-term average of 30 inches reported for the Santa Cruz area (Western Regional Climate Center) in five of the six years. **Table 3** presents monthly rainfall data from the DeLaveaga Golf Course, located just north of Arana Gulch (data is available from the California Department of Water Resources (DWR) California Irrigation Management and Information System (CIMIS) (see Station 104 at https://cimis.water.ca.gov/WSNReportCriteria.aspx). Precipitation for the 2018 water year was 17.6 inches and is similar to the drought years of 2013 and 2015. The 2017

precipitation total of 55 inches was the second highest amount ever recorded by DWR at this site.

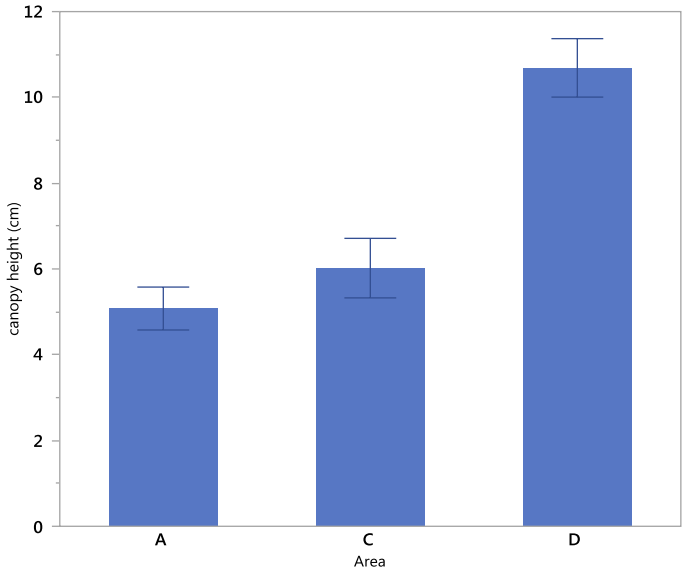
Table 3. Monthly rainfall (inches) at the CIMIS weather station (DeLaveaga) for the 2013-2018 water years.

	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**

Vegetation Assessment. The results below compare the un-grazed conditions in April 2015 to grazed conditions in April 2016, May 2017, and April 2018. Although it is not ideal to use 2015 as a baseline because the vegetation had been subject to 6 weeks of grazing when it was sampled and it was a very dry year, it is the most representative baseline dataset among the three years available (2013-2015). Data from the 2013 and 2014 are presented in the 2013 and 2014 Annual Reports, respectively and are available from the City on request.

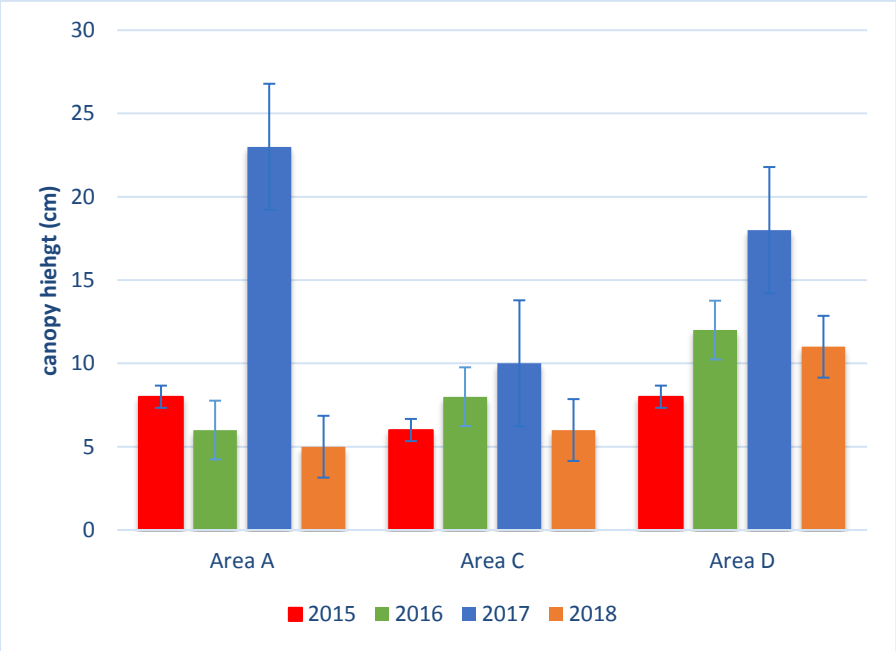
Canopy Height. In the HMP, Objective 3A is to reduce canopy height between the months of November thru April, to 5 to 8 cm (2-3 in). In 2018, canopy heights in February were within the target in Area A and C, but not in Area D **(Figure 18).** The cattle were moved into Area D on February 27th to reduce canopy height.

Figure 18. Mean canopy height (cm) in Area A, C, and D measured in February of 2018. Each error bar is constructed using 1 standard error from the mean



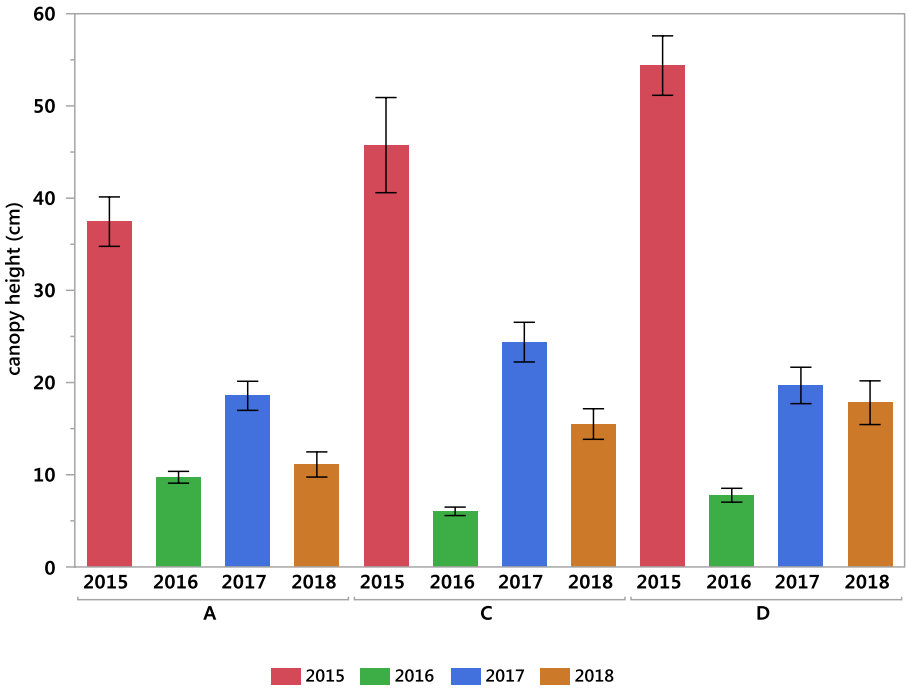
Canopy heights measured in February were significantly reduced in Area A compared to the 2015 baseline, yet are similar to the baseline in Area C and Area D **(Figure 19).** Canopy heights were above the baseline on 2017, which was an above average rainfall year. The 2018 average canopy heights in Area A and Area B were within the target objective of 5 to 8 cm (2-3 in). Area D was above the target height.

Figure 19. Mean canopy height (cm) in Area A, C, and D measured in February of 2015-2018. Each error bar is constructed using 1 standard error from the mean



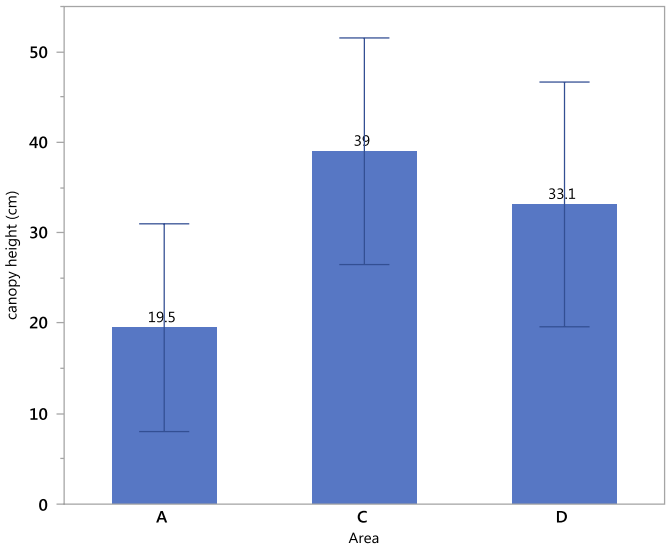
Canopy heights measured in April were significantly reduced compared to the 2015 baseline in the first full year of grazing in 2016 and have remained significantly lower in all three areas in 2018 (Kruskall-Wallis ($p<.0001$) in JMP v14.0) **(Figure 20).** However, the 2018 average canopy heights of 11 to 18 cm (4-7 in) across Areas A, C, and D are still slightly greater than the target objective of 5 to 8 cm (2-3 in). Compared to 2017, canopy heights in 2018 were significantly reduced in Areas A and C, but not in D (Kruskal-Willis, $p<.0001$). Although the cattle were in Areas C/ D for all of March, they had access to both paddocks and likely spent the bulk of the time in the larger space of Area C. Additional cattle were added to Areas C/D on April 17th, less than a week before the monitoring was conducted on April 23-24th. The cattle may need to be confined to Area D for a longer period to reduce canopy height to within target.

Figure 20. Mean canopy height (cm) in Area A, C, and D measured in April of 2015-2018. Each error bar is constructed using 1 standard error from the mean



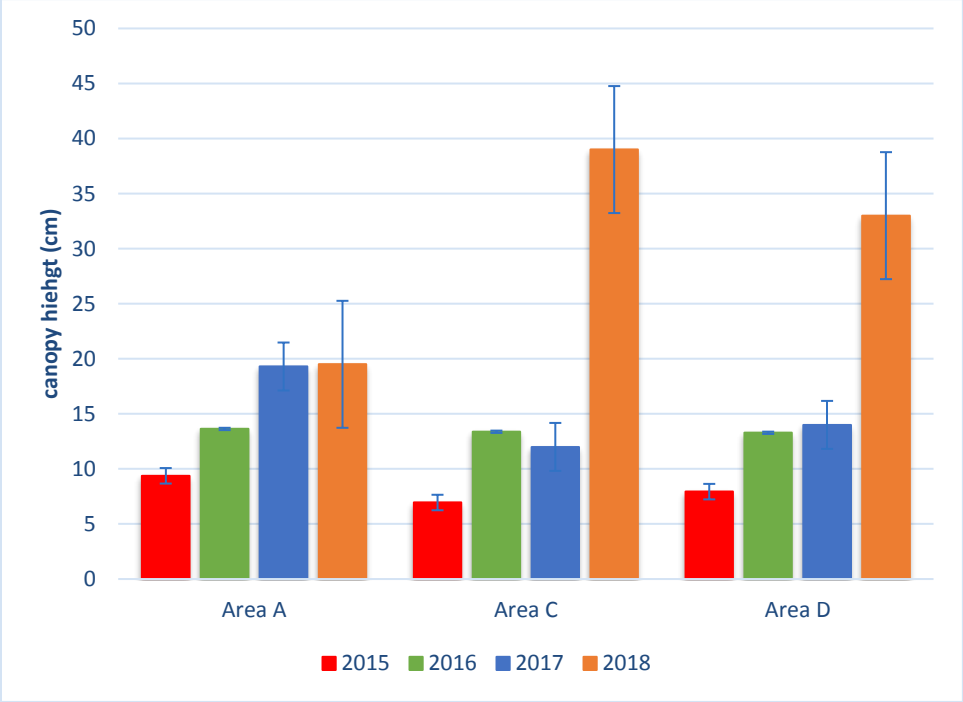
Average canopy heights measured on August 21, 2018 were on average 8 cm (3 in) higher across Area A than they were in April, and were 25 cm (10 in) higher in Areas C and D **(Figure 21)**.

Figure 21. Mean canopy height (cm) in Area A, C, and D measured in August of 2018.



Canopy heights measured in August 2018 area higher in all areas compared to the 2015 baseline **(Figure 22).** This is likely due to seasonal mowing that occurred on site in 2015 (prior to cattle grazing). August canopy in 2017 and 2018 were similar; however, canopy height in Areas C and D was higher in 2018, compared to 2017. The HMP has no target canopy height for August.

Figure 22. Mean canopy height (cm) in Area A, C, and D measured in August of 2015-2018. Each error bar is constructed using 1 standard error from the mean

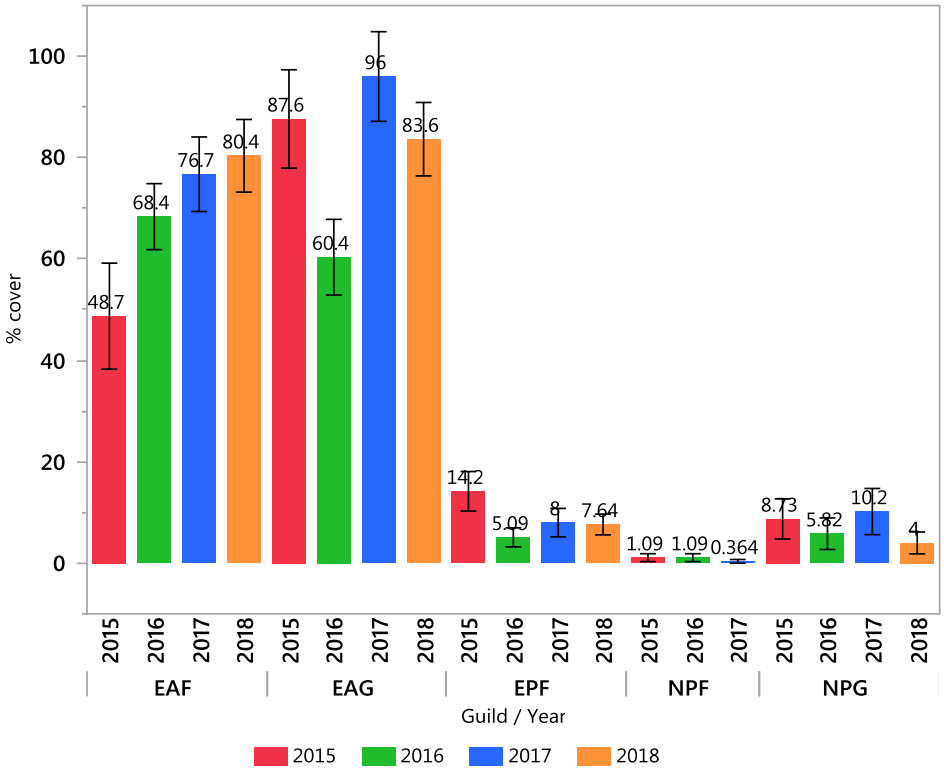


Canopy Cover. Objective 3B is to reduce the cover of non-native species and Objective 3C is to increase the cover of native species. In 2018, across the three areas, non-native plant guilds were not significantly reduced and the cover of native species was not increased, so these objectives were not met.

Exotic annual forbs (EAF) and exotic annual grasses (EAG) dominate the vegetation in Area A **(Figure 23)**. Percent cover of EAF has increased steadily since grazing commenced in 2015, climbing from 48 to 80% in 2018. In contrast, cover of EAG dipped sharply in 2016 due to a sharp drop in the cover of wild oat (*Avena fatua*), but otherwise has remained greater than 80%. Exotic perennial forbs (EPF) have declined, due to declines in English plantain (*Plantago sp.*) and common vetch (*Vicia sativa sp.*). Area A is the only area where native species have been measured with the point intercept method. California poppy (*Eschscholzia californica)*, California oatgrass *(Danthonia californica)*, spreading rush (*Juncus patens)*, purple needlegrass (*Stipa pulchra)*, and California brome (*Bromus carinatus*) have been consistently detected in sampling across the years. Cover of native perennial forbs (NPF),

represented only by California poppy, was 1% or less in 2015-2017, but poppy was not recorded on the transects in 2018. Cover of native perennial grasses (NPG) has ranged from 5 to 10% in 2015-107, but the decline to 4% in 2018 was not significant (Kruskall-Willis p=0.26) likely due to large standard deviations. It is also possible that some of the perennial grasses that were grazed and lacked flower heads may have been overlooked in the sampling in 2018.

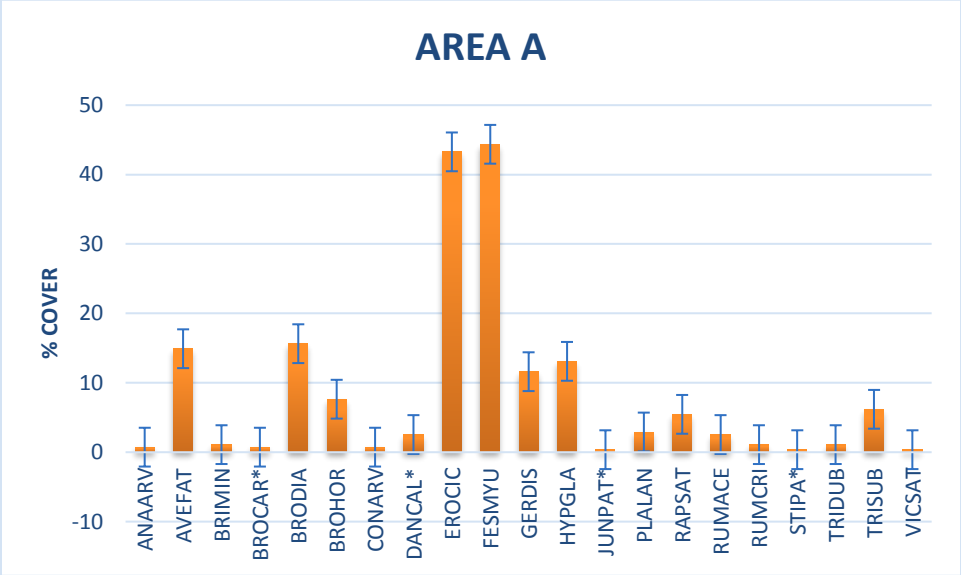
Figure 23. Mean percent cover of 5 plant guilds in Area A in April of 2015-2018. Each error bar is constructed using 1 standard error from the mean.



The transect data from Area A in 2018 was very similar to 2017. In Area A in 2018, cover of 21 species was recorded on the transects with cover values ranging from less than 1 to 43% (**Figure 24**). Native species all had less than 1% cover on the transects, except for oatgrass, which had 2.5% cover. A primary change in individual species cover in comparison to baseline conditions, is that the cover of wild oat, which was 43% in 2015, has remained around 15% since it dropped in 2016 in response to grazing (data not shown). Although the wild oat stayed low, cover of EAG rebounded due to an increase in rat-tail fescue (*Festuca myuros*) from around 30% in 2015/16 to between 44-57% in 2017- 2018. At the same time, cover of cat's ear (*Hypochaeris sp.*), clover (*Trifolium sp.).*, and geranium (*Geranium dissectum*), which were mostly absent in 2015, now have around 10% cover each. The decline in canopy height on the prairie (see Figure 15) has allowed greater light penetration to

the ground and has likely facilitated the overall increase in exotic annual forbs. The very high cover of exotic grasses and forbs likely remains a factor in the low overall species diversity.

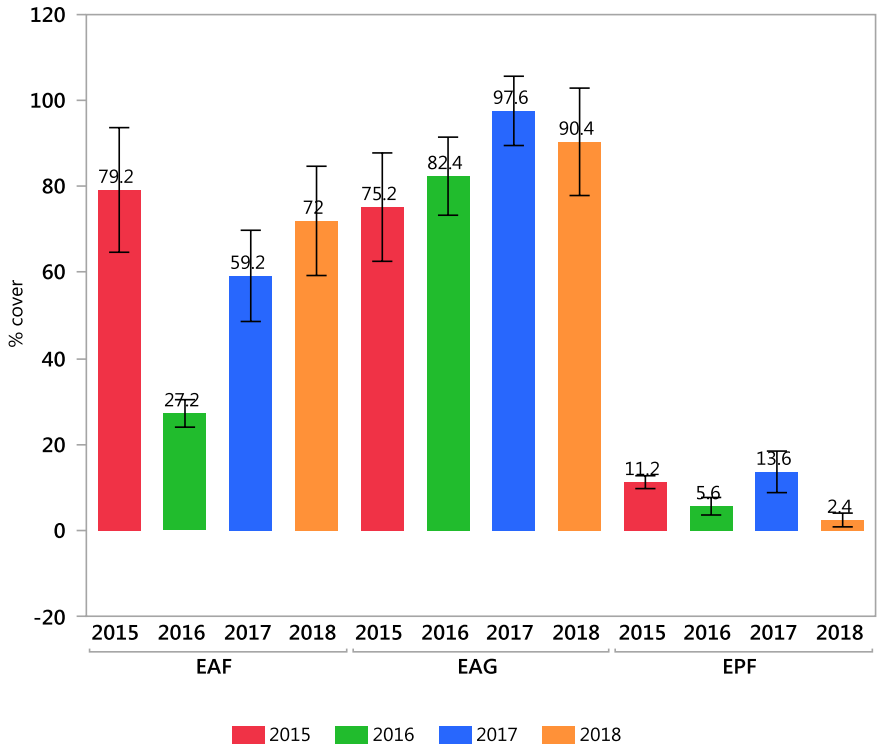
Figure 24. Mean percent cover of all plant species[6] in Area A in April, 2018. Native species are marked with *. Each error bar is constructed using 1 standard error from the mean.



Area C remains dominated by non-native species and native species are still not present in measurable quantities (**Figure 25**). Although the cover of EAF decreased significantly in 2016 after grazing commenced, it has since returned to baseline levels. Cover of EAG has not changed significantly since 2015. Cover of EPF has apparently declined, due to a decrease in common vetch (*Vicia sativa)*, which is the only other species represented in the guild other than Italian thistle (*Carduus pycnocephalus*).

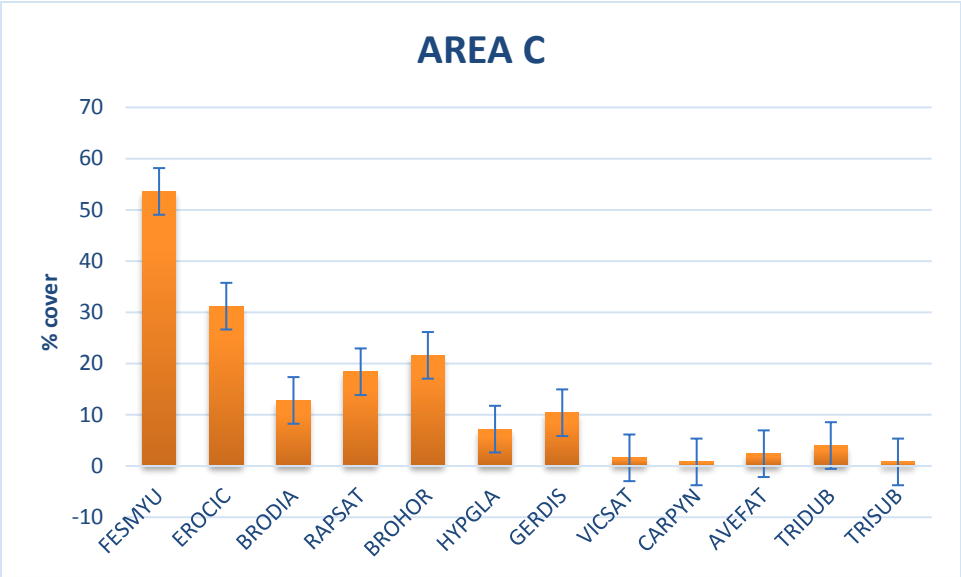
[6] See Table 5 for plant species codes

Figure 25. Mean percent cover of 3 plant guilds in Area C in April of 2015-2018. Each error bar is constructed using 1 standard error from the mean.



In Area C, 12 non-native species were recorded on the transects in 2018 with cover values ranging from <1 to 53 % (**Figure 26**). The average cover of rat-tail fescue (*Festuca myuros)*, which doubled from 21% in 2015 to 40% in 2016, increased even further in 2018, rising from 37% in 2017 to 53% (data not shown). This grass now has the greatest cover in Area C and the thick litter/thatch layer it creates likely remains a factor in the low overall species diversity. The significant drop in cover of EAF in 2016 was due to the decline in cover of wild radish (*Raphanus sativa)* from 58% in 2015 to only 12% in 2016. Wild radish cover has remained low while the average cover of filaree (*Erodium cicutarium*) apparently doubled in 2018, increasing from 15 to 30%.

Figure 26. Mean percent cover of all plant species[7] in Area C in April, 2018. Each error bar is constructed using 1 standard error from the mean.



Area D is also dominated by non-native species and no native species have been measured on the point intercept transects across the sampling years (**Figure 27**). In 2018, only 11 species were recorded on the transects, down from 16 in 2017, with cover ranging from 1 to 72% (**Figure 28**). The cover of EAF has fluctuated. The temporary decline in cover of EAF observed in 2016 was likely due to a significant decline in filaree, however, the species rebounded the next year and cover has remained high. During the monitoring, average cover of geranium has increased from 5 to 18%, so that average EAF cover in 2018 was about 20% greater than the 2015 baseline. Cover of EAG has declined significantly, mainly due to a large drop in wild oat (*Avena sp.)*, which had average cover of 48% in 2015 and only 3% in 2018. Cover of EPF, represented mainly by fiddle dock (*Rumex acetosella)*, has remained similar. Cover of velvet grass (*Holcus lanatus)*, the only exotic perennial grass, increased significantly in 2018.

[7] See Table 5 for plant species codes

Figure 27. Mean percent cover of 4 plant guilds in Area D in April of 2015- 2018. Each error bar is constructed using 1 standard error from the mean.

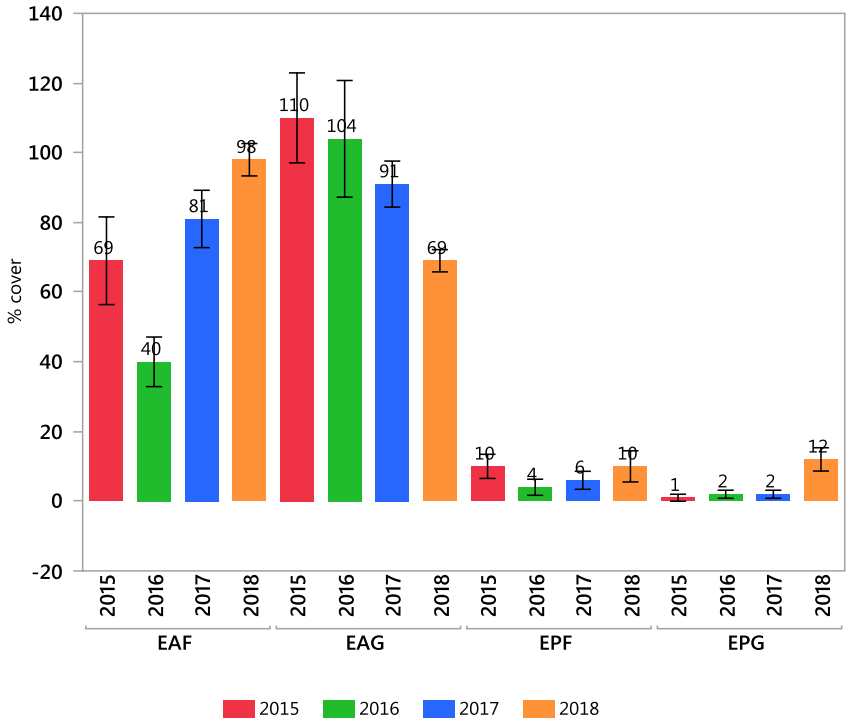
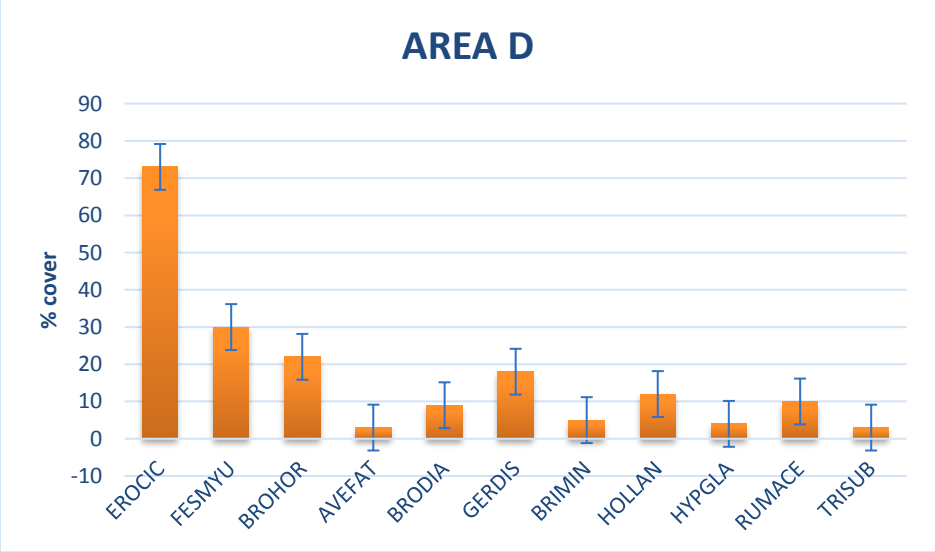


Figure 28. Mean percent cover of all plant species[8] in Area D in April, 2018. Each error bar is constructed using 1 standard error from the mean.



[8] See Table 4 for plant species codes

Species Richness. Objective 3D is to increase native species richness. Baseline species richness across Areas A, C, and D was low in 2015, with fewer than 13 species detected in the belt transect (encompassing 125 square meters) on average (**Table 4**). While total species richness has increased an average of one to five species in all Areas, the increase is due to an increase in non-native species. Native species richness has remained at one in Area A and less than one across the rest of the coastal prairie.

Table 4. Species richness in Areas A, C, and D in sampling conducted in 2013-2018, (with one standard deviation in parentheses).

Species Richness	2015	2016	2017	2018
AREA A				
Total # species/125 m^2	11.2 (3.8)	10.5 (4.4)	12.1 (3.9)	13.3 (3.2)
# Native species/ 125 m^2	1.0 (1.1)	1.0 (0.9)	1.3 (1.0)	1.4 (1.3)
AREA C				
Total # species/125 m^2	7.4 (0.9)	10.5 (2.1)	14.5 (2.6)	12.4 (2.3)
# Native species/ 125 m^2	0	0.8 (1.5)	0	0.4 (.89)
AREA D				
Total # species/125 m^2	12.3 (1.7)	11.3 (2.2)	13.5 (3.3)	13.5 (3.3)
# Native species/ 125 m^2	0	0.8 (0.5)	0.8 (0.9)	0.75 (1.0)

Note: Belt transect encompasses 125 m^2

A total of 42 plant species have been detected in the sampling across the years (**Table 5**). Only 11 native species have been recorded including one tree, two shrubs, three forbs, three grasses, and two rushes. A few other native species have been observed in Area A outside of the sample plots including gumplant (*Grindelia stricta)*, coast sun cups (*Taraxia ovata*), and Santa Cruz tarplant (*Holocarpha macradenia)*. The sun cups may be new since grazing commenced.

Table 5. Plant species detected in Areas A, C, and D in sampling conducted in 2013-2018 (native species are in **bold).**

Scientific Name, TJM 2	Area(s) found	Common Name	Life form	Family	Species Code
Anagallis arvensis	A, C, D	Scarlet pimpernel	EAF	PRIMULACEAE	ANAARV
Avena fatua	A, C, D	Wild oat	EAG	POACEAE	AVEFAT
Baccharis pilularis	A	Coyote brush	Shrub	ASTERACEAE	BACPIL
Briza maxima	A, D	Rattlesnake grass	EAG	POACEAE	BRIMAJ
Briza minor	A, D	Quaking grass	EAG	POACEAE	BRIMIN
Bromus carinatus	**A**	**California brome**	**NPG**	**POACEAE**	BROCAR

Scientific Name, TJM 2	Area(s) found	Common Name	Life form	Family	Species Code
Bromus diandrus	A, C, D	Ripgut brome	EAG	POACEAE	BRODIA
Bromus hordeaceus	A, C, D	Soft chess	EAG	POACEAE	BROHOR
Carduus pycnocephalus	C	Italian thistle	EPF	ASTERACEAE	CARPYN
Cerastium glomeratum	A, C	Mouse-ear chickweed	EAF	CARYOPHYLLACEAE	CERGLO
Cirsium vulgare	A	Bull thistle	EPF	ASTERACEAE	CIRVUL
Convolvulus arvensis	A, C, D	Bindweed	EPF	CONVOLVULACEAE	CONARV
Danthonia californica	**A, D**	**California oatgrass**	**NPG**	**POACEAE**	DANCAL
Deinandra corymbosa	**C**	**coast tarplant**	**NPF**	**ASTERACEAE**	DEICOR
Elymus triticoides	**A, D**	**wild rye**	**NPG**	**POACEAE**	ELYTRI
Erodium botrys	A, C, D	long bill stork's beak	EAF	GERANIACEAE	EROBOT
Erodium cicutarium	A, C, D	red stem filaree	EAF	GERANIACEAE	EROCIC
Eschscholzia californica	**A**	**California poppy**	**NPF**	**PAPAVERACEAE**	ESCCAL
Festuca (Vulpia) myuros	A, C, D	Rattail six weeks grass	EAG	POACEAE	FESMYU
Festuca perennis (Lolium multiflorum)	A, C, D	Italian ryegrass	EAG	POACEAE	FESPER
Geranium dissectum	A, C, D	Cutleaf geranium	EAF	GERANIACEAE	GENMON
Holocarpha macradenia	**A**	**Santa Cruz tarplant**	**NPF**	**ASTERACEAE**	HOMA
Holcus lanatus	A, C, D	velvet grass	EPG	POACEAE	HOLLAN
Hypochaeris glabra	A, C, D	Smooth cat's-ear	EAF	ASTERACEAE	HYPGLA
Hypochaeris radicata	A, C, D	rough cat's-ear	EPF	ASTERACEAE	HYPRAD
Juncus bufonius	**C**	**toad rush**	**NAG**	**JUNCACEAE**	**JUNBUF**
Juncus patens	**A, C, D**	**Spreading rush**	**NPG**	**JUNCACEAE**	JUNPAT
Lactuca serriola	C, D	Prickly lettuce	EPF	ASTERACEAE	LACSER
Plantago lanceolata	A, C, D	English plantain	EPF	PLANTAGINACEAE	PLALAN
Quercus agrifolia	**A**	**Coast live oak**	**Tree**	**FAGACEAE**	QUEAGR
Raphanus sativus	A, C, D	wild radish	EAF	BRASSICACEAE	RAPSAT
Rosa californica	**A**	**California rose**	**Shrub**	**ROSACEAE**	ROSCAL
Rubus ameniacus	A, C	Himalayan blackberry	Shrub	ROSACEAE	RUBARM
Rumex acetosella	A, D	Sheep sorrel	EPF	POLYGONACEAE	RUMACE
Rumex crispus	A, C	Curly dock	EPF	POLYGONACEAE	RUMCRI
Silybum marianum	C, D	Milk thistle	EPF	ASTERACEAE	SILMAR
Sonchus asper	A, C, D	Sow thistle	EPF	ASTERACEAE	SONASP
Stipa pulchra	**A**	**Purple needlegrass**	**NPG**	**POACEAE**	STIPUL
Tragopogon pratensis	A, C, D	Salsify	EPF	ASTERACEAE	TRAPRA
Trifolium dubium	A, C, D	Subterranean clover	EAF	FABACEAE	TRIDUB
Trifolium subterranean	A, C, D	Subterranean clover	EAF	FABACEAE	TRISUB
Vicia sativa subsp. sativa/nigra	A, C, D	common/narrow leaved vetch	EPF	FABACEAE	VICSAT

In Area A, total species richness within the belt transect (encompassing 125 square meter) has ranged from 11 to 13 species, but there has been less than one native species captured per sampling unit in all years 2015-2018 (**Table 6**). The same seven native species including California oatgrass *(Danthonia californica)*, California poppy *(Eschscholzia californica)*, spreading rush (*Juncus patens)*, purple needlegrass (*Stipa pulchra)*, California brome (*Bromus carinatus*), coyote brush (*Baccharis pilularis*), and California rose (*Rosa californica*) have been consistently detected in very low levels across all sampling years.

Table 6. Mean number of species recorded along 25 m transects and detected within a 5m belt transect in Area A (with one standard deviation in parentheses).

Species Richness	2015	2016	2017	2018
# Species per transect	7.6 (2.5)	8.0 (3.4)	9.1 (2.4)	9.1 (2.3)
# Additional species in belt transect	3.6 (2.3)	2.5 (1.8)	3 (1.9)	4.2 (1.8)
Total # species/125 m^2	11.2 (3.8)	10.5 (4.4)	12.1 (3.9)	13.3 (3.2)
# Native species per transect	0.7 (0.8)	0.6 (0.7)	0.9 (0.7)	0.5 (0.7)
# Additional native sp. in belt transect	0.3 (0.5)	0.5 (0.5)	0.5 (0.7)	0.8 (0.9)

Note: Belt transect encompasses 125 m^2

In Area C, average total species richness was 12.4, with non-native species richness of 12 and native species richness of only 0.4 (**Table 7**). Two native species (toad rush Juncus *bufonius* and coast tarweed *Deinandra corymbosa*) were detected in the belt transects in 2018. The coast tarweed has not been previously detected in sampling, although it has been observed in the area.

Table 7. Mean number of species recorded along 25 m transects and detected within a 5m belt transect in Area C (with one standard deviation in parentheses).

Species Richness	2015	2016	2017	2018
# Species per transect	6.0 (1.0)	7.0 (0.8)	9.3 (1.5)	7.75 (1.3)
# Additional species in belt transect	1.4 (0.9)	3.5 (2.6)	5.3 (1.7)	4.6 (2.1)
Total # species/125 m^2	7.4 (0.9)	10.5 (2.1)	14.5 (2.6)	12.4 (2.3)
# Native species per transect	0	0.3 (0.5)	0	0.0
# Additional native sp. per belt transect	0	0.5 (1.0)	0	0.4 (.89)

Note: Belt transect encompasses 125 m^2

In Area D, total species richness across the sampling years has ranged from 11 to 13 species (**Table 8**). The same two native species that have been previously recorded in the belt transects were observed in 2018; spreading rush (*Juncus patens)* and California oatgrass (*Danthonia californica)*.

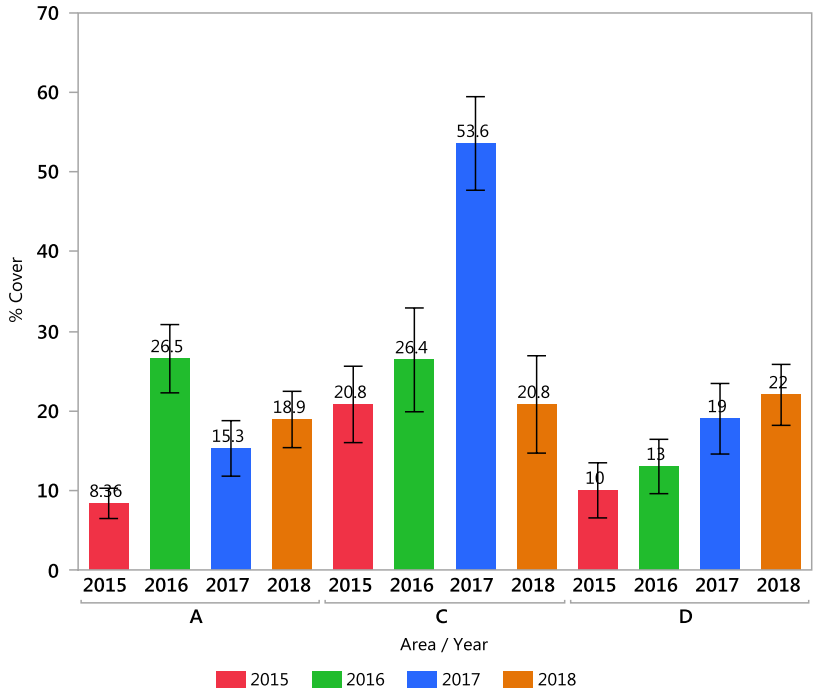
Table 8. Mean number of species recorded along 25 m transects and detected within a 5m belt transect in Area D (with one standard deviation in parentheses).

Species Richness	2015	2016	2017	2018
# Species per transect	8.5 (2.1)	7.8 (1.7)	10 (2.2)	8.75 (2.6)
# Additional species in belt transect	3.8 (1.0)	3.5 (0.6)	3.5 (2.1)	2.25 (1.0)
Total # species/125 m^2	12.3 (1.7)	11.3 (2.2)	13.5 (3.3)	13.5 (3.3)
# Native species per transect	0	0	0	0.0
# Additional native sp. in belt transect	0	0.8 (0.5)	0.8 (0.9)	0.75 (1.0)

Note: Belt transect encompasses 125 m^2

Bare Ground. Objective 3E is to increase the cover of bare ground. This objective has been met in Area A, where the average cover of bare ground has increased significantly since 2015 (**Figure 29**, Kruskal-Wallis p<.05). In Area A, bare ground increased from 8.36% in 2015 to 18.9% in 2018. Measured bare ground cover in Area C increased significantly in 2018 to 54% from 26%, but otherwise bare ground in Area C and has not changed significantly. In Area D, the increase in bare ground from 10% in 2015 to 22% in 2018 is only slightly significant (ANOVA p=0.059), likely due to small sample size and large standard deviations. Conducting additional bare ground measurements in Nov-Dec during SCT germination period may be informative. Cover of litter across the prairie has fluctuated, but there has not been a declining trend (data not shown).

Figure 29. Mean cover of bare ground sampled in Areas A, C, and D in April, 2015-2018. Each error bar is constructed using 1 standard error from the mean.



5.2.3 HMP Performance Evaluation

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

Two objectives address SCT competitive ability. Objective 3A is to reduce canopy height between the months of November thru April, to 2 to 3 inches (5-8 cm). Objective 3E specifies an increase in bare ground to a level that enables SCT to complete their lifecycle. Canopy measurements have been taken in February, April, and August in order to capture winter, spring, and summer conditions. Bare ground is only collected in the April monitoring; however, data was collected in September 2018 at known SCT sites in Area A (see Section 5.1.2.3).

Compared to pre-grazing conditions in 2015, average canopy heights have been reduced in all three areas of the coastal prairie. In February 2018, canopy heights were within the target in Area A and C, but not in Area D. By April, average canopy height had increased by several inches across all areas and were slightly greater than the target by 1-4 inches. By late August, average canopy height was only slightly higher in Area A than in the spring, but was 10 inches higher in Areas C and D.

The objective to increase bare ground has been met in Area A, where the average bare ground has more than doubled since 2015. Bare ground in Area C jumped in 2017 but returned to 2015 baseline levels in 2018. In Area D, bare ground has increased steadily across the years and was more than double the baseline level in 2018. However, the changes are only moderately statistically significant due to the small sample size and large standard deviations. Since the canopy height and bare ground targets were only partially met, conducting an additional measurement of both parameters in November-December during the time that SCT is likely to germinate is recommended.

The other three interim success criteria address species composition and richness during peak production in April. Objective 3B is to reduce the cover of non-native species, Objective 3C is to increase the cover of native species, and Objective 3D is to increase native species richness. Across the prairie, the cover of non-native plant guilds has not been significantly reduced and the cover of native species has not increased since the grazing began, so these objectives are not met. However, changes in species composition have been observed. The most visible change on the prairie is a decline in wild oat, which formed a very tall canopy layer in the first baseline samplings in 2013-2014. The tall-statured wild oat (*Avena sp.)* has declined in all three areas, but rat-tail fescue (*Festuca myuros)* has filled in its place, so overall grass cover has not declined and the thick layer of rat-tail fescue (*Festuca myuros)* continues to contribute to litter build up.

Although grass cover has not declined, the reduction in canopy height and increase in bare ground have likely facilitated an increase in exotic annual forbs such as cat's ear (*Hypochaeris spp.)*, filaree (*Erodium spp.)*, and geranium (*Geranium spp.)*. The response of

perennial non-natives has varied. In Area C, cover of Italian thistle (*Carduus pycnocephalus)* has declined and common vetch (*Vicia sativa)* has also declined, but velvet grass (*Holcus lanatus)* cover increased significantly in Area D in 2018. Higher cattle stocking rates may be needed to reduce non-native cover further. Increasing native species continues to present a greater challenge. In 2018, only five native species were captured in the sampling in Area A and none in Areas C and D. Across all the sampling years, only 11 of the 42-plant species captured in the sampling are native. Anecdotal observations of the grazing area have documented the occurrence of dwarf brodiaea (*Brodiaea terrestris)* and clarkia (*Clarkia purpurea),* but SCT still has not been captured in the transect monitoring.

5.2.3 Soil Testing

In 2018 the AMWG recommended that soil tests be conducted in the grassland/prairie. The soil tests were recommended to determine if soil properties were inhibiting prairie restoration and/or SCT growth. December 2018, the City received a research permit from CDFW to collect soil samples from areas that currently or historically support(ed) SCT. Twenty-six soil samples were obtained from Areas A, C, and D and sent to a soil lab for nutrient analysis. The location of the soil samples is presented on **Figure 30**. Samples were taken at 0-2" and 3-6" depths. Samples were submitted to Waypoint Analytical for nutrient testing. Table 9 presents a summary of the soil sample data. Detailed sample data is presented in **Appendix C, Item C-6.**

Figure 30. Location of soil sample sites, December 2018.

The soil nutrient analysis was received and the data was compared to soil data from 2013. Available nitrogen (N) and phosphorus (P) decreased from 2013 to 2018. Soil pH slightly declined. The soil has high levels of manganese (Mn) and iron (Fe). A summary of the soil sample data is presented in **Table 9**. A comparison of the 2018 data to the 2013 soil sample data is presented in **Table 10**.

Table 9. Summary of soil sample data, December 2018 (26 samples; 13 samples at 0-2" depth and 13 samples at 3-6" depth)

	Area A (10 samples)			Area B (4 samples)			Area C (6 samples)			Area D (6 samples)			Mean (all samples)
	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean	
ORGANIC MATTER													
Available N (ppm)	12	20	13	9	13	12	11	15	12	10	21	14	**13**
NUTRIENTS													
Phosphorus (P) – Olsen	3	7	4	10	19	15	4	8	6	3	5	4	**7**
Potassium (K) (ppm)	42	436	161	237	392	332	166	353	238	74	180	107	**209**
Magnesium (Mg) (ppm)	109	209	157	115	143	130	77	128	109	75	103	87	**120**
Calcium (Ca) (ppm)	587	786	743	532	622	591	553	769	643	459	620	536	**628**
Manganese (Mn) (ppm)	16	35	24	12	19	15	18	24	21	15	22	19	**20**
Iron (Fe) (ppm)	72	253	145	75	108	93	68	184	105	86	146	109	**113**
Boron (B) (ppm)	.08	.16	.11	.07	.09	.08	.08	.13	.10	.07	.10	.09	**0.10**
Nitrogen NO3-N (ppm)	1	6	3	1	3	2	1	7	2	1	10	4	**2.75**
OTHER PROPERTIES													
Ph	4.4	5.0	4.7	4.6	5.3	4.9	4.5	5.5	4.9	4.4	5.2	4.8	**4.8**
Cation Exchange Capacity (meq/100g)	4.2	6.8	5.1	4.5	5.1	4.8	4.1	5.5	4.6	3.0	4.3	3.6	**4.5**
LEGEND[1]		**Very Low**											
		Low											
		Medium											
		Optimum											
		High											

Table 10. Summary of comparison of 2013 and 2018 soil sample data

Summary of Soil Sample Data, 2013 (Sue Bainbridge Study)				Change from 2013 to 2018
	All Sites (56 samples)			
	Minimum	Maximum	Mean	
ORGANIC MATTER				
Available N (ppm)	59	115	86.5	Decrease from mean of 86.5 (optimum) to mean of 13 (very low)
NUTRIENTS				
Phosphorus (P) – Olsen	3	38	13.2	Decrease from mean of 13.2 (medium) to mean of 7 (very low)
Potassium (K) (ppm)	88	467	201.5	Small increase from mean of 201.5 (optimum) to mean of 209 (optimum)
Magnesium (Mg) (ppm)	91	682	137	Small decrease from mean of 137 (optimum) to mean of 120 (optimum)
Calcium (Ca) (ppm)	440	2899	622.3	Small change from mean of 622.3 (medium) to mean of 628 (medium)
Manganese (Mn) (ppm)	N/A	N/A	N/A	
Iron (Fe) (ppm)	N/A	N/A	N/A	
Nitrogen NO3-N (ppm)	3	87	19.3	Decrease from mean of 19.3 to mean of 2.75
Boron (B) (ppm)	N/A	N/A	N/A	
OTHER PROPERTIES				
Ph	4.4	6.2	5.0	Decrease from mean of 5.0 to mean of 4.8 (strongly acidic)
Cation Exchange Capacity (meq/100g)	5.5	23.5	8.5	Decrease from mean of 8.5 to mean of 4.5
LEGEND[1]	**Very Low**			
	Low			
	Medium			
	Optimum			
	High			

1- levels based on soil test ratings, Waypoint Analytical, 2018

5.3 Grazing and Stocking Program

5.3.1 Management Actions

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); 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. Fences, access gates, and other features to support cattle grazing were inspected and maintained throughout 2018.

The City's grazing contractor had cattle onsite from January 11 through June 6. The HMP's original estimate for cattle was 2 to 6 cow calf pairs. However, it became evident during the 2018 grazing season (as with previous 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 2018 grazing season are presented on **Table 11**. At the height of the spring season, a total of 23 cattle were on site. Cattle were first brought onto Area C and D (gate open between areas) on January 11, then on January 15 they were moved in to Area A. In Area C, grass height was 6-12 inches (20 cm). When cattle were moved in to Area A, canopy height in the northern portion of Area A was 6-12 inches (20 cm); however, the southern area was shorter at 2-4 inches (10 cm). Cattle were left in Area A for approximately 6 weeks (until February 27), then they were moved to Areas C and D (gates open between areas). On April 17, 15 cattle were placed into Area A and 8 cattle placed into Areas C and D (gate open). On May 25 the cattle were removed from Area A and all 23 cattle grazed Areas C and D (gate open). Cattle were removed from site on June 6.

As grazing occurred in 2018, 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). In 2016, four wood rubbing posts (4x4's) installed in the grazing area in December to encourage cattle to congregate and create additional bare ground that may be suitable for SCT germination. Small area of bare ground was found around these posts in 2018, yet no SCT was detected in these areas.

Residual Dry Matter. 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 22 by Kathleen Lyons. 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 Pesola gram scale, 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 help calibrate visual estimated 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.

Table. 11. Number of Cattle and Duration of Grazing Season per Grazing Area in 2018

Duration	# of Cattle in Area A	# of Cattle in Area C	# of Cattle in Area D	# of Cattle in Areas C & D (open gate)	# of months grazed	The cattle were 600 lb heifers and steers. AU Conversion (0.6)	AUM	Comments
January 11 to January 15				15	.13	0.6	1.17 AUM Area C/D	Grass height around six to eight inches at start of grazing. Short grazing period to get cattle used to site before moving to Area A.
January 15 to February 27	15				1.43	0.6	12.87 AUM Area A	Kept up with grass height.
February 27 to March 31				15	1.07	0.6	9.6 AUM Area C/D	Moved to C&D to as grass height jumped in these areas.
March 31 to April 17	15				0.6	0.6	5.46 AUM Area A	Moved back to A to continue for remainder of season.
April 17 to May 25	15			8	1.2	0.6	10.8 AUM Area A 5.76 AUM Area C/D	Added more to C&D to keep up.
May 25 to June 06				23	.37	0.6	5.06 AUM Area C/D	Moved to C&D to close out season.

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:

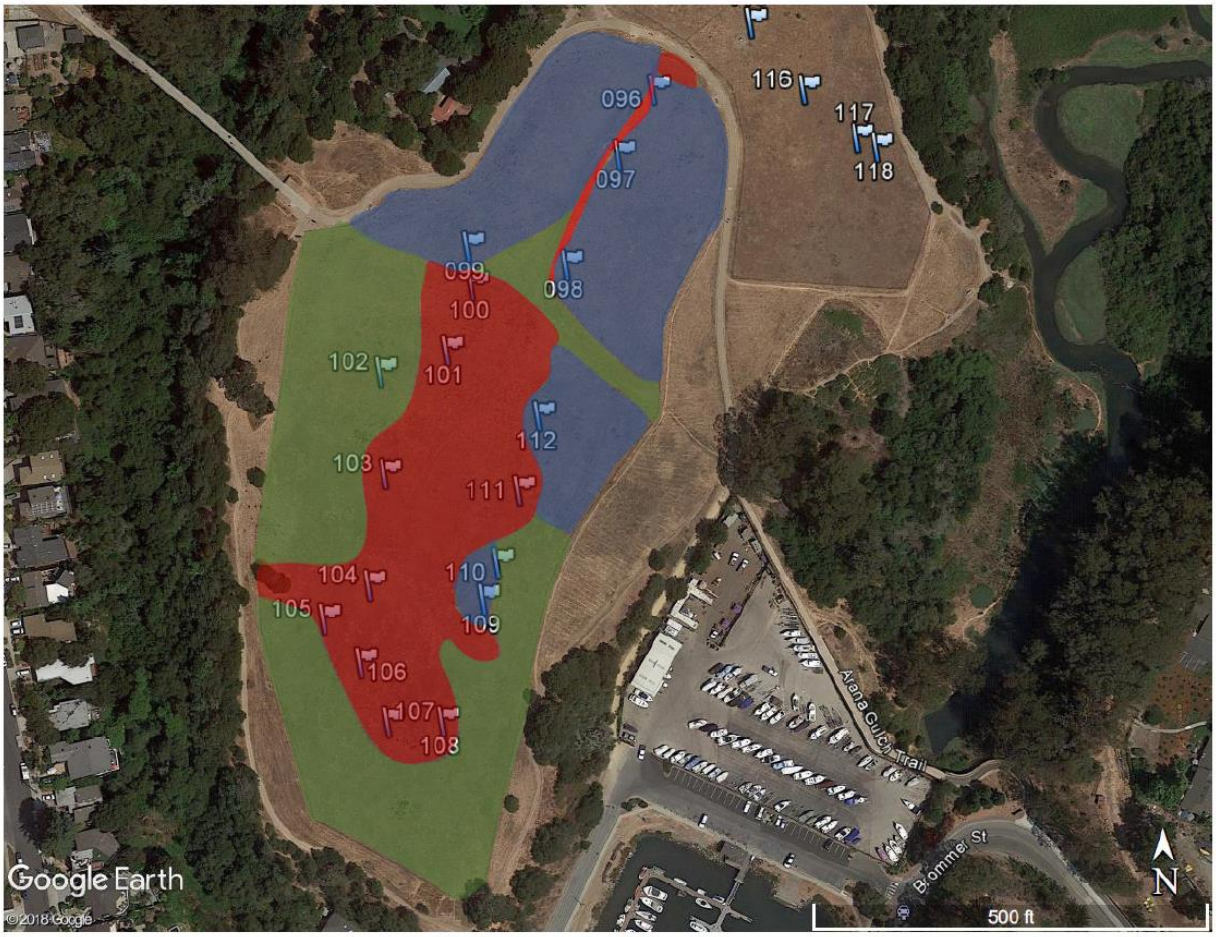
BLUE:	Highest RDM (exceeds objective (>650 lbs./acre)
GREEN:	Middle RDM (meets objective (500-650 lbs. per acre)
RED:	Lowest RDM, below objective (<500 lbs./acre)

5.3.2 Monitoring Results

Residual Dry Matter. In Area A, most of the southern portion of the grazing area was recorded as middle RDM (green, 500-650 lbs./acre) or the lowest RDM (red, <500 lbs./acre) which reflects the effects of seasonal grazing that occurred between February and June. The northern portions of the grazing area had higher RDM values.

At most locations, thatch was not evident as cattle ingested the current and previous year's growth. **Figure 31** exhibits the RDM map for Area A. **Figure 32** displays the RDM map for Areas C and D. **Figures 33, 34,** and **35** show clip plots with highest RDM (>650 lbs./acre), middle RDM (500-650 lb./acre) and lowest RDM (<500 lbs./acre), respectively.

Figure 31. RDM map for Grazing Area A, October 2018



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)

Figure 32. RDM map for Grazing Areas C and D, October 2018

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)

Figure 33. Clip plot of highest RDM (Blue), October 2018

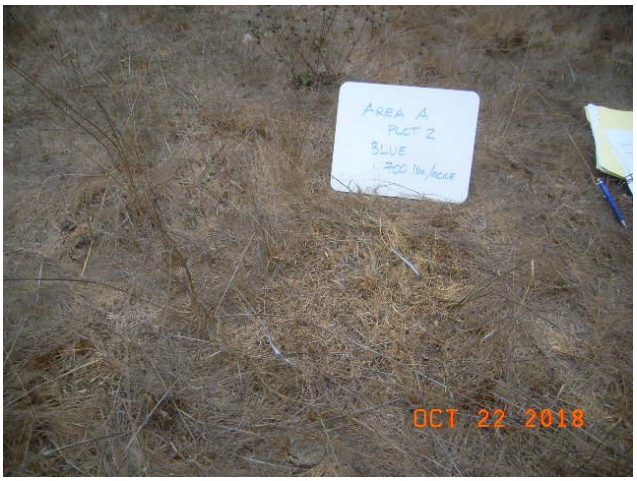


Figure 34. Clip plot of middle RDM (Green), October 2018

Figure 35. Clip plot of lowest RDM (Red), October 2018

5.3.3 Discussion

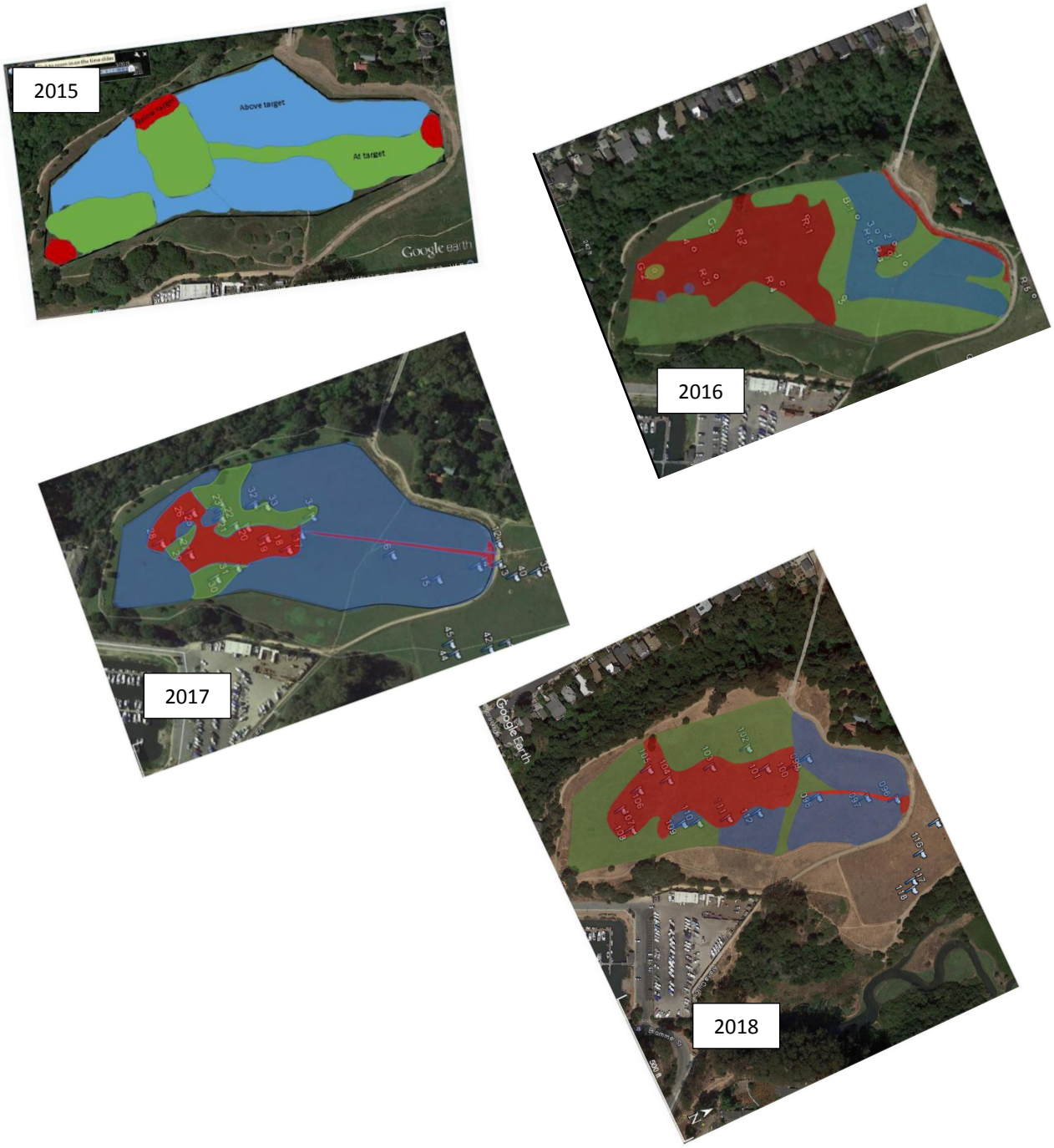
In 2018, cattle grazing significantly reduced canopy height during months the cattle were on site (January – June). When cattle were brought onto Area A in January, canopy grass height in the southern section was visually assessed at 2-4 inches (10 cm), which was within the desired target range for the SCT germination and emergence period. When canopy heights were measured in February, the heights were also within the target.

Compared to pre-grazing conditions in 2015, average canopy heights have been reduced in all three areas of the coastal prairie. In February 2018, canopy heights were within the target in Area A and C, but not in Area D. The cattle were moved into Area D on February 27th in response. By April, average canopy height had increased by several inches across all areas and were slightly greater than the target by 1-4 inches. By late August, average canopy height was only slightly higher in Area A than in the spring, but was 10 inches higher in Areas C and D. The cattle in Areas C/ D often had access to both paddocks, but may spend the bulk of the time in the larger space of Area C, so the cattle may need to be confined to Area D for longer periods to reduce canopy height to within target. Higher stocking rates may also be needed across the prairie to reduce canopy height to within target.

Similar to 2017, once grazing was initiated, the cattle reduced biomass across the prairie and in the process also increased bare ground. Non-native species remained dominant with very high cover, but a few reductions were observed. Percent cover of exotic annual forbs (EAF) has increased since grazing commenced in 2015 to 80% cover (recorded in April 2018); however, cover by exotic annual grasses (EAG) has decreased. Several species with high forage value declined in the sampling, including wild oat (*Avena fatua)* and wild vetch (*Vicia sp.)*. Cover by rattail fescue (*Festuca myuros)* increased in 2018. The lower canopy height from grazing appears to be beneficial to this grass species. Native species cover did not increase, but five natives were found in Area A (similar to 2017).

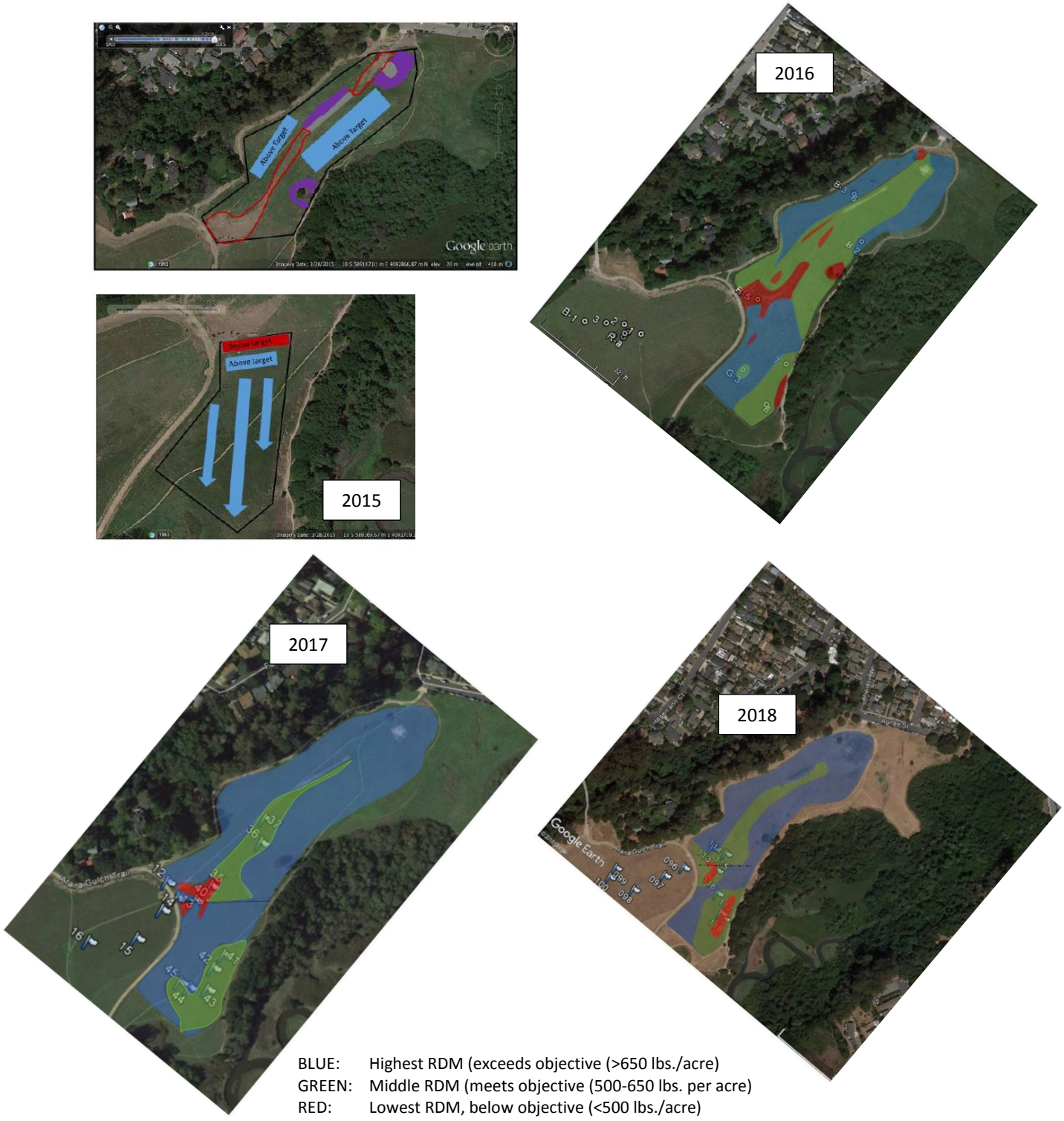
RDM levels decreased in most of the grazed areas between 2015 and 2018, except for some areas that retained high RDM (blue RDM level). A comparison of RDM levels between 2015 and 2017 is presented in **Figures 36** (Area A) and **Figure 37** (Areas C and D).

Figure 36. Comparison of RDM for Area A in 2015 - 2018



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)

Figure 37. Comparison of RDM for Areas C and D in 2015- 2018



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)

Areas of lowest RDM (red) increased in Area A from 2017 to 2018, primarily in the central portion of the grazing area. Green RDM levels were recorded along the edges of the central prairies, corresponding to areas supporting two perennial grasses, purple needlegrass (*Stipa pulchra)*, and California oatgrass (*Danthonia californica)* and one area supporting creeping wild rye (*Leymus triticoides)*. Areas of red RDM levels increased in Area C and D in 2018, primarily along the central area in Area C and the lower bench in Area D.

The large reduction in biomass, canopy height, and RDM across the prairie represents positive progress in improving vegetation conditions. However, Arana Gulch has been highly disturbed for well over one hundred years and returning the prairie to reference conditions, if possible, will take many more years.

5.3.4 Evaluation of HMP Goals

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 2a requires that the grassland achieve residual dry matter (RDM) measurements within a range appropriate for SCT growth. Seasonal grazing was continued in 2018 and many areas of the grazed areas were in the red and green RDM range, thus, the first two objectives have been met.

Observations and BMP implementation monitoring of the grazing program were implemented concurrent with grazing. The protocol for monitoring of the grazing program in 2017 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[9] , were implemented and monitored:

- The AMWG recommended that temporary fencing was not needed around the seasonal wetland within the southern grazing area or its 50-foot buffer. Grazing was allowed in the seasonal wetland area between January and June.
- 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 2018.
- The 2018 grazing season was in a slightly below 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 2018. There were no incidents of cut fence lines during the grazing season. The City and the

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

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 2018. 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 2018 occurred in areas with red RDM levels, suggesting the HMP target for SCT (green RDM level) is too high for SCT establishment and growth. The SCT target RDM may need to be revisited in light of these observations. Some grazing areas were measured at the blue RDM level. Increasing the stock rate or extending the grazing period should be considered to bring these areas into the green RDM level.

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). 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)*, Himalaya blackberry (*Rubus ameniacus)*, and milk thistle (*Silybum marianum).* The IWWP is presented in the Year 2 Annual Report, Appendix B.

In 2016 the City filled a park maintenance position with dedicated hours for Arana Gulch. Park maintenance continued throughout 2018. Maintenance tasks included the continued removal of thistles (*Cirsium sp. and Carduus pycnocephalus)* and re-sprouts of cotoneaster (*Cotoneaster sp.)*, Himalaya blackberry (*Rubus ameniacus)*, and English ivy (*Hedera helix)* from the coastal prairie on the hillside near the Harbor entrance.

In addition, significant maintenance was provided to remove and control thistles from the grassland, including the grazing areas. In spring 2018, thistle rosettes were routinely shovel cut and/or weed-whipped from the grassland. As per the IWWP, the City implemented control actions and if seed heads of thistles were observed, they were cut and disposed of off-site. As thistles (*Cirsium, Silybum,* and *Carduus spp.)* were previously widespread on site, control of these species was a significant effort and the control efforts has significantly

reduced cover by these species. Large thickets of Himalaya berry (*Rubus ameniacus)* in the northern portion of the grassland were also routinely mowed and/or weed-whipped. Occurrences of ivy (*Hedera helix)* and non-native vines were removed/controlled along the western property line. A log of the City's maintenance actions is presented in **Appendix B**.

5.4.2. Evaluation of HMP Goals. 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 2a requires that the grassland achieve residual dry matter (RDM) measurements within a range appropriate for SCT growth. These objectives have been met for some of the management area in 2018 (see **Table 12**).

5.5 Proposed Actions for 2019

The following actions and expected timing are proposed for 2019:

- Continue the cattle grazing program, beginning in January 2019, with grazing extending to June, depending upon presence of SCT flowers.
- Consider implementing interim grassland management actions (i.e., focused mowing or other management) in winter (December – January) 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.
- Monitor grazing operation and implement the HMP-designated BMPs (see Section 3.5.6 in HMP and bullet list above) (January– June 2019).
- Mow or graze all delineated areas (May/June 2019). Conduct pre-mowing surveys for breeding birds and locally unique flora.
- Evaluate and update, as needed, the draft sub-management area map.
- 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)*
- Using soil sampling test data evaluate soil deficiencies that may affect the growth of SCT and other native plant species.
- Review results of needlegrass seeding plot. Collect seed of needlegrass and other native species (i.e., California poppy) in spring/summer 2019 for out-planting in fall 2019 to boost plant species diversity.

- Conduct census for SCT and monitor plant cover at occupied sites; consider monitoring soil moisture during SCT growing period (July/August/September 2019).
- Monitor plant cover, canopy height, species richness, bare ground at permanent transects and compare data to previous years and HMP desired direction of change (April/May 2019).
- Document canopy height three times a year: February, April/May, and August/September 2019
- Document RDM in September/October 2019.
- Document amount of bare ground in SCT areas in November/December 2019 (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. 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.

Table 12. Biological Variables Monitored in Coastal Prairie/Tarplant Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Interim Target Date	Year 5 (2018) 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	267 SCT	No, but increase from 0 plants in 2017. [10]
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	SCT limited to Area A	No
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 in 2018	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; areas were at target, yet several areas above target	Yes, some areas were above target; SCT detected in target and below target areas

[10] HMP acknowledges that number of aboveground SCT is not likely to increase until after grazing program is implemented; SCT increase from grazing may not be fully detected for several seasons.

Table 12. Biological Variables Monitored in Coastal Prairie/Tarplant Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Interim Target Date	Year 5 (2018) Results	Objective Met?
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. – April) from the baseline level to 2-3 inches[11] by 2015	Average canopy height	3x during growing season	Reduction	2015	Canopy heights were at target in February and April in Area A; other areas above target.	Partially, cattle grazing reduced canopy height in Area A and portions of Area C.
Objective 3B. 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	There was continued decline in the cover of EAG in Area A, yet increase in EAF Total non-native cover was well above 100% in all 3 areas.	No, cattle grazing reduced cover of some non-native plant guilds and a few select species but total cover remains very high and non-native species dominate the plant communities.
Objective 3C. Increase cover of native species from baseline levels to one more representative of a reference functioning coastal prairie system by 2020.	Percent cover of native plants	Yearly at peak growth in April	Increase	2020	Cover of native species remains at <1%. Reference systems have range of 20-40% cover as per Holl and Reed (2010), Hayes and Holl (2003).	No, cover of native species has not increased significantly and native plants are encountered very infrequently. Native grass revegetation plot implemented in 2018
Objective 3D. Increase native species richness from baseline levels to one more representative of a reference functioning	Native species richness	Yearly at peak growth in April	Increase	2020	11 native species including one tree, two shrubs, two forbs and six grasses have been detected in the sampling across Areas A,	Yes, meeting trend of increased native species richness; coast tarplant and toad rush were

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

Table 12. Biological Variables Monitored in Coastal Prairie/Tarplant Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Interim Target Date	Year 5 (2018) Results	Objective Met?
coastal prairie system by 2020.					C, and D. Reference systems have a range of 4 to 21 species as per Holl and Reed (2010), Hayes and Holl (2003).	detected for the second time since 2016.
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	Average cover of bare ground increased in Areas A, C and D	Yes, meeting trend of increased bare ground in Area A, C and D.
	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.	Yes, photo points were re-sampled in 2018
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 and then assessed every 5 years.	Seed bank density (#of viable ray achenes)	Yearly	Increase	2015	No viable seed in Areas B and C; viable seed found in Areas A and D	N/A, baseline determined in 2015 and will be reassessed every 5 years; SCT collected ad deposited at UCSC Greenhouses for plant propagation, seed increase, and seed storage.

6. Habitat Management and Monitoring - 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, consistent with Goal 5 of the HMP and 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 completed in 2017.

In 2018, the City removed and controlled occurrences of invasive, non-native plant species. Volunteers, City staff, and contractors were used for this work.

6.1 Management Actions

6.1.1 Bridge Construction Project

Management actions associated with the bridge construction project were in place until the completion of bridge construction, which was December 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 bridge project. This plan was contained in the Year 1 Monitoring Report. The plantings, six native California roses (*Rosa californica)* will be planted near the eastern bridge abutment in early 2018.

6.1.2 Integrated Pest Management (IPM)

The extent of invasive plant species was mapped in the management area in 2017. The following species were identified in the gulch: eucalyptus (*Eucalyptus sp.)*, elm (*Ulmus sp.)*, poplar (*Poplar sp.)*, privet *(Ligustrum sp.)*, English ivy (*Hedera helix)*, Cape ivy (*Delairea odorata)*, nasturtium (*Tropagaluem majus)*, Himalaya berry (*Rubus ameniacus)*, French broom (*Genista monspessulana)*, poison hemlock (*Conium maculatum)*, Monterey pine (*Pinus radiata)*, cotoneaster (*Cotoneaster sp.)*, and *Prunus*. The distribution of invasive plant species is depicted on **Figure 38**.

In 2018, occurrences of invasive, non-native plant species were removed from the management area. Occurrences of English ivy, French broom, Monterey pine, and cotoneaster were removed. Areas treated are depicted on **Figure 38**. The Natural History Museum's Earth Steward's Program, a program to teach youth environmental restoration job skills, had two work days with approximately 15 students who helped remove invasive plants from the Hagemann Gulch Riparian Woodland Management Area.

6.1.3 Fire Hazard

No management actions were implemented in 2018; however, the invasive plant removal reduced cover by invasive, non-native plant species which reduced the fire hazard within the areas treated.

6.1.4 Wildlife Protection

Prior to construction of the bridge over Hagemann Gulch, measures were implemented to avoid impacts to wildlife. These measures were completed in 2014. No additional management actions were implemented in 2018.

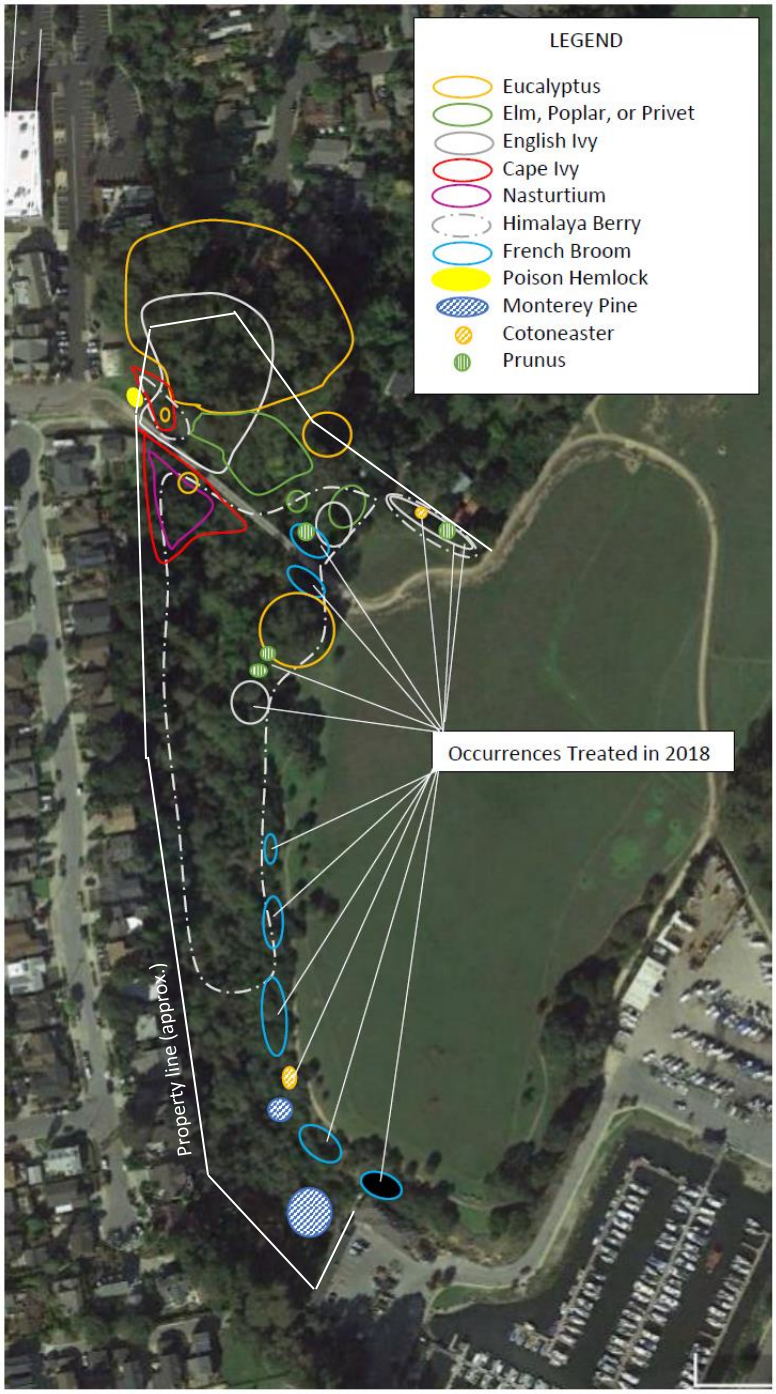
6.1.5 Appropriate Uses in Hagemann Gulch

Rangers 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. Branches were placed to block areas that appeared to be used for unauthorized access to the riparian area.

6.1.6 Rose of Castille Bushes

The "Rose of Castille" bushes located near the Hagemann Gulch bridge construction area were relocated to City Hall in 2013, in consultation with the City Arborist. The roses receive regular maintenance and care and are thriving in their new location. Staff has decided that adding interpretive signage is too risky and may lead to vandalism or theft. The potential risks to the plants outweigh the educational benefits from the signage.

Figure 38. Distribution of invasive plant species, Hagemann Gulch Management Area, October 2017 and Areas Treated in 2018



6.2 Monitoring and Performance Evaluation

6.2.1 Monitoring Methods

Areas where invasive, non-native plant species were documented were monitored after treatment and invasive maps were updated.

6.2.2 Monitoring Results

The invasive plant species map was updated to show occurrences of invasive, non-native plant species that were removed in 2018.

6.2.3 Evaluation of HMP Goals

Table 13 presents a summary of the biological variables monitored, the Year 5 (2018) 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). The City allocated funds in 2018 for this task; and thus, these objectives were met. Removal and control of invasive, non-native plant species was implemented in 2018.

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 2017 City park rangers routinely 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 2019

The following actions and expected timing are proposed for 2018:

- Monitor appropriate uses within Hagemann Gulch through periodic City ranger patrols (January– December 2019).
- Install six California rose (*Rosa californica)* as part of riparian revegetation plan; maintain plantings throughout year with weeding and supplemental irrigation; monitor plant survival (winter 2019).
- Continue to remove and control invasive, non-native plant species within the management area.

Table 13. Biological Variables Monitored in Hagemann Gulch Riparian Woodland Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 5 (2018) 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	Thickets of French broom, cotoneaster, and	Partial compliance; non-native thickets have been

Table 13. Biological Variables Monitored in Hagemann Gulch Riparian Woodland Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 5 (2018) Results	Objective Met?
				pines removed in 2018	controlled along Coastal 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

Table 13. Biological Variables Monitored in Hagemann Gulch Riparian Woodland Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 5 (2018) 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 rangers and maintenance staff periodically inspected the area in 2018; 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. Habitat Management and Monitoring - 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. Consistent with Goal 3 of the HMP, the City continued to work with the Resource Conservation District of Santa Cruz County (RDCSCC) on measures to implement habitat enhancement actions within the Arana Gulch watershed. In addition, the City continued in implement a plan to reduce the non-native understory in the management area. City staff and contractors removed invasive weeds from several areas of the management area in 2018, consistent with Goal 4 of the HMP.

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 within 2015, 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. Additional willow pole cuttings (25) were installed along the slope above Arana Creek to replace previous plantings that died. These planting were maintained throughout 2018.

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 2017.

7.1.3 Integrated Pest Management (IPM)

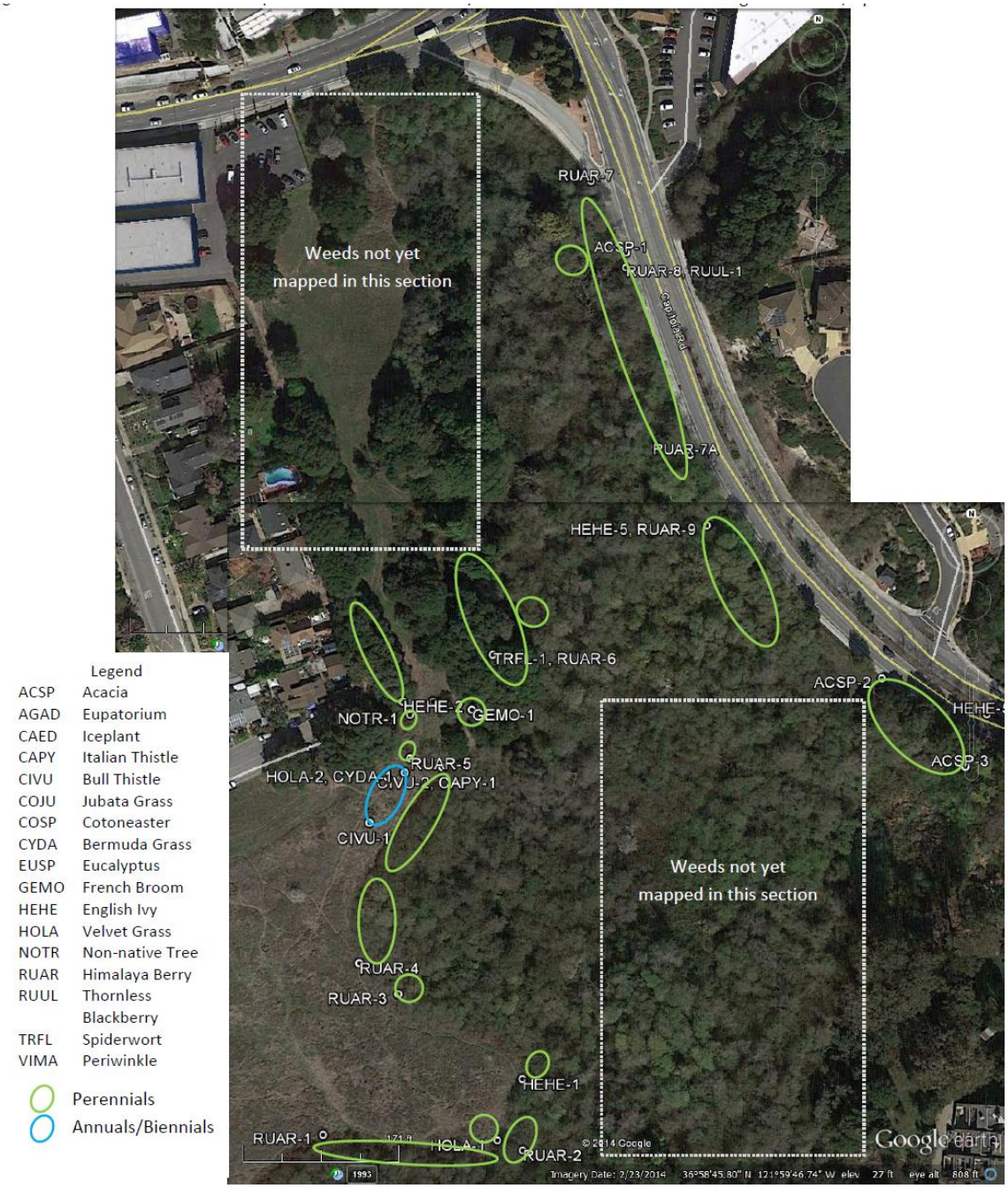
In 2014 and 2015, mapping of invasive weeds within this management area was initiated. The mapping is to guide future management activities for species removal/ control. The approximate size, density of plants (dense, moderate, and sparse) and the location of each non-native invasive species patch was documented using GPS and mapped on aerial photos. A map of data collected, as of April 2015, is presented in **Figure 39A-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 2018, occurrences of invasive species were removed and controlled along the Arana Creek Trail and Marsh Vista Trail. English ivy (*Hedera helix)*, cotoneaster (*Cotoneaster sp.)*, French broom (*Genista monspessulana)*, acacia (*Acacia sp.)*, were removed from 16 polygons in June 2018, as noted on **Figure 39B, C,** and **D**. City staff removed patches of ice plant near Arana Creek. The City continued closure of the ad-hoc path along Arana Creek to discourage public access to the natural area. Straw wattles and straw were maintained at the northern end of the trail to reduce run-off from the Coastal Loop Trail from entering Arana Creek.

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.

Figure 39A. Location of invasive plant species within Arana Gulch Creek Riparian Woodland and Wetland Management Area, April 2015 and Areas Treated in 2018



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

Figure 39B. Location of invasive plant species within Arana Gulch Creek Riparian Woodland and Wetland Management Area, April 2015 and Areas Treated in 2018

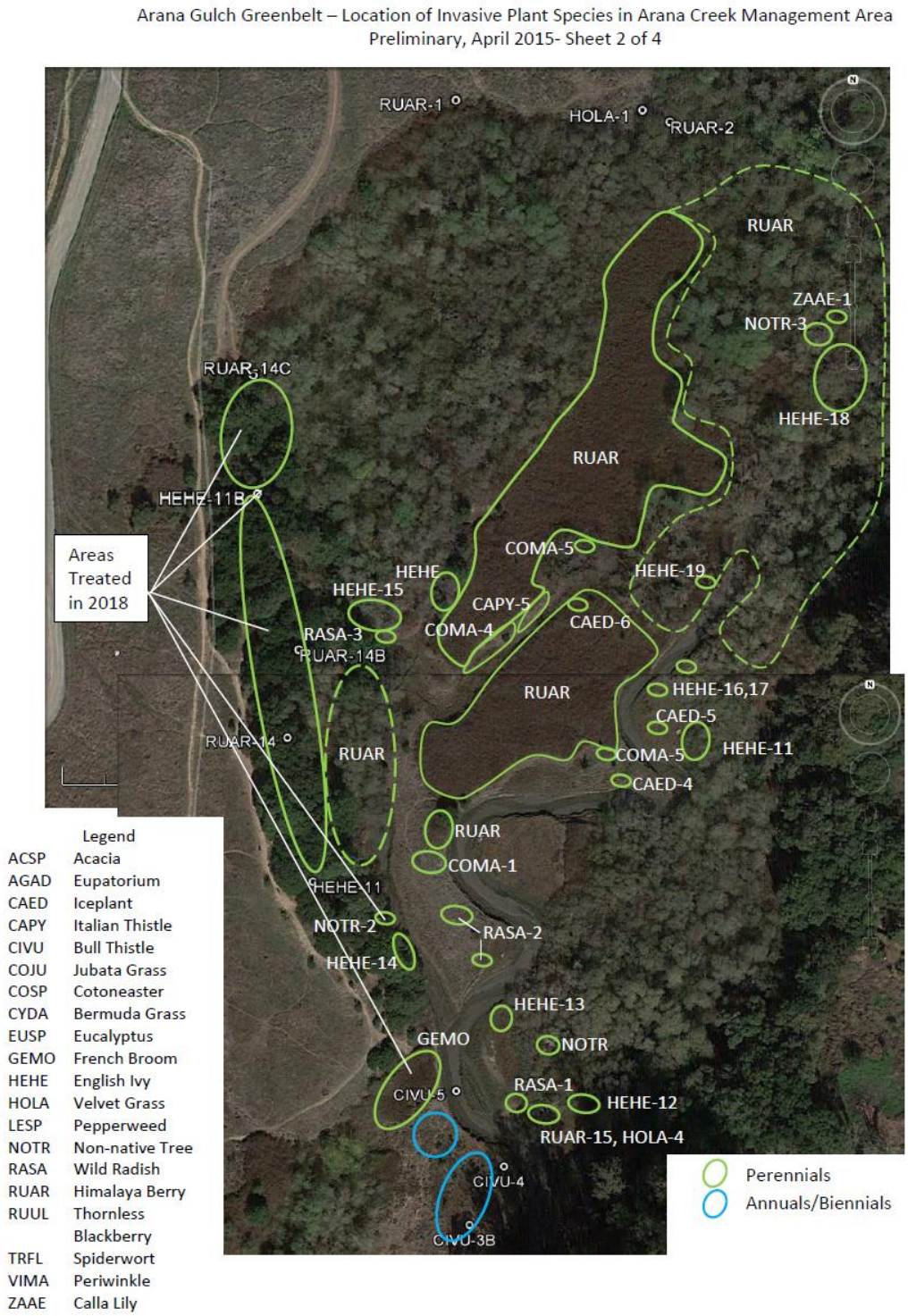
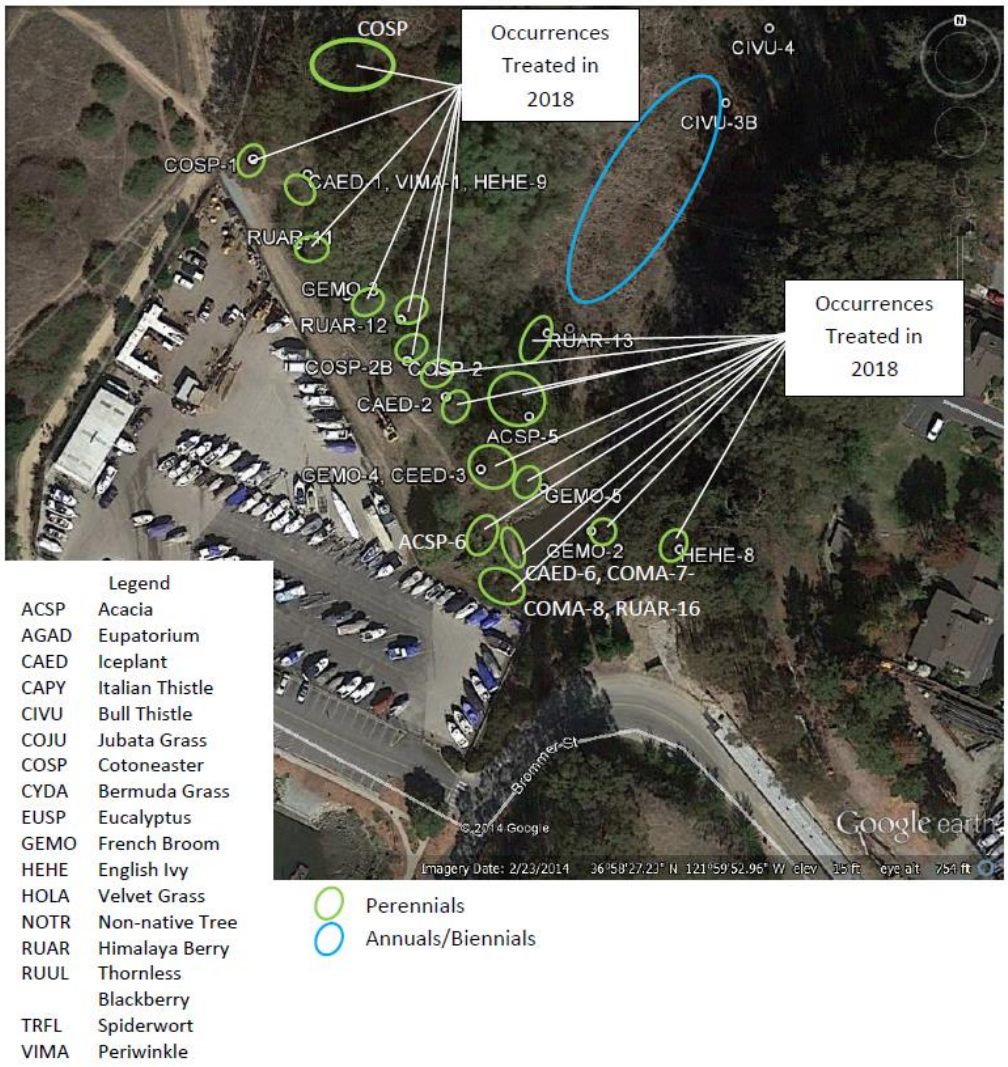
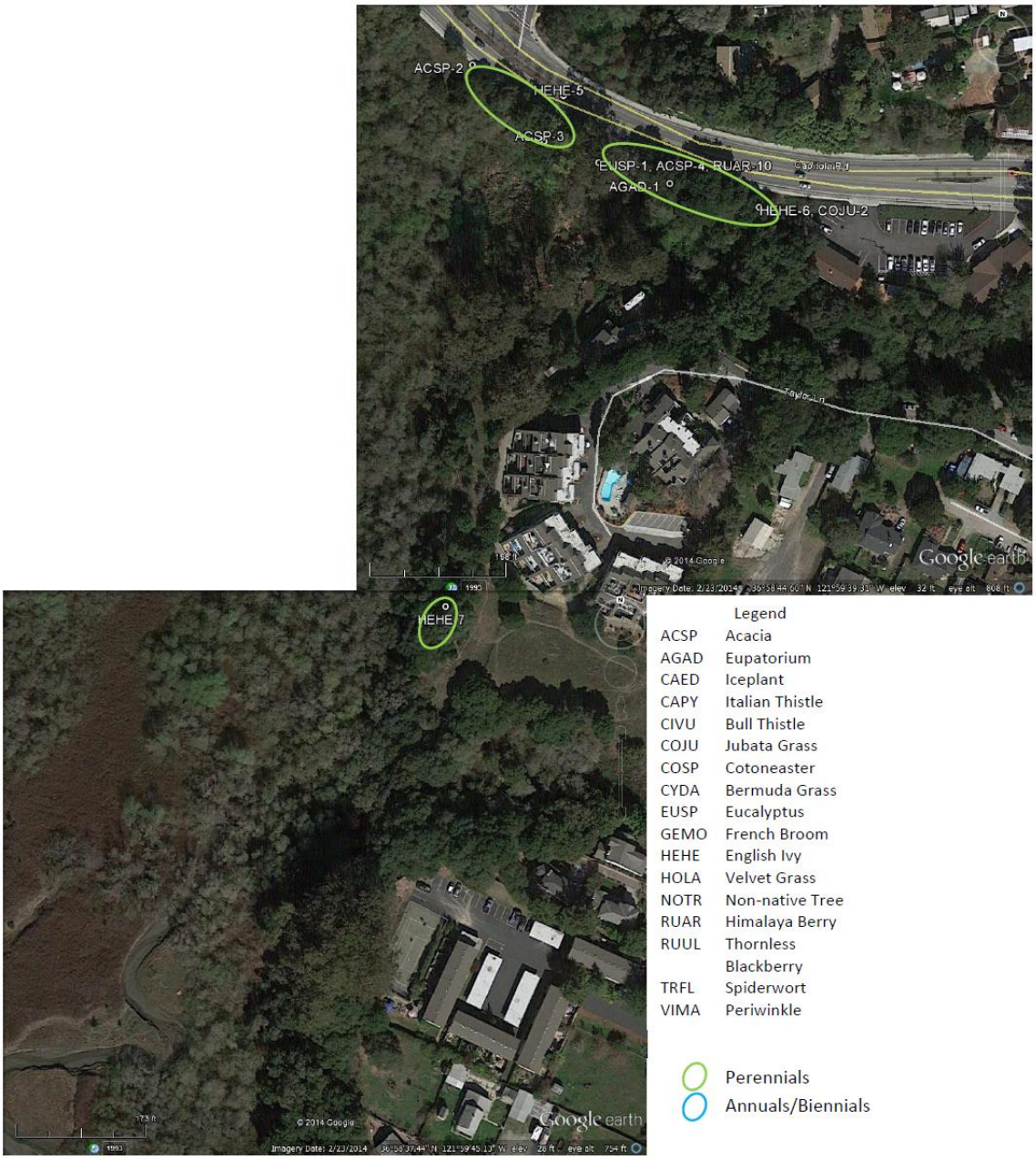


Figure 39C. Location of invasive plant species within Arana Gulch Creek Riparian Woodland and Wetland Management Area, April 2015 and Areas Treated in 2018



Arana Gulch Greenbelt – Location of Invasive Plant Species in Arana Creek Management Area
Preliminary, April 2015- Sheet 3 of 4

Figure 37D. Location of invasive plant species within Arana Gulch Creek Riparian Woodland and Wetland Management Area, April 2015 and Areas Treated in 2018



7.1.4 Coordination with the RCDSCC

The City continued to coordinate with the RCDSCC on measures to improve habitat conditions in the watershed. This coordination followed outreach conducted in 2016, wherein the RCDSCC attended an AMWG field meeting and had their consultants (Balance Hydrology) present their findings on a watershed sediment study and a discussion on erosion problems in the management area. A more recent watershed study evaluated watershed issues that have the potential to deliver significant amounts of new sediment to the harbor (two gullies in upper watershed) and compared existing conditions to the 2002 Arana Gulch Enhancement Plan. The results of that study were not available at the time of this report. Based on discussions about erosion and sediments in Arana Creek, the City closed the steep and eroding ad-hoc trail along the bank of Arana Creek.

7.2 Monitoring and Performance Evaluation

7.2.1 Monitoring Methods

The riparian revegetation areas were monitored in 2018. A plant survival count was conducted in December 2018. The revegetated areas are required to meet 80% absolute cover of native species (including planted and naturally regenerating species) and less than 5% of invasive weeds; therefore, plant cover within the revegetation area was documented by a visual assessment using the CDFW Combined Vegetation Rapid Assessment and Releve Field Form. A copy of these forms is presented in **Appendix D**.

7.2.2 Monitoring Results

Within Area A, the 2018 monitoring found a dense cover of naturally-establishing Himalaya berry (*Rubus ameniacus)*. Willow cuttings exhibited a 30% survival rate; six of the 20 willow cuttings were found to be alive. Additional willow plantings need to be installed. Plant cover within the revegetation area was recorded at is 95%, provided by Himalaya berry (*Rubus ameniacus)* and willow (*Salix lasiolepis).* Eucalyptus, which provided cover in 2017 have been removed (see **Table 14**). This area does not meet the required 80% native woody cover required by CDFW; planting of additional willows is needed.

Within Area B, 40 creeping wild rye (*Elymus triticoides)* were planted in 2015. Due to poor survival and poor growing conditions; these plantings were abandoned and additional shrubs were installed in Area C; however, pre-existing creeping ryegrass plants are still present in the area, which is reflected in the plant cover measurements (see **Table 13**). Within Area C. plant cover was recorded at 80%, with cover provided by California rose (*Rosa californica)* (15%), mugwort (*Artemisia douglasiana)* (15%), creeping wild rye (*Elymus triticoides)* (20%), coastal live oak (5%) and grasses and forbs (40%). These data are depicted on **Table 13**. This area does not yet meet the required 80% native cover required by CDFW. Additional growth is needed for the plantings to provide additional cover; the plantings will be maintained throughout 2018.

Table 14. Monitoring Results from Riparian Revegetation Area, Arana Creek, 2018

Species	# Installed Plants Alive, 2018	Plant Cover
Area A		
Willow	6	20%
Himalaya Blackberry	-	75
Grasses and Forbs	-	5
Area C		
Creeping Wild Rye	-	20%
California Rose	41	15%
Mugwort	17	15%
Coast Live oak	3	5%
Grasses and Forbs		60%

7.2.3 Evaluation of HMP Goals

Table 15 presents a summary of the biological variables monitored, the Year 5 (2018) 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 conferred with the RCDSCC to discuss management activities within the watershed and within the greenbelt property. The City coordination with the RCDSCC is in compliance with goals of the HMP, yet the goal has not yet been met.

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 2019

The following actions and expected timing are proposed for 2019:

- Continue to engage with the RCDSCC on watershed and greenbelt projects through annual meeting with the RCDSCC. (January– December 2019).
- Maintain all plantings throughout year with weeding and supplemental irrigation; monitor plant survival in fall 2019.
- Continue to remove and control occurrences of invasive, non-native plant species within the management area.

Table 15. Biological Variables Monitored in Arana Gulch Creek Riparian Woodland and Wetland Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 5 (2018) 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	Funding provided to RCD to seek grant opportunities and help prioritize projects.	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	Funding provided to RCD to seek grant funding and help prioritize projects.	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	City has engaged with RCDSCC	Yes. City will continue to coordinate with RCDSCC to meet goals
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 along the tidal reach of Arana Gulch Creek.	Funding level for the tidal reach restoration	Yearly	Obtain/increase	Funding provided to RCD to seek grant funding and help prioritize projects.	No

Table 15. Biological Variables Monitored in Arana Gulch Creek Riparian Woodland and Wetland Management Area

Objective	Variable	Measurement Frequency	Desired Direction of Change	Year 5 (2018) Results	Objective Met?
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	Funding provided to RCD to seek grant funding and help prioritize projects.	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	16 polygons of invasive plants were removed/controlled in 2018	Yes, invasive, non-native plant species are being 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 5 and Recommendations for Year 6 (2019)

8.1 Conclusions from 2018

The City continued its initiation of the HMP in 2018 (Year 5). Actions were conducted in all of the management areas. Cattle were grazed in the coastal prairie for SCT management and invasive weed control was implemented in all management areas. There was effective and efficient coordination between the City, the AMWG, and the RCDSCC in 2018 as management actions and monitoring protocols were discussed. The City communicated with users of the greenbelt on the cattle-grazing and provided a ranger 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 on site from January to June. Implementing cattle grazing is in compliance with the HMP. Grazing was successful in maintaining the desired canopy height from November through April. 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 not yet been met.

Grassland management actions were implemented in areas not subject to seasonal grazing. Flail mowing of the perimeter was conducted in June/July. Management of the grassland is required under the HMP; therefore, the City is in compliance with the HMP.

A census of SCT was conducted in 2018; Over 200 above-ground plants were documented from the site in 2018. The HMP objective of reaching 348 plants was not met in 2018.

The City took soil samples from the management areas and submitted the samples to a soil laboratory for testing. The results were compared to the 2013 soil test data. The City also implemented a test plot to seed purple needlegrass (*Stipa pulchra)* into Area A to increase plant diversity. Results of the seeded plot will be available in 2019. SCT seed was collected and deposited at UCSC Greenhouses for seed storage, seed increase, and possible out planting of SCT plants in 2019.

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 2018. Invasive plant removal and control was conducted within both management areas in 2018, meting the objectives of the HMP. The City coordinated with the RCDSCC on management issues within the Arana Gulch watershed in compliance with the HMP.

8.1.3. Adaptive Management and Public Outreach

The City engaged with the AMWG in 2018 through meetings in February and August 2017 as well as 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, 2017 to June 30, 2018 and fiscal year July 1, 2018 to June 30, 2019. 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 2019

The City will discuss with the AMWG recommendations for management actions for 2019 at a January 2019 meeting. 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 2019 (Year 6) is the continuation of seasonal cattle grazing within the prairie/grassland. The City will continue to implement the Stocking and Work Program. 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 within the non-grazed areas that are to be retained as grassland. A census of the SCT will be conducted in summer 2019. Seed collection of SCT may occur depending on the SCT population and prior approval from CDFW. Seed and/or plants grown at UCSC Greenhouses may be installed within management areas in 2019.

Additional seed plots of purple needlegrass and other native plant species may occur in 2019.

8.2.2 Hagemann Gulch Riparian Woodland Management Area

HMP activities identified for 2019 (Year 6) will be to monitor appropriate uses within the gulch concurrent with public use of the trail and bridge. City park rangers will monitor use as

per their regular patrol duties within the greenbelt. Riparian revegetation as per an approved CDFW Streambed Alteration Agreement (SAA) will be maintained in 2019. Plantings will be maintained and monitored throughout 2019 as per the SAA. 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 2019 (Year 6) will be continued removal and control of invasive, non-native plant species. Riparian revegetation plantings will be maintained and monitored throughout 2019 as per the SAA.

8.2.4 AMWG and Public Outreach

In 2019 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 first meeting for 2017 will be conducted in January. 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 16 presents a schedule for the HMP actions scheduled for 2019. The City has allocated funds for fiscal year July 1, 2018 to June 30, 2019 and funding for fiscal year July 1, 2019 to June 30, 2020.

Table 15. Timeline for Habitat Management Actions Proposed for Year 6 (2019)

	2019												2020
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)													
Objective 2. Monitor grazing program and variables	✶												
Objective 3. Monitor baseline condition and photo points													
Hagemann Gulch Riparian Woodland Management													
Objectives 1 and 2. Implement IPM Plan and reduce fire hazard													
Objectives 3 and 4. Document wildlife habitat features and implement infrastructure monitoring[12]													
Objective 5A and 5B. Monitor survival of Rose of Castille shrubs													
Arana Gulch Creek Riparian Woodland and Wetland Management													
Objectives 1, 2, and 3. Collaborate with RCDSCC													

[12] Includes completion of riparian revegetation at bridge and implementing year-long maintenance and monitoring.

Table 15. Timeline for Habitat Management Actions Proposed for Year 6 (2019)

	2019												2020
Task	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**
Objective 4. Implement removal/control of invasive 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.

9. References

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USFWS, 1996. Guidelines for Conducting and Reporting Botanical Inventories for Federally Listed, Proposed, and Candidate Species. September 23, 1996.

Appendix A AMWG Meeting Minutes, 2018

NOTE: Please see the separate Appendix document

A-1: AMWG Meeting Minutes for:

February 2018
August 2018

Appendix B Restoration Maintenance Activity Log

NOTE: Please see the separate Appendix document

B-1. Arana Gulch Restoration Maintenance and Activity Log

Appendix C Coastal Prairie/Santa Cruz Tarplant Management Area

NOTE: Please see the separate Appendix document

C-1. SCT Survey Route Map

C-2. Pre-mow Plant and Breeding Bird Survey

C-3. Plant Cover Data, SCT Sites

C-4. Transect Photos

C-5. Photo Monitoring

C-6. Soil Sampling Data

Appendix D Arana Gulch Creek Riparian Woodland and Wetland Management Area and Hagemann Gulch Riparian Woodland Management Area

NOTE: Please see the separate Appendix document

D-1: Arana Creek Revegetation Areas: Revegetation Monitoring Results: CNPS and CDFG Combined Vegetation Rapid Assessment and Releve Field Forms