Serpentine Prairie Restoration Plan
Year 1 Report

East Bay Regional Park District
Planning and Stewardship

February 2010

Acknowledgements

The following people in the EBRPD Planning and Stewardship Department were involved in developing, writing and reviewing this report: David Amme, Neal Fujita, Wilde Legard, and Brian Wiese. Special thanks and appreciation are also due to Christal Niederer, Lech Naumovich, and Stuart Weiss of Creekside Center for Earth Observation for their contributions to designing and implementing the initial monitoring protocol, and writing the 2008 Baseline Data Annual Report and the 2009 Year 1 Annual Report.

David Amme, Wildland Vegetation Program Manager

East Bay Regional Park District

Serpentine Prairie Restoration Plan: Year 1 Report

Abstract

The Serpentine Prairie is the largest undeveloped outcrop of a much larger expanse of exposed serpentine soils that once existed in the Oakland Hills between Skyline Boulevard and the Warren Freeway and northeast into Joaquin Miller Park. Housing developments and landscaping have eliminated most of the west-facing portion of the original prairie. The southeast-facing remnant has been under the management of the East Bay Regional Park District (District) since 1935. Since the removal of livestock grazing in the 1950s, the development of the District headquarters on the site in the mid 1960s, and past intensive uses as an equestrian field jumping course and pasture the health and vigor of this remnant perennial grassland has been greatly compromised. A review of aerial photographs taken over the last 50 years, shows that hundreds of pines and acacias were planted, and coastal scrub habitat within the prairie has increased in density and distribution. Increased park use as an off-leash dog exercise and gathering area has also added to the impacts on the landscape. This report describes the first year's implementation of the Serpentine Restoration Plan that is focused on restoring the natural grassland habitat and enhancing the rare and endangered plant species.

Introduction

The Serpentine Prairie is one of two localities known to contain the State and Federally-listed Endangered Presidio clarkia (*Clarkia franciscana*). It also provides habitat for the State and Federal-listed Threatened Alameda whipsnake (*Masticophis lateralis euryxanthus*). The Presidio clarkia was listed by the California Department of Fish and Game (CDFG) as endangered in 1978 and by the USFWS as endangered in 1997. The Alameda whipsnake was listed by the California Department of Fish and Game as a threatened species in 1971 and by the USFWS as threatened in 1997. The Federal-listed endangered Callippe Silverspot Butterfly (*Speyeria Callippe*) is not found in the Serpentine Prairie. The Silverspot host plant, *Viola pedunculata*, is absent from the Serpentine Prairie and adjacent grasslands in the vicinity. Management of the Serpentine Prairie is included in an Environmental Assessment (EA) developed for FEMA in 2003 and a 2001 USFWS Biological Opinion (BO) (USFWS 2001) for fire mitigation projects along the urban wildland interface. The BO covers effects of prescribed fire and vegetation management to the Alameda Whipsnake and outlines conservation measures to minimize impacts to Presidio clarkia.

During the 1940s, 50s, and 60s, cattle and horse grazing and associated trail use impacted most of the Serpentine Prairie. The management of this area became linked to the development of the adjacent horse rink to the southeast in the early 1950s. In 1962, the East Bay Regional Park District chose the southwest edge of the Serpentine Prairie as the site for the new district headquarters. At this time the adjacent grassland summit area southeast of the headquarters, known locally as "Hunt Field," was used as an equestrian field course. A large portion of the site was also fenced and utilized as a horse pasture. The riding course was managed by the Metro Horsemen's Association (MHA). This organization developed riding trails, jumps, and obstacle courses for competitive riding

events throughout the Serpentine Prairie. In the 1970s, new trails and terraces were graded into the hillsides and several dirt mounds were constructed to add jumping obstacles to the field course. Impacts on this area increased until the 1980s when official equestrian events closed down. During this time the area below the new Park District headquarters was still fenced for horse grazing.

Concurrent with the establishment of the District headquarters, a variety of native and exotic trees (primarily Monterey pines and acacias) were planted in scattered locations on the serpentine prairie. Monterey pines were planted within the stands of native Idaho fescue and on the adjacent slopes below the new headquarters. Over the course of the past 45 years, many of the planted pines have reached maturity and are beginning to die naturally of age. Many of the trees have developed a closed canopy, enabling coast live oak and Monterey pine seedlings and saplings, native shrubs, and annual grasses to fill in under the mature pine canopy during the last 20 years. In addition to shading and the buildup of a litter layer under these trees, fog condensation in the pines has increased the amount of moisture that collects and deposits on the prairie. Another important impact has been an increase of nitrogen deposition as a result of urban air pollution related to the use of catalytic converters on vehicles, which has increased the availability of nitrogen in a form that is directly absorbed by plants. On serpentine soils, especially downwind from urban areas, these elevated levels of nitrogen have accelerated the invasion of exotic annuals, especially annual ryegrass (*Lolium multiflorum*) (Weiss 1999). The cumulative result of this process is the incremental degradation and fragmentation of the grassland and the reduction in the quality of the habitat that otherwise supports a rich assemblage of native perennial grasses, wildflowers, and perennial forbs (Photo 1).

Photo 1. Old and sapling Monterey pines dominate the landscape in portions of the Serpentine Prairie.

The District completed the Serpentine Prairie Restoration Plan in January 2009 (EBRPD 2009). The plan is available on line at the EBRPD home page. During the planning phase the Park District acquired a permit from the Department of Fish and Game (Memorandum of Understanding # 2081(a)-09-01-RP) on February 26, 2009 (CDFG 2009). A CEQA document (Initial Study and Proposed Mitigated Negative Declaration, May of 2009) was approved by the Regional Parks Board of Directors on July 7, 2009 (EBRPD 2009). This document is also available on line at the EBRPD home page. The Notice of Determination was filed with Alameda County and sent to the State Clearing house on July 8, 2009. In addition, the U. S. Fish and Wildlife Service completed a Reinitiation of the Formal Consultation of the Regional Park District's Fire Mitigation Projects on August 14, 2009. This document revised the original Consultation (dated August 14, 2009) to minimize the impact to the Presidio clarkia, allows for the protective fencing, and monitoring for the Alameda whipsnake during construction (USFWS 2009).

Monitoring

Early in the planning process the District retained the assistance of Creekside Center for Earth Observations (CCEO) to conduct a thorough baseline inventory and status assessment of the Presidio clarkia in the spring of 2008. This assessment included the establishment and measurement of a large macroplot as a baseline estimate/census of Presidio clarkia prior to management treatments. In addition, this baseline inventory established and measured thirty-two management plots with controls on the Serpentine Prairie. The 2008 baseline report is presented below in Appendix A. Appendix B presents the first year's 2009 Year 1 report which covers the information gathered in the spring of 2009. This report presents the latest information regarding the status of the Presidio clarkia and the management treatment plots and constitutes the main part of this 2009 Year 1 Report. The primary work during 2009 included the removal of the Monterey pines and acacia trees in and around the heavily impacted Hunt Field area, the construction of a protection fence to prevent trampling and recreational dog use and allow recovery, and the establishment of an interpretive loop trail that runs along the outside of the fence. CCEO will continue to monitor the plots and, if funds allow, implement grazing treatments and prescribed fire trials in 2011 as outlined in the Serpentine Prairie Restoration Plan.

Year 1 2009 Project Implementation

The agency approvals arrived just in time to implement the first phase of the restoration plan, which includes the first phase of the tree removal, constructing the interpretive loop trail and building the protection fence. The pine trees, acacia trees and miscellaneous small hardwoods were cut and removed from the site between August 19th and September 1st. Approximately 73 large pine and acacia trees (6"- 24" DBH) and 51 smaller trees and brush (less than 6" DBH) were cut and removed. Figure 1 shows the tree removal treatment area. Special care was taken to lift the trees and debris out of the treatment area with a crane in order to minimize disturbance to the ground. All material (tree boles/wood, green waste, chips, etc.) were removed and disposed of according to the County Agricultural compliance agreements for Sudden Oak and Light Brown Apple Moth Quarantine Programs. No chips or debris was left on the ground. All tree stumps

were cut at ground level. To prevent resprouting of hardwood brush and small trees the stumps were topically treated with Pathfinder II herbicide. There was no property damage, erosion problems, hazards or collateral tree damage. Park District employees removed the thick duff that had developed in the acacia stands and some of the pine stands. These areas were seeded with local serpentine adapted native perennial grasses (meadow barley and California brome).

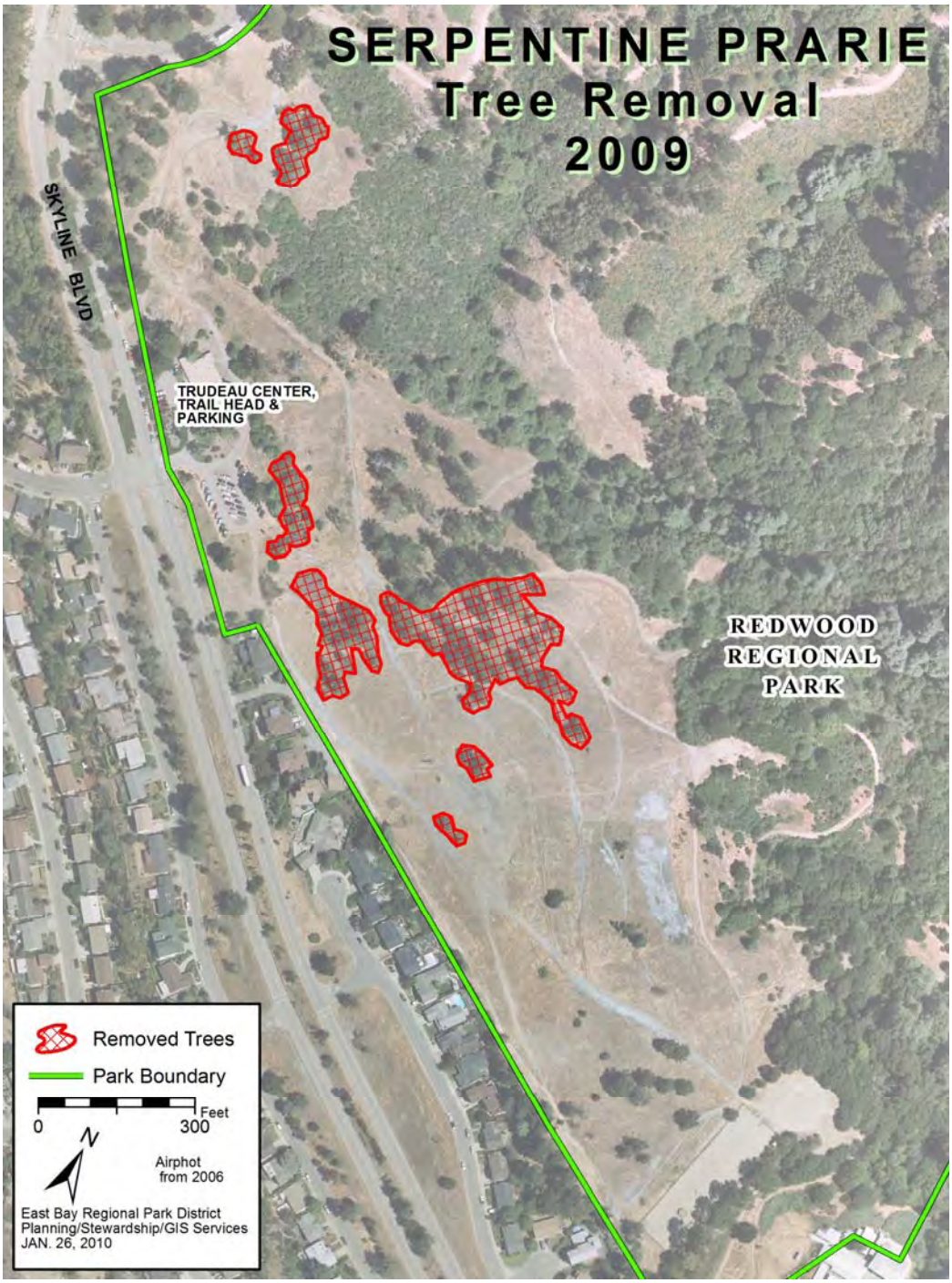

Figure 1. Serpentine Prairie Phase I tree removal treatment area

Figure 2 shows the final alignment of the protection fence and interpretive Serpentine Loop Trail. The trail was completed between September 9th and 11th. The original fence design was enhanced near the parking lot and the public overlook interpretive area with redwood split post and rail design.

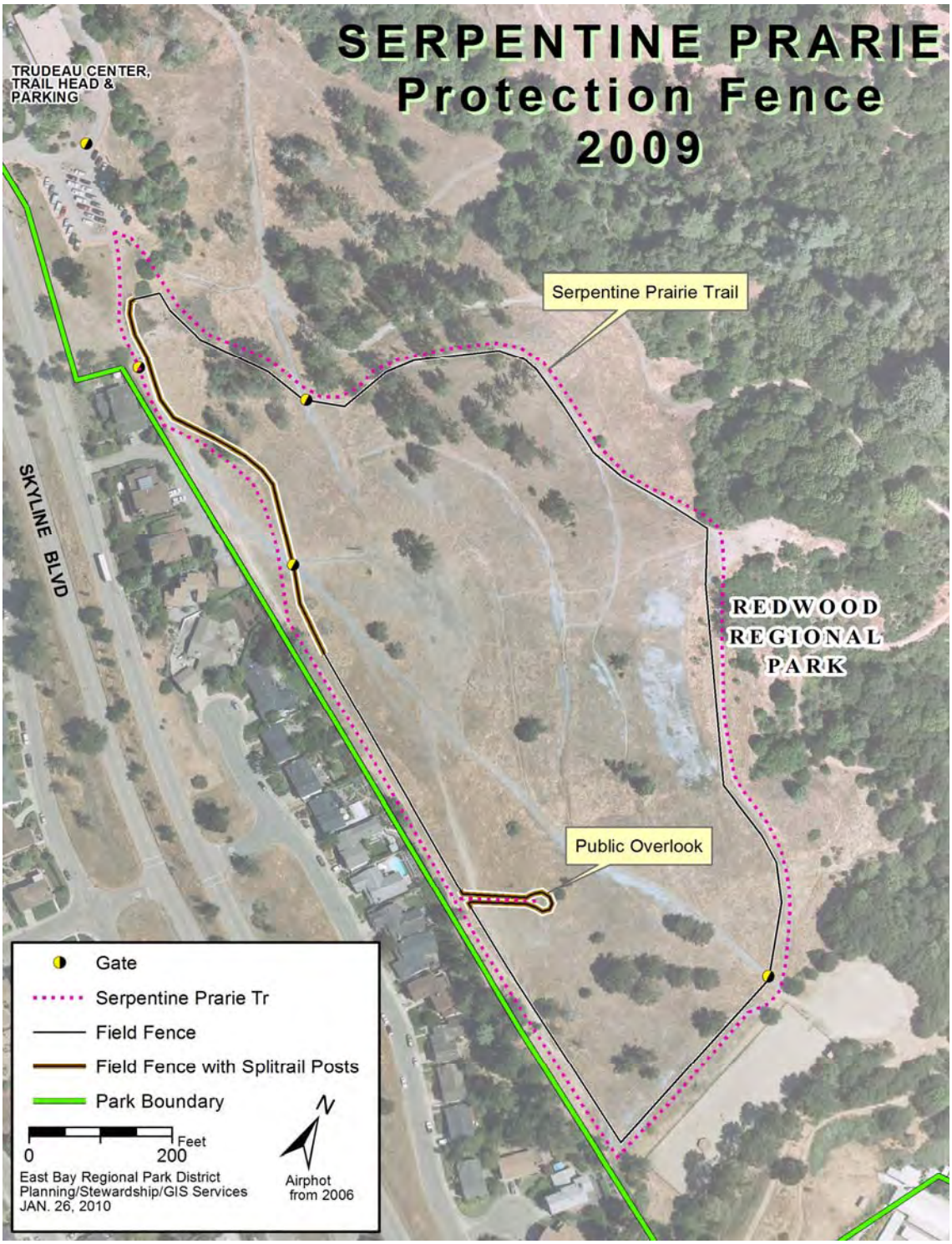

Figure 2. Serpentine Prairie protection fence.

The majority of the fence was built with short unpainted T-posts that are allowed to rust. The emergency access gates were custom built iron gates that are also allowed to rust. The 39" high wire field fence is built of special high strength, low carbon galvanized steel. The fence's wire mesh grid was reversed to allow for wider gaps close to the ground to allow for wildlife to pass through unimpeded. The fence construction and funding was approved by the Regional Park Board of Directors on October 6, 2009. The fence construction started on October 23rd and completed on November 30th. The Serpentine Prairie contains habitat for the Alameda whipsnake (Swaim 2009). During the construction period qualified district wildlife biologists monitored the area during tree cutting and fence construction activities. In late November and early December Redwood park personnel removed the last of the thick duff and organic matter down to the soil level associated with the dense acacia and pine stands and sowed a native perennial grass erosion control mix consisting of locally collected California brome (*Bromus carinatus*) and meadow barley (*Hordeum californicum*).

Photographs below present before and after images of the project. Also presented below are meeting flyers and the signs that were posted before, during and after the Phase I work including.

Citations

CDFG. 2009. Research and Management Permit No. 2081(a)-09-01-RP. East Bay Regional Park District Clarkia franciscana (Presidion Clarkia) Restoration and Management of the Serpentine Prairie at Redwood Regional Park. 7 pp.

EBRPD. 2009. Serpentine Prairie Restoration Plan, Redwood Regional Park, January 2009. 75 pp.

EBRPD. 2009. Initial Study and Proposed Mitigated Negative Declaration for Serpentine Prairie Restoration Plan, Redwood Regional Park, California. 90 pp.

Swaim, K.E. 2009. Results of Trapping Surveys at Redwood Regional Park (May 20-July 18, 2008).

USFWS 2001. Formal Consultation on East Bay Regional Park District's Fire Mitigation Projects, FEMA-919-DR-CA, HMGP #919-515024, Alameda County, California.

USFWS 2009. Reinitiation of the Formal Consultation on East Bay Regional Park District's Fire Mitigation Projects, FEMA-919-DR-CA, HMGP #919-515024, Alameda County, California (Service file# 1-1-00-F-0205. 6 pp.

Weiss, S.B. 1999. Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-Poor Grasslands for a Threatened Species, *Conservation Biology, 13(6). 1476-1486*

Before and After Tree Removal

Photos 2 & 3. View looking southwest from the upper disjunct removal of Monterey Pine grove.

Photos 5 & 6. View looking south on upper slope just South of the Trudeau Center parking lot. This is the main interpretive trail entrance view

Photos 7 and 8. View looking northwest up to the new site of the beginning of the Serpentine Prairie Interpretive Trail south of the parking lot.

Photos 9 & 10. View from the beginning of the new Serpentine Prairie Interpretive Trail.

Photos 11 & 12. Serpentine Prairie Interpretive Trail entrance showing the split rail post and beam fence design.

Educational Signage

East Bay Regional Park District
www.ebparks.org

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Serpentine Prairie

RESTORATION

PHASE 1: August - October 2009

The Skyline Serpentine Prairie is home to one of Northern California's richest arrays of native plants due to the serpentine found here. Serpentine is California's official state rock and is critically important for the survival of many endangered species. This prairie is home to the endangered Presidio clarkia and rare Tiburon buckwheat along with other rare plants and animals. Unfortunately, decades of overuse and the invasion of exotic plants are seriously impacting the natural environment. If steps aren't taken to protect this area, it likely will be lost forever.

To help the prairie survive so that future generations can enjoy it, the Park District is beginning PHASE I of a four-phased project to be implemented over the next four years.

Beginning in August 2009, park visitors will notice a change in the prairie with removal of trees within the grassland area. Most of the trees being removed are planted Monterey pines and small pine seedling and hardwoods coming up in the understory. These trees are changing the composition of the soil by shedding leaves and needles and adding excessive moisture through fog drip. The result is invasive grasses and weeds taking over and seriously compromising the survival of rare and endangered plants that grow here naturally.

PHASE I has three main components: removing trees throughout the 6-acre project site as determined by Park District vegetation management experts, installing protective fencing around a 3-acre area that has been impacted by over-use, and completing a one mile trail around the perimeter of the protection area.

This phase is scheduled to be completed by October 2009 with the fence staying in place as the field reestablishes itself. Visit www.ebparks.org for more information and updates.

In cooperation with East Bay Chapter of the California Native Plant Society and the California Department of Fish and Game.

Photo: Wild Legard

Federally endangered Presidio Clarkia

Photo: Wild Legard

Cream Cups

Photo: David Amme

Idaho fescue

PHASE I Quick Facts:

Action: Three month selective tree removal, protective fence installation, completion of trail around perimeter of Serpentine Prairie.

Size: Approx 6 acres of a 45-acre project site located within the 1,836 acre Redwood Regional Park.

Funding: $25,000 for PHASE I from Federal Emergency Management Agency (FEMA) fund and $25,000 from the Park District's General Fund.

Target Habitats/ Species: Reduce number of invasive and introduced trees affecting rare serpentine area which includes the endangered Presidio clarkia.

Improvements: One mile loop trail connecting to Redwood Regional Park's trail system. Tree removal, and new trailhead.

Program Manager: David Amme • ***Email:*** damme@ebparks.org • ***Office:*** 510-544-2344

Public Meeting

Monday, May 11, 6-8 PM
Richard Trudeau Center
11500 Skyline Boulevard
Redwood Regional Park
Oakland

Take a Naturalist-Led Prairie Hike

Come learn more.
Hikes meet at Trudeau Staging Area,
11500 Skyline Boulevard
Redwood Regional Park, Oakland

- Saturday, May 17, 2 to 4 PM
- Saturday, June 13, 3 to 4 PM

Additional hikes have been scheduled for late July and August.

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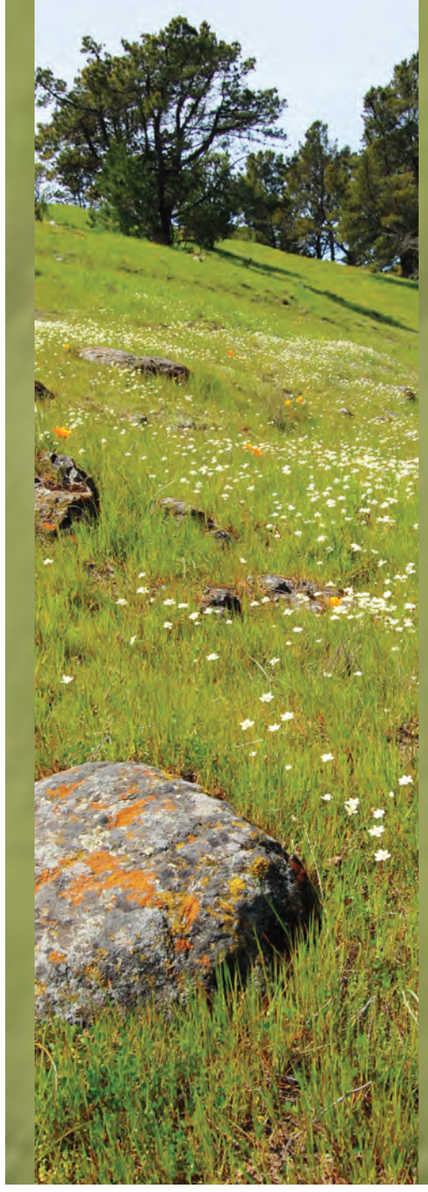

Restoring the Serpentine Prairie

The Skyline Serpentine Prairie is home to one of Northern California's richest arrays of native plants due to the serpentine found here. Serpentine is California's official state rock and is critically important for the survival of many endangered species. This prairie is home to the Federally endangered Presidio clarkia and Tiburon buckwheat along with other rare plants and animals. Unfortunately, decades of overuse and the invasion of exotic plants are seriously impacting the natural environment. If steps aren't taken to protect this area, it likely will be lost forever.

To help the prairie survive so that future generations can enjoy it, the Park District is beginning PHASE I of a three-phased project to be implemented over the next five years.

Beginning in July, park visitors will notice a change in the prairie with removal of trees and other vegetation. Most of the trees being removed are non-native. A few are native but were introduced in this location over time. These trees are changing the composition of the soil by their debris and shade cover. The result is invasive grasses and weeds taking over and seriously compromising the survival of rare and endangered plants that grow here naturally.

PHASE I has three main components: removing trees throughout the 6-acre project site as determined by Park District vegetation management experts, installing protective fencing around a 3-acre area that has been impacted by over-use, and creating a one mile permanent multi-use trail around the perimeter of the project area for hikers, cyclists, dog-walkers, and equestrians.

This phase is scheduled to be completed by October 2009 with the fence staying in place for several years as the field reestablishes itself. PHASES II and III will be completed as funding becomes available. Visit www.ebparks.org for more information and updates.

David Amme, Wildland Vegetation Program Manager
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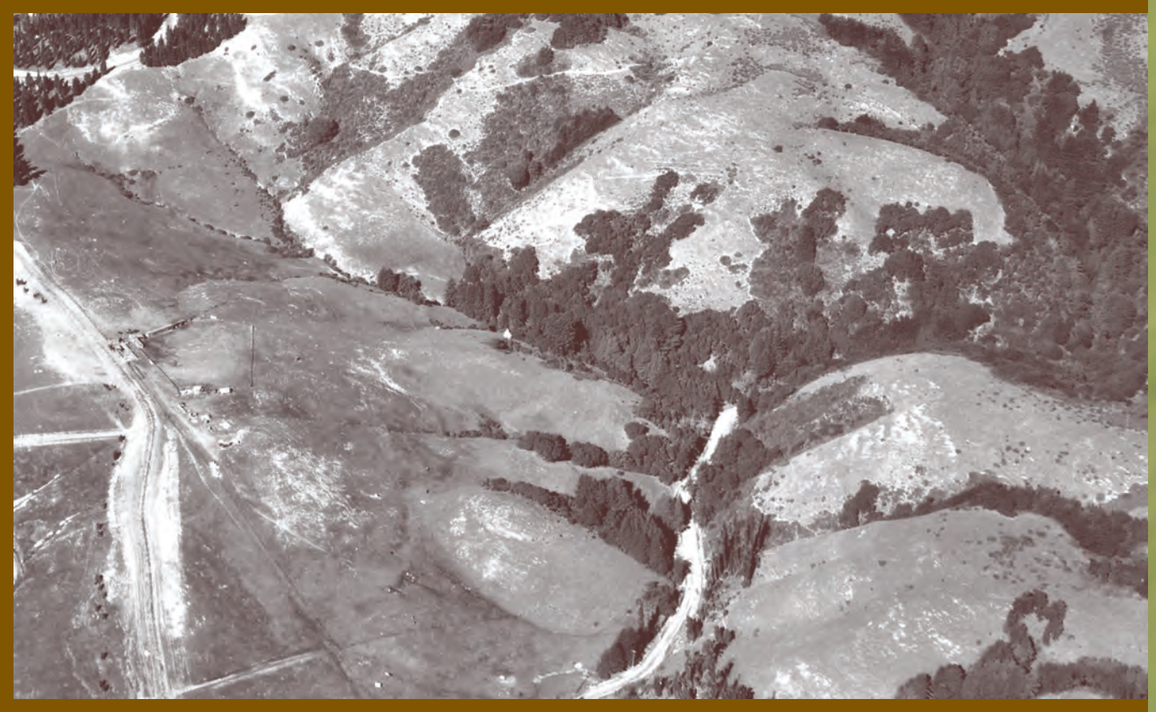
This project is supported by the California Native Plant Society and the California Department of Fish and Game.



The Past: *This 1935 photo shows the prairie before the introduction of non-native vegetation and beginning construction of the Trudeau Center and Skyline Boulevard.*

Current Time: *Non-native trees and plants encroach on the Prairie threatening the survival of this unique resource.*

The Future: *The reconstruction of the Prairie will allow native and endangered Serpentine Prairie plants to thrive.*

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Serpentine Prairie

RESTORATION

Area of Critical Environmental Concern

Protect the Prairie - Stay on Designated Trails

Photo: Wilde Legard

Goldfields are native flowers that continue to thrive in the remaining prairie. However, overuse and invasive plants may seriously impact their overall survival. The District's restoration project is a long-range sustainable plan to ensure native plants and wildflower survival for park visitors to enjoy.

PHASE 1: August - October 2009

The East Bay Regional Park District and partners are working to preserve this fragile ecosystem and create a healthy environment for rare and endangered plants to thrive. The grassland before you is part of PHASE 1 of a multi-year project. This phase will begin in August and should be finished by the end of October 2009. During this phase, we will be removing trees and installing a protective fence around a 3-acre site. The fence will remain in place to give the field a rest from overuse. We want our visitors to continue enjoying this area and will be completing a mile long loop trail around the perimeter that will connect to the Park's main trail system.

PLEASE HELP PROTECT THIS SENSITIVE HABITAT
STAY ON DESIGNATED TRAILS

Project information, maps, photos, interpretive hikes, and upcoming meetings will be posted on our Website, www.ebparks.org and at Redwood Regional Park's bulletin board in the Skyline parking lot.

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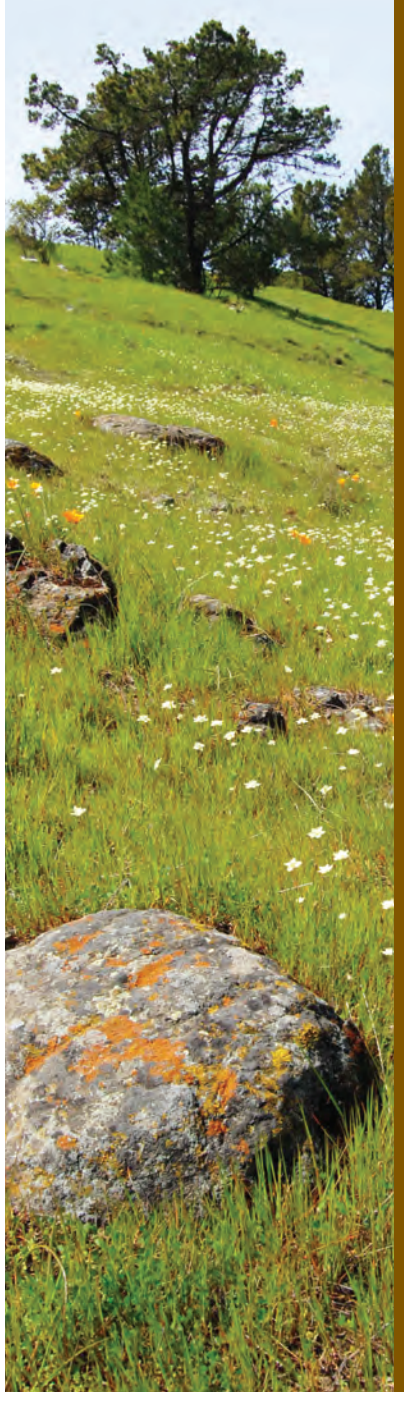

Serpentine Prairie

RESTORATION

Area of Critical Environmental Concern

Protect the Prairie - Stay on Designated Trails

Photo: Wilde Legard

"The greatest treasure that this prairie preserves is serpentine grassland. Serpentine is California's official state rock and is critically important for the survival of many endangered species. The Skyline Serpentine Prairie, before the 1960s, was more than twice as large as it is now. The west half of the prairie was turned into housing and whatever botanical riches it preserved were lost forever. What remains is an exceedingly precious part of the biological heritage of California, but it has been deteriorating. Our window of opportunity for protecting it may be closing." Steve Edwards, Regional Parks Botanic Garden Director.

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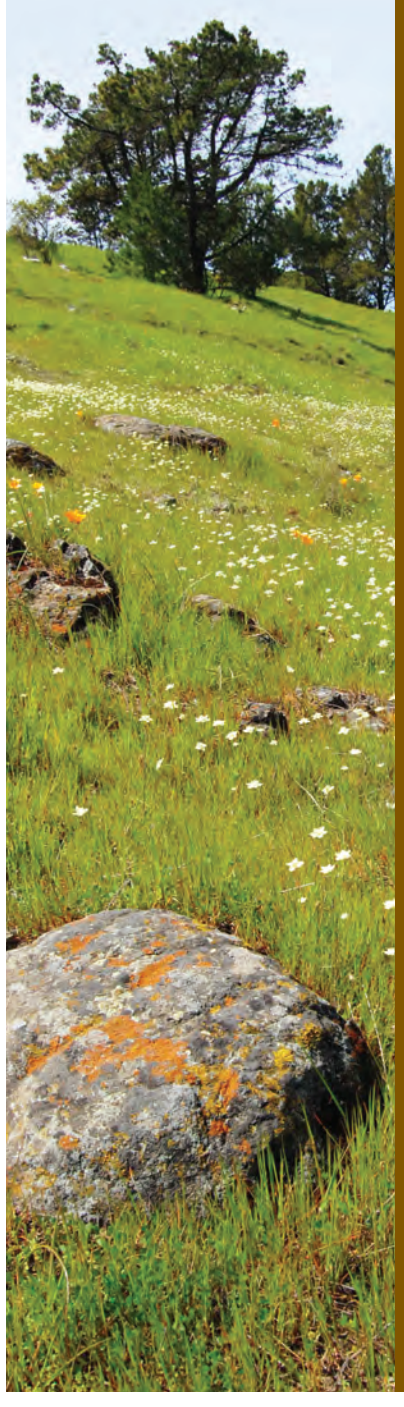
Protect the Prairie - Stay on Designated Trails

The introduction of both non-native and native trees to the prairie has dramatically changed the composition of the soil. These trees are changing the composition of the soil by shedding leaves and needles and adding excessive moisture through fog drip. Removal of these trees is critical to the long-range success of restoring the prairie to its native state.



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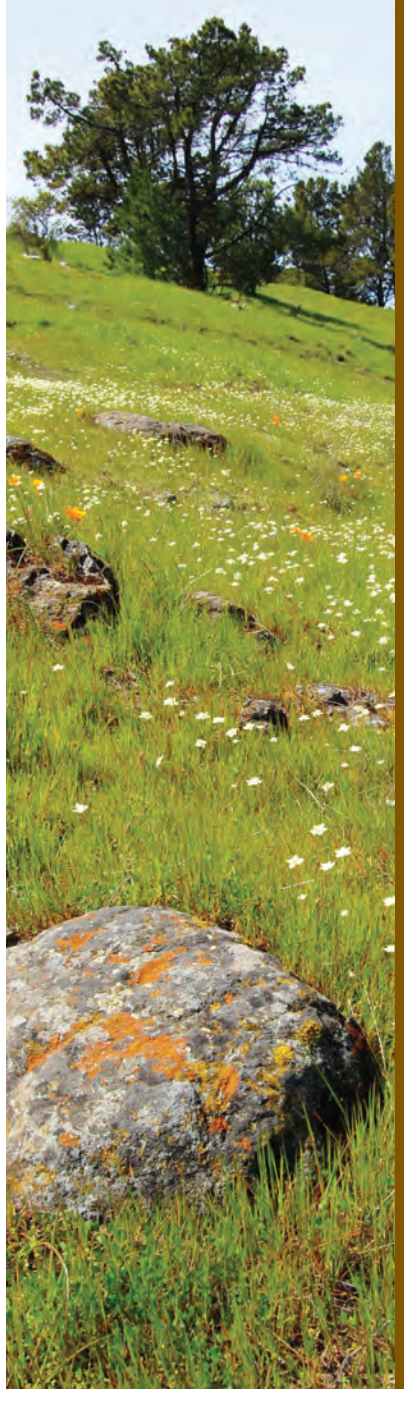
Serpentine Prairie

RESTORATION

Area of Critical Environmental Concern

Protect the Prairie - Stay on Designated Trails

As part of Phase I, the Park District will complete a Serpentine Prairie loop trail with interpretive overlook. The trail will be open during the duration of the project so visitors can enjoy the area. This fairly level trail has a few gentle slopes.



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Appendix A

2008 Annual Report: Baseline Data

Serpentine Prairie Restoration Project

Redwood Regional Park

2008 Annual Report: Baseline Data

A Creekside Center for Earth Observation Project

Lech Naumovich, Christal Niederer, Stuart Weiss

Executive Summary

The Serpentine Prairie Restoration Project was initiated in 2008. The purpose of the project is to restore the vitality and botanical diversity of the prairie and to manage the site to ensure survival of special status species associated with the prairie, including the State and Federal-listed Endangered Presidio Clarkia (*Clarkia franciscana*). The project also aims to provide for the enjoyment and appreciation of park users [Excerpted from *Serpentine Prairie Restoration Plan*, EBRPD]. The Redwood Regional Park – Serpentine Prairie study area is a located on land owned and managed by the East Bay Regional Park District (EBRPD). Data from the first year represent baseline vegetation composition information, or pre-project conditions. Thirty-two plots for three treatments plus control were located on the Serpentine Prairie, and background data were collected before any experimental methods were initiated. This report does not include data from the Presidio Clarkia population monitoring effort, which was reported separately in the Serpentine Prairie Restoration Plan. Vegetation composition data showed that some native species were found exclusively (or nearly exclusively) under the tree canopy. Biodiversity at Serpentine Prairie may depend in some part on the tree canopy.

Introduction

The Redwood Park Serpentine Prairie is the largest undeveloped outcrop of a much larger expanse of exposed serpentine soils that once existed in the Oakland Hills, between Skyline Boulevard and the Warren Freeway and north east to Joaquin Miller Park. Hundreds of pines and acacias were planted, brush has expanded, and an increasing number of park users have also added to the impacts on the landscape. Invasion by nonnative annual grasses, likely exacerbated by dry and wet nitrogen deposition, further threatens native diversity at the prairie.

Methods

Baseline vegetation composition is critical for determining changes due to experimental treatments. The adaptive management framework, rationale for treatment selection, and Presidio Clarkia population monitoring methods with 2008 results are detailed in the Serpentine Prairie Restoration Plan.

The work completed in 2008 includes:

- Establishing 32 permanent 10 x 10 m treatment plots (Figure 1) with wooden stakes. Each treatment plot has five 0.5 x 0.5 m quadrats. All locations were mapped with a sub-meter accurate Trimble GeoXT.

- Pre-treatment surveys on all 160 sampling quadrats located on the Serpentine Prairie. Percent cover of each species, including litter and bare ground, was recorded using ocular estimation in each quadrat.
- Spring mow treatment at 8 permanent plots with handheld gas trimmer.
- Fall rake and removal of thatch at 8 permanent plots with metal gardening rake.

Permanent plot locations were randomly selected within the following requirements. Spring mow plots were located in areas where Clarkia was not surveyed so that no take of the species occurred in this treatment. Fall rake plots were located in areas where Clarkia was present in low concentrations, with raking occurring only after seed set. We do not anticipate a negative impact from raking these plots. Tree removal plots were located in areas beneath pines. These areas were not expected to have Clarkia, due to a thick duff layer of needles. No tree removal occurred in 2008. Control plots were located in areas of known Clarkia allowing us to determine the effect of environmental conditions on the annual variability of Clarkia abundance.

Fence construction was initially planned in 2008, but this has been postponed. Once the fence is erected, plots can be further stratified by whether they are inside or outside the fence.

Data collection in spring 2008.

Figure 1 shows the location of our experimental and control plots. The initial selection was supported with maps showing the distribution of Clarkia in 2007, provided by the Park District.

The bulk of plot data were collected in the spring when the majority of plants were identifiable (May). Tree plot data was collected slightly later (June) to reflect plant phenology. Data were entered into a Microsoft Access database for analysis. All data were entered and subsequently checked for quality control by revisiting all the entered numbers.

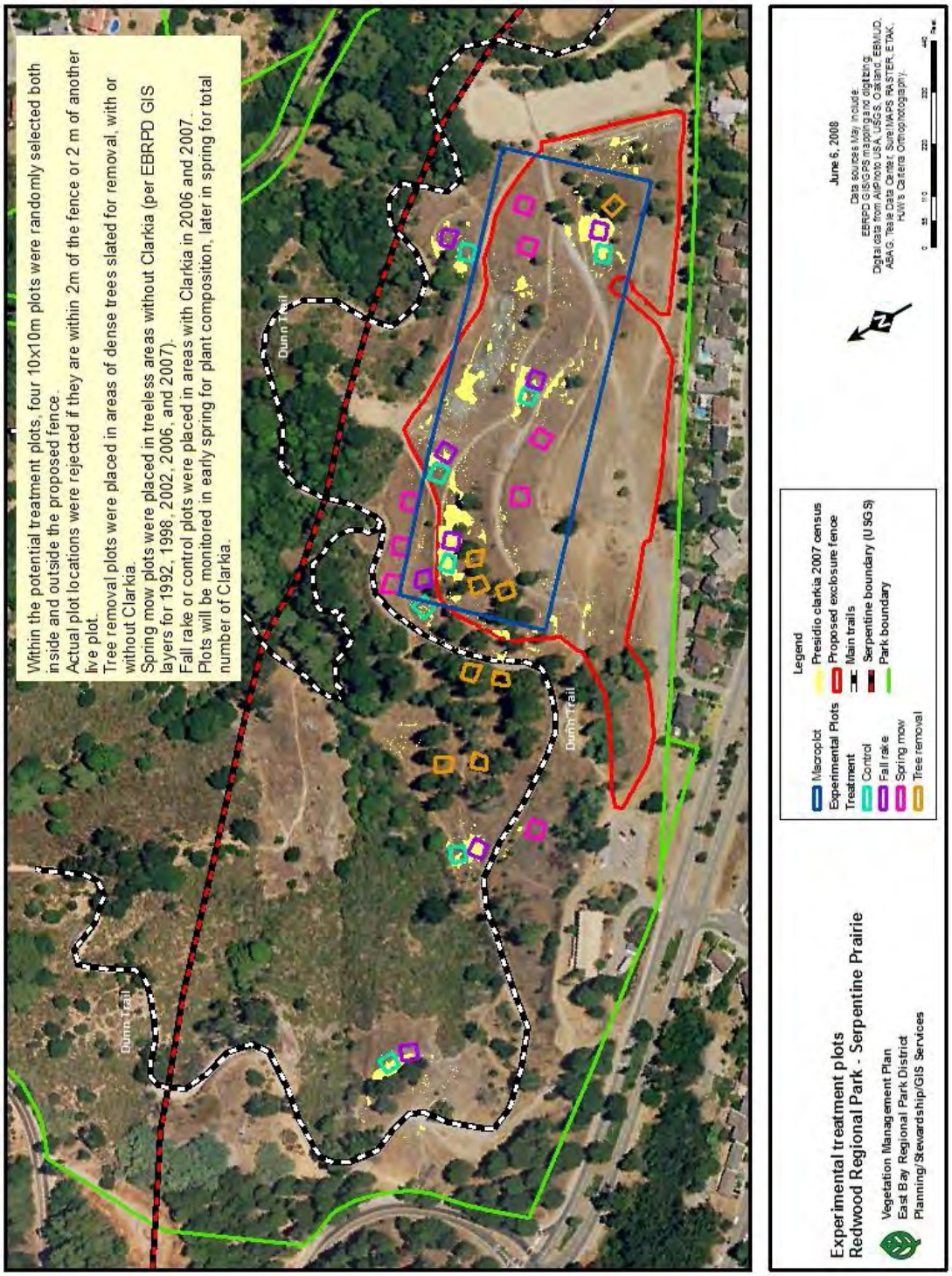


Figure 1: Plot locations

Results

Since Clarkia is the target species for this project, we took care to check to see that the plots were located properly. Figure 2 shows the percent cover of Clarkia in each of the treatment groups. The control (0.28 ± 0.07) and fall rake (0.28 ± 0.08) treatment plots show Clarkia presence, while the spring mow and tree removal treatment plots effectively show less than a 1/10 of a percent cover Clarkia. Clarkia was present and absent where expected.

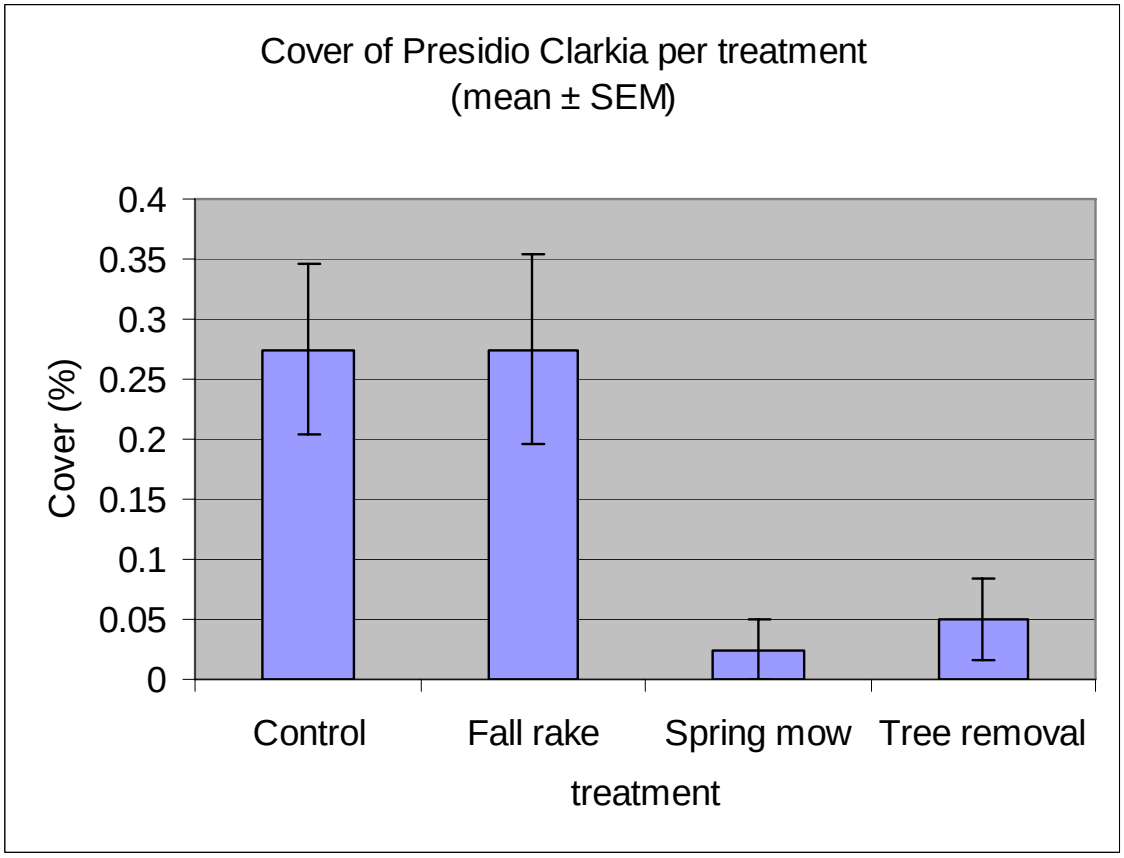


Figure 2: Clarkia cover in 4 treatments

Figure 3 shows the percent bare ground and percent thatch (or residual dry matter) found in each of the surveyed plots. Notably, the tree removal treatment plots showed little bare ground, and high thatch (51.0 ± 2.5), as visually observed by the amount of pine needles on the ground. Control (25.8 ± 3.7) and fall rake plots (19.5 ± 3.0) had the highest percentage of bare ground, which is understood to provide suitable habitat for Clarkia. The spring mow plots contained more thatch (23.8 ± 2.2) than in control and fall rake areas, thus indicating a possible buildup of thatch from the annual grasses.

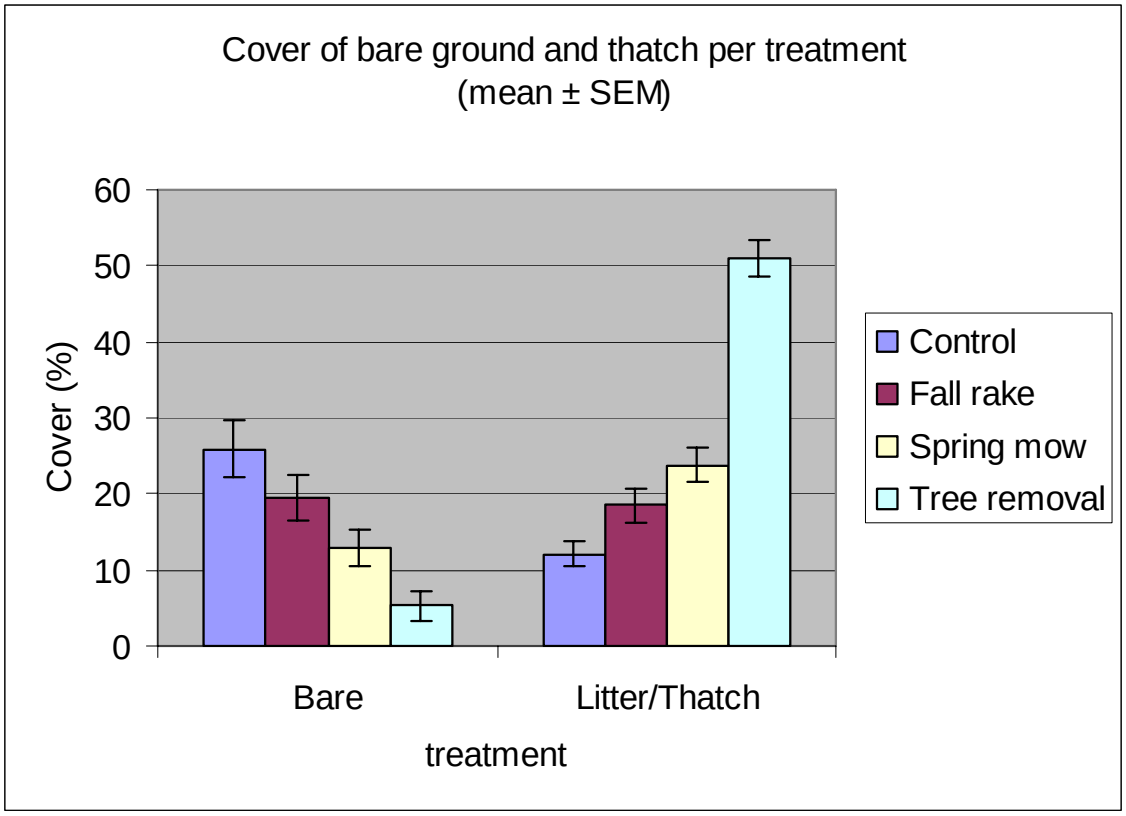


Figure 3: Cover of bare ground and thatch per treatment

Data were analyzed to determine the percent cover of several guilds of plants found in each of the treatments. Figure 4 shows that each plot, regardless of location, showed about equal cover of native perennial forbs. Native annual forbs preferred plots and sites with more bare ground and less thatch, thus were present at about 10% cover in both the control and fall rake plots. Native annual forbs dropped off significantly in plots with tree canopy or an abundance of non-native annual grasses (spring mow and tree removal). Notably, native perennial grasses were observed at equal levels among all treatment plots except for the tree removal plots where 18.9 ± 2.8 of the cover was native perennial grasses that were tolerant of pine needles and heavy shading. In these same plots, non-native annual grasses were a much lower percent of the cover (12.6 ± 2.1).

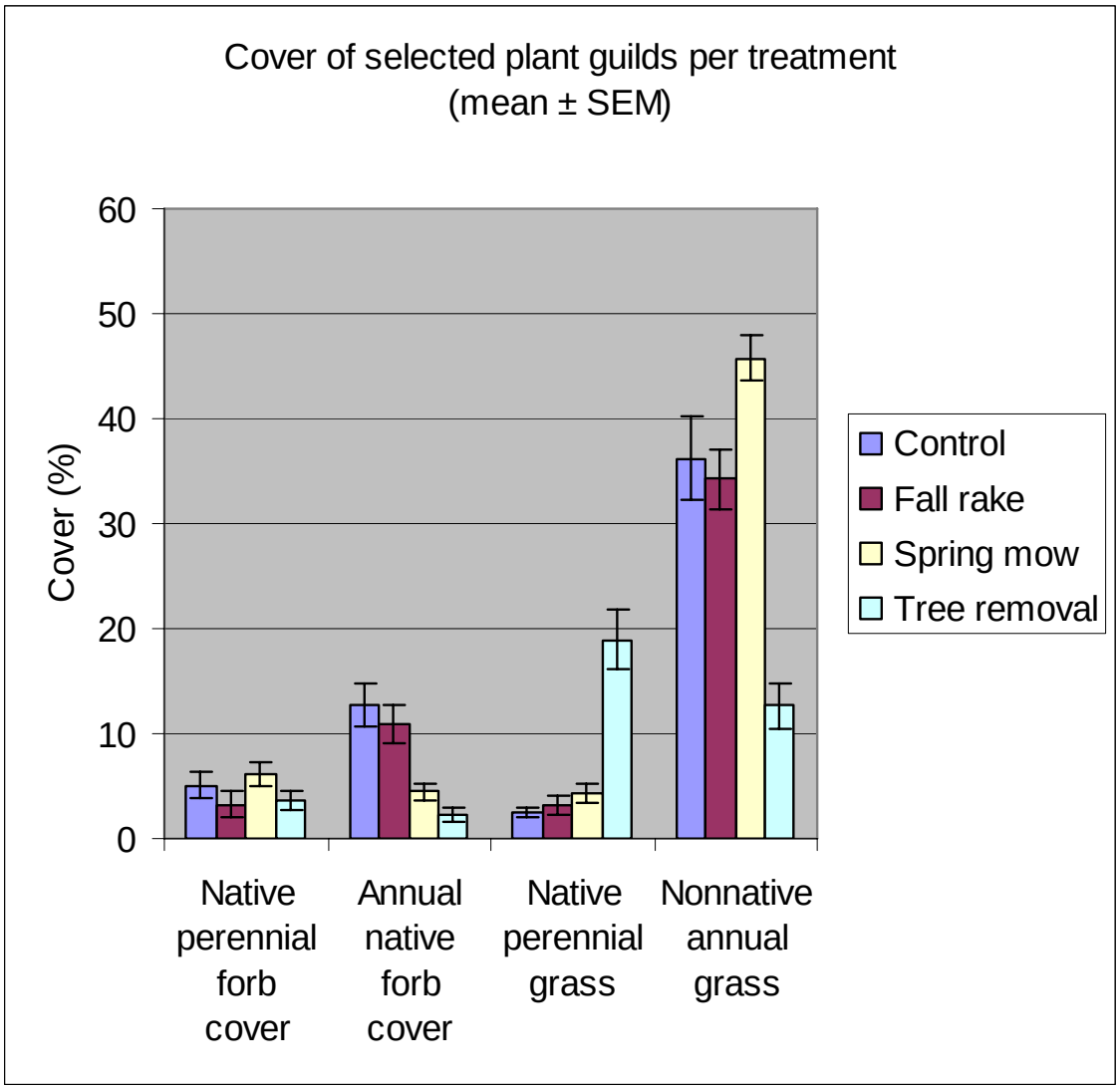


Figure 4: Cover of various plant guilds in the treatment plots

Because baseline surveys of the Serpentine Prairie find the number of native species outnumbering non-natives by a 3:1 ratio, analysis of percent cover is also offered of each of these categories. The highest ratio of native to non-native plants was found in the tree removal plots, where it is anticipated that native perennial grasses benefit from a wetter, shaded understory. Tree removal plots had 28.9 ± 2.5 native cover, but only 13.9 ± 2.3 non-native cover. Spring mow plots had the highest non-native cover (46.7 ± 2.2), dominated by annual grasses, while only having 15.8 ± 1.5 native cover. Control and fall rake plots were indiscernible in their total covers and ratios.

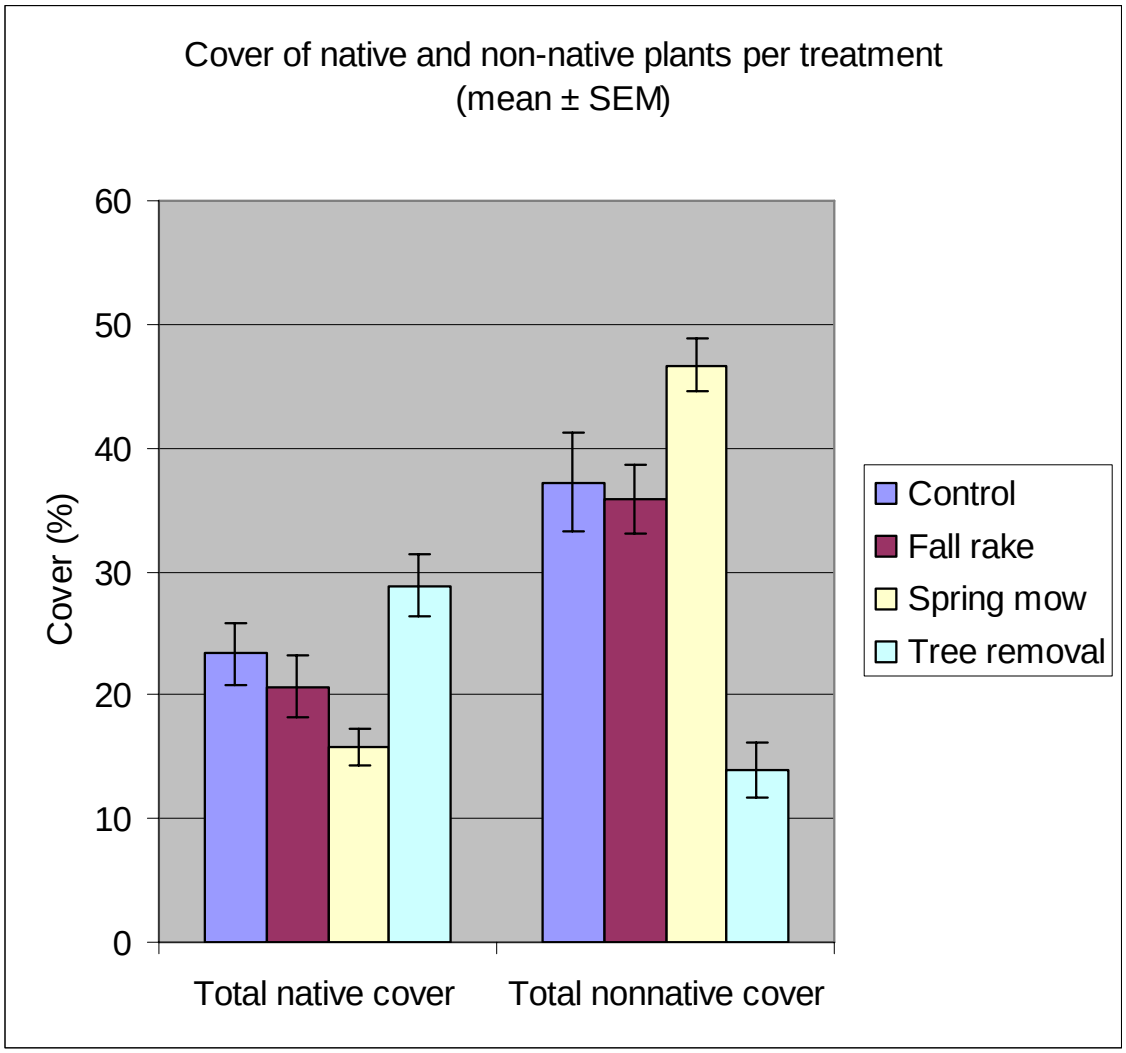


Figure 5: Native vs. Non-native cover in each treatment

The tree removal plots have a unique vegetation community below the Monterey pines, including a large percent cover of native perennial grasses. Other taxa found predominantly or exclusively in the tree removal plots are listed in Table 1. These same areas were found to have juvenile pine tree, bay, and oak tree recruits.

Table 1: Taxa found predominantly or exclusively in the tree removal plots

Agoseris heterophylla
*Agrostis pallens**
Chlorogalum pomeridianum
Daucus pusillus
Elymus glaucus
Festuca idahoensis
*Festuca rubra**
Nasella lepida
Quercus agrifolia (juvenile)*
Rumex acetosella
Sanicula tuberosa
Trifolium albopurpureum var. *albopurpureum*
Uropappus lindleyii
Vulpia microstachys
*Species found exclusively in tree removal plots

Discussion

The plots show substantial variation between treatment types, as expected given the targeted habitat types. Areas with low bare and high thatch cover were found to have little Clarkia as well as a low cover of native annual forbs. Therefore, we anticipate an increase in native annual forbs with the selected treatments, which aim to increase bare ground and reduce thatch. Manual seed dispersal may be required to establish Clarkia.

An important discovery is the very high native cover in the tree removal plots, as well as the list of species that were entirely or mainly found in those plots. While some of these species are undesirable, such as the nonnative *Rumex acetosella* or even native *Quercus agrifolia* juveniles, many native perennial grasses were limited to plots under the tree canopy. The native grasses are shade tolerant and appear to thrive in the pine needle/thatch dominated understory. We anticipate that the percent cover of native grasses in these plots may decrease once the trees are removed, thus shifting this habitat to more xeric and sunny. The valued biodiversity of the Serpentine Prairie may depend in some part on the tree canopy.

Appendix B

2009 Annual Report: Year 1

Serpentine Prairie Restoration Project Redwood Regional Park

2009 Annual Report: Year 1

A Creekside Center for Earth Observation Project
Lech Naumovich, Christal Niederer, Stuart Weiss

Contents

Executive Summary

The Serpentine Prairie Restoration Project was initiated in 2008. The Redwood Regional Park – Serpentine Prairie study area is located on land owned and managed by the East Bay Regional Park District (EBRPD).

Data from 2008 represent baseline conditions. Data collected in 2009 represent Year 1, or the results of a single year of treatment.

In both years, Presidio Clarkia (*Clarkia franciscana*) individuals were sampled in a 100 x 300 m macroplot. With 80% confidence, the Clarkia count in the macroplot in 2009 is estimated to be 63,210 ± 8627. This number is significantly increased from the 15,569 ± 1888 individuals reported in 2008. The climate, specifically late spring precipitation in 2009, is believed to be the main cause for the dramatic increase in individuals.

Thirty-two experimental plots were observed for Presidio clarkia individuals and vegetative cover. At the time of data collection, the spring mow and fall rake plots had been treated. The tree plots were treated in August and September 2009, after data collection. At the time of this report, fence installation has begun in the central serpentine prairie area as described in the Serpentine Prairie Restoration Plan. Therefore this report examines the effects of control, spring mow, and fall rake plots only.

Clarkia individuals did not increase more in treated areas than in the control. Both spring mow and fall rake plots showed significant increases in bare ground and decreases in thatch compared with the control. The spring mow additionally significantly increased native plant cover, namely annual forbs, by significantly reducing non-native annual grasses. After a single year of treatment, the spring mow plots are now statistically similar to the Clarkia-occupied control plots in such key parameters as non-native annual grass cover, annual forb cover, and overall native cover.

A lack of Clarkia seedbank response implies that this plant is seed limited on the prairie. Broadcasting locally collected seed into mowed or otherwise appropriate habitat on the prairie is suggested.

Introduction

The Redwood Park Serpentine Prairie is the largest undeveloped outcrop of a much larger expanse of exposed serpentine soils that once existed in the Oakland Hills, between Skyline Boulevard and the Warren Freeway and northeast to Joaquin Miller Park. In the 1960s, hundreds of pines and acacias were planted. More recently, shrubs have expanded around the margins of the prairie, and an increasing number of park users have also added to the landscape impacts. The purpose of this restoration plan is to restore the vitality and botanical diversity of the Serpentine Prairie, manage the site to ensure survival of special status species associated with the prairie, and provide for the enjoyment of park users. [Excerpted from *Serpentine Prairie Restoration Plan*, EBRPD]

Methods

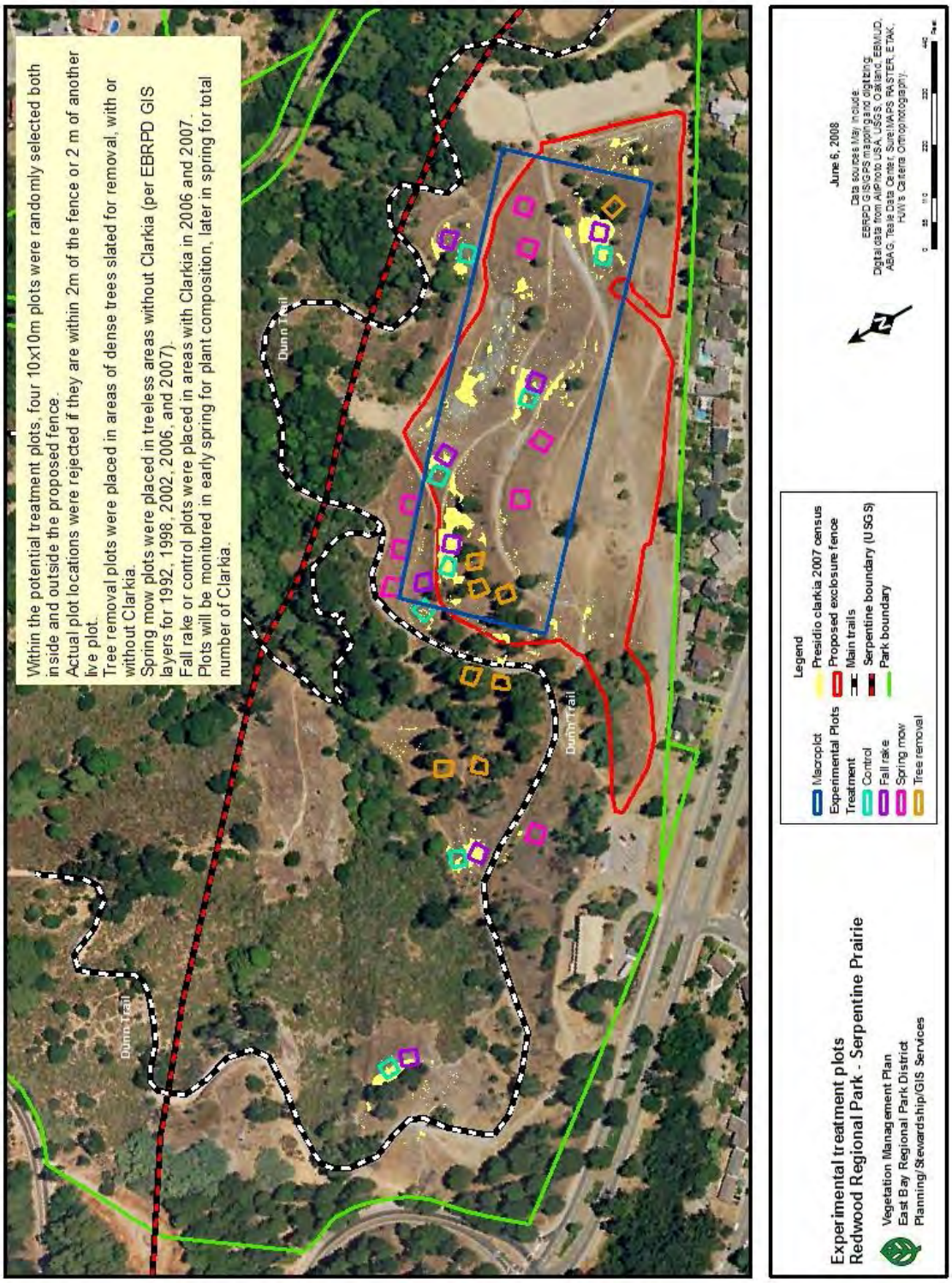
The primary goal of the restoration project is to restore the health and vitality of the Serpentine Prairie located at Redwood Regional Park, Alameda County. Particular emphasis is placed on managing the federal- and state-listed endangered Presidio Clarkia (*Clarkia franciscana*). Work completed includes:

- Establishing a 100 x 300 meter macroplot inside the core Presidio Clarkia population in April 2008. Macroplot corners were established with 6-foot T-bar posts hammered to a depth of approximately 24 inches.
- Establishing 32 10 x 10 m permanent treatment plots with wooden stakes in April 2008 (Figure 1). All locations were mapped with a sub-meter accurate Garmin GPS.
- Censusing Clarkia in each of the 32 permanent treatment plots in May 2008 and 2009.
- Spring mow treatment with handheld gas trimmer at 8 permanent treatment plots in April 2008 and 2009.
- Fall rake and thatch removal with metal gardening rake at 8 permanent treatment plots in September 2008 and 2009.
- Provision of meter-by-meter distribution and density data for Presidio Clarkia surveyed in the macroplot in May 2008 and 2009 to EBRPD staff.

Permanent treatment plot locations were selected for the experimental treatments with the following guidelines. Control plots were located in areas known to contain Clarkia, allowing us to determine the effect of environmental conditions on the annual variability of Clarkia abundance. Fall rake plots were located in areas where Clarkia was present in low concentrations, with raking occurring only after seed set. No negative impact on Clarkia is expected from raking these plots. Raking was expected to reduce thatch,

which has been shown to inhibit germination of forbs such as Clarkia. Spring mow plots were located in areas where Clarkia was not surveyed so that no take of the species would occur. Spring mowing was anticipated to reduce cover of annual grass, which has been shown to outcompete annual forbs such as Clarkia. Tree removal plots were located in areas beneath pines. These areas were not expected to have Clarkia, due to a thick duff layer of needles. Tree removal is expected to reduce shading and thatch, which are detrimental to open grassland forbs such as Clarkia.

Plate 1: Data collection in spring 2008.



Map 1 shows the location of experimental and control plots. The initial plot selection was supported with maps showing the distribution of Clarkia in 2007, provided by the Park District. The macroplot and proposed fence boundary are also shown.

2008 and 2009 Treatments

A spring mow was conducted in late April when the majority of non-native annual grasses were in the soft dough stage. Cut material was left in place. The fall rake occurred in September before the first rains but after the majority of Clarkia seed pods had opened. Photos of these treatments are presented below in Plates 2 and 3.

Plate 2: Post-treatment of two spring mow plots (S7 & S8)

Plate 3: Fall Rake Treatment, Plot F8

Phase one of tree removal occurred in August/September of 2009. This phase removed trees that were formerly impacting plots T1, T2, and T3. All data for this report were recorded before tree removal, therefore, there is no measurement of the effect of tree removal in this annual report.

Although fence construction was initially planned in 2008, and would impact half of the plots, the fence was not installed before data collection in 2009. Therefore no data will be presented comparing plots inside vs. outside the fence. As of November 2009, fence installation has begun and is scheduled for completion before the end of the year.

Data Collection and Analysis

The Clarkia population of the macroplot (100 x 300 meters) was estimated by selecting twenty 0.5 x 300 meter transects using a restricted random start.[1] Total individuals were counted along each one meter interval.

For plot census data, each individual Clarkia in the entire 10 x 10 m permanent treatment plot was counted. For cover data, percent relative cover of each species, plus bare ground and thatch, was recorded in each of five evenly spaced 0.25m^2 quadrats in each treatment plot.

Vegetation information for each of the plots was collected in the spring when the majority of plants were identifiable (Apr). Tree plot data were collected later (June) since shade created a later phenology. Individuals in the macroplot and experimental treatment plots were counted in May.

Data were entered into a Microsoft Access database for analysis. All data were checked for quality control by revisiting all the entered numbers.

Results

Macroplot

With 80% confidence, the population of the macroplot for 2009 is 63,210 ± 8627 individuals. The 2009 estimate is significantly greater than the 2008 estimate of 13,845 ± 1888. A total of 10% of the area was sampled to achieve the 2009 estimate.

Annual variation of climate is known to affect the distribution and frequency of annual plants. The total annual precipitation for 2008 and 2009 was similar, but the amount of spring rainfall was dramatically different. Late season rain appears to be a critical variable for Clarkia, which is a late annual bloomer. The spring precipitation (March-June) for 2008 was 0.81 inches (the lowest in 10 years) versus 4.95 inches in 2009 (Figure 1). Similar interannual variability in Clarkia is seen in populations at the Presidio,

1 Note that in 2008, data were collected in 1 x 300 m transects. Analyzing that year's data showed we could meet the parameters of our sampling goal using skinnier transects, which required less time and created less impact on the rare plants.

San Francisco, where large swings in population size can occur from year to year, including a large increase from 2008 to 2009 (Figure 2).

Figure 1: Precipitation at the Serpentine Prairie: Annual data (Oct-Sept) and Spring (Mar-June). Source: Westmap (http://www.cefa.dri.edu/Westmap/)

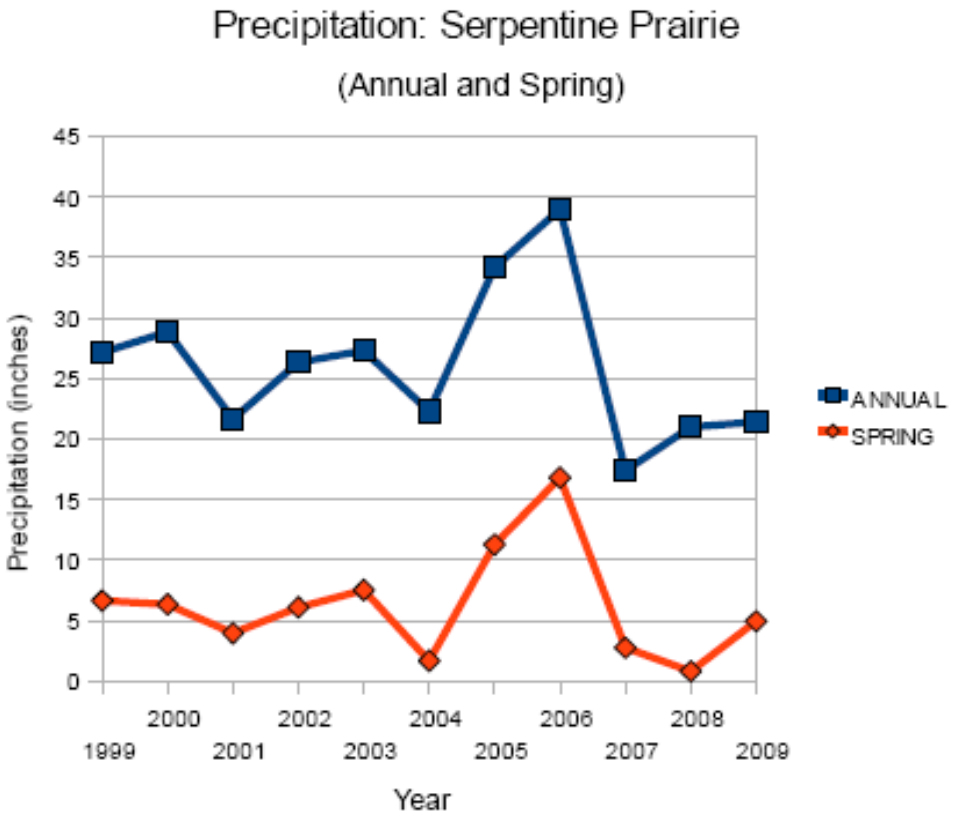
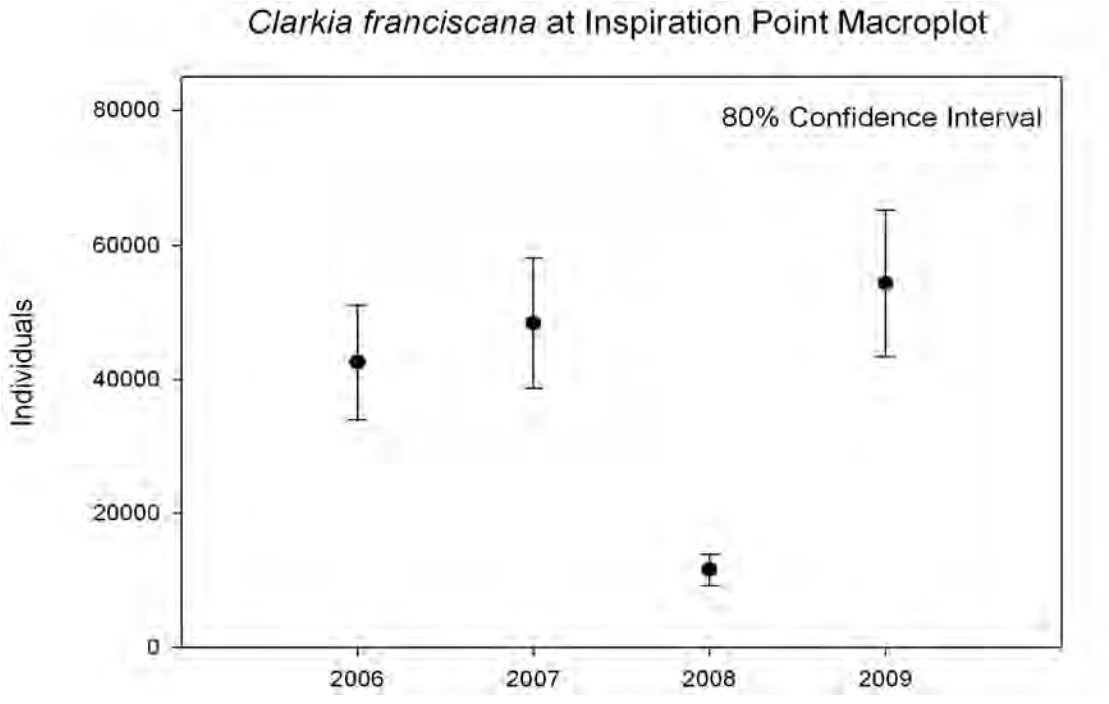


Figure 2: Presidio Clarkia sampling data from Inspiration Point, San Francisco Presidio. Data from L. Stringer, GGNRA.



Clarkia Plot Census

Each of the experimental treatments showed a statistically significant increase in individuals from 2008 to 2009 (Table 1). Notably, the 2009 control and fall rake treatment plots had about a 2.5X increase from 2008. Spring mow plots, where no Clarkia was observed in early May of 2008, had 24 individuals (23 in plot S5 and 1 in S8) in 2009. These individuals were noted *after* the second year of treatment. The tree removal plots show a 12X increase in number of Clarkia individuals from 2008, yet a much smaller absolute increase compared to the control and fall rake treatments. No trees were removed before data collection, so changes here are due to climate rather than treatment. None of the increases in treated plots are statistically different from the increase in the control.

Table 1: Total Clarkia individuals per treatment

	2008	2009
Control	1229	3030
Fall Rake	1238	3254
Spring Mow	0	24
Tree Removal	15	184

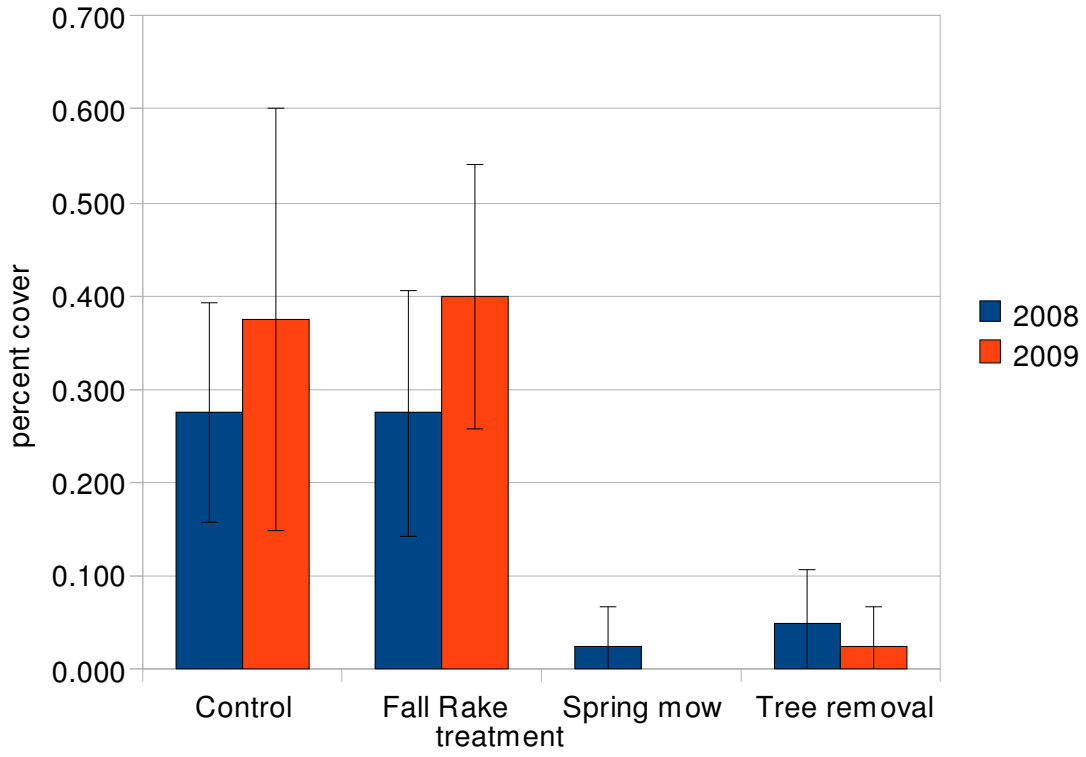
Experimental Treatments

CLARKIA COVER

No significant change in the cover of Clarkia was observed in any of the treatments (Figure 3). Clarkia is present in similar coverage as last year, regardless of the increase in number of individuals. Since Clarkia cover is so low, the census data above are probably a better indicator of treatment efficacy.

In 2009, no Clarkia was detected in the spring mow sampling plots at the time of survey, versus a trace amount in 2008. (The opposite trend was found when censusing the entire spring mow plot, Table 1).

Figure 3: Average Cover of Clarkia
±90% CI



BARE GROUND AND THATCH

The percent of bare ground significantly increased after one year of treatment for both the fall rake and spring mow plots (Figure 4). Thatch declined in the fall rake and spring mow treatments (Figure 5).

Figure 4: Percent Bare Ground
±90% CI

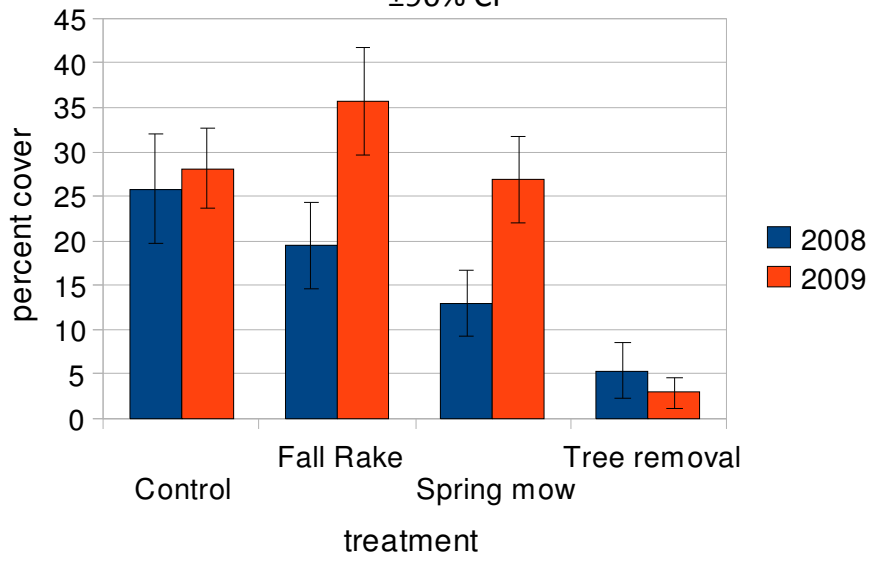
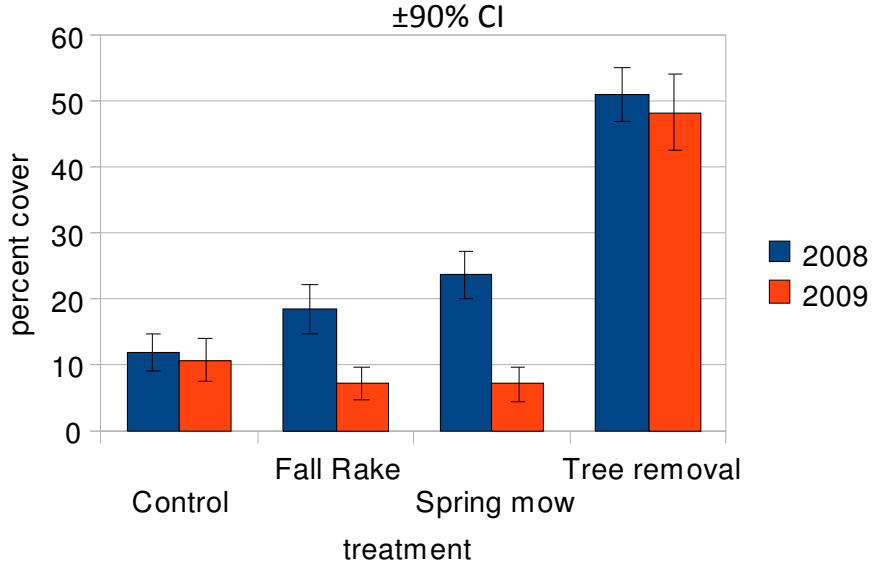


Figure 5: Percent Thatch
±90% CI



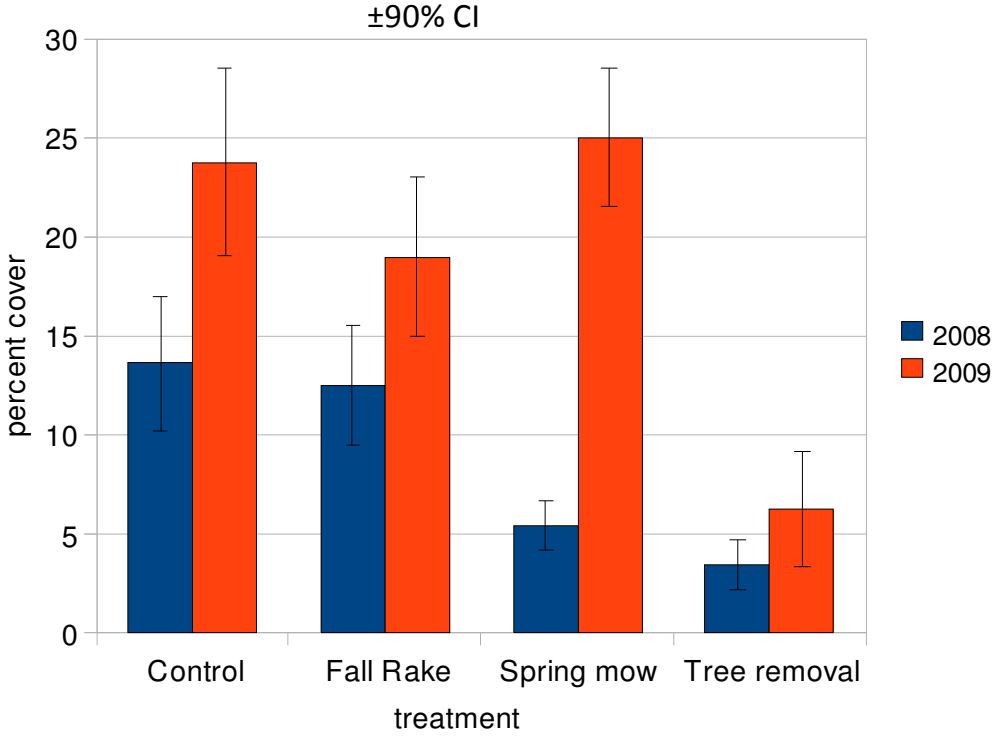
Treatment by Guilds

Data were analyzed to determine the percent cover of several plant guilds found in each of the treatments.

ANNUAL FORBS

Annual forbs as a whole are typically sensitive to changes in interannual climate. Since the two years had substantially different patterns of precipitation, the control plots reflected a significant difference in the percent cover of annual forbs. Meanwhile, the fall rake and tree removal plots (a treatment not completed in 2009) had insignificant increases (Figure 6). Notably, the greatest increase in annual forb cover was observed in the spring mow plots. The 2008 cover was 5.45 ± 1.21, and 2009 percent cover increased to 25.0 ± 3.46. The areas selected for spring mowing contain a viable seed bank that is released if non-native annual grasses are mowed in a timely manner. More than 90% of the annual forb cover recorded is native, so increasing this guild provides an important ecological benefit for the Prairie.

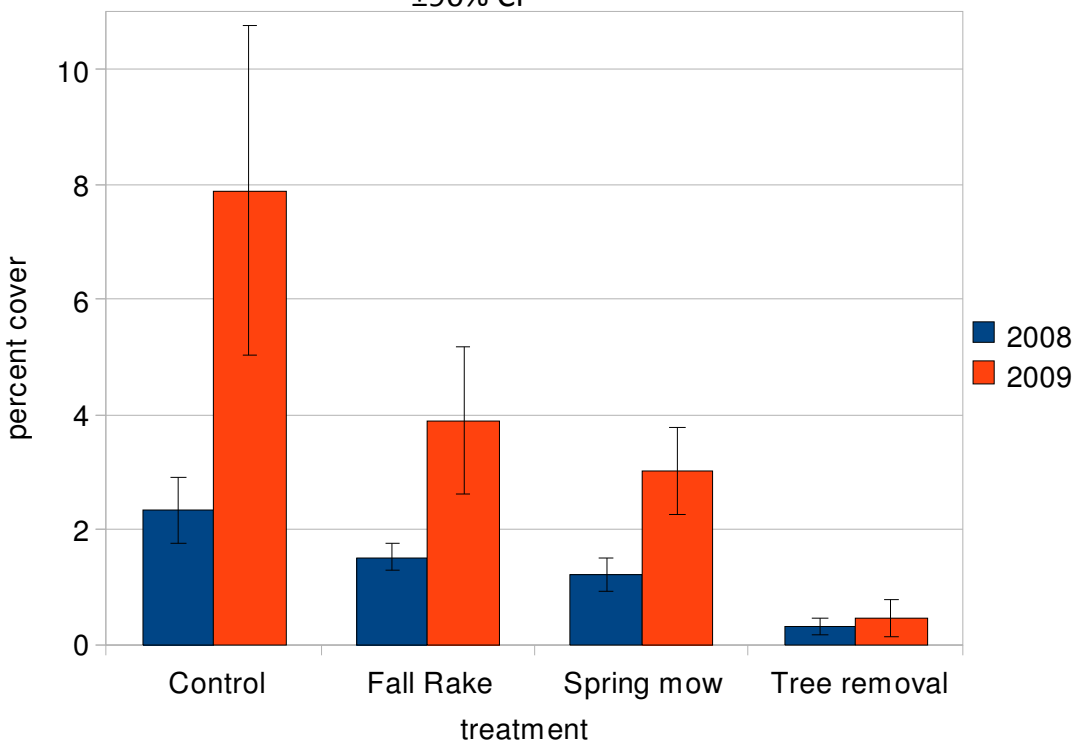
Figure 6: Percent Cover for Annual Forbs ±90% CI



NATIVE LEGUMES

All treatments except for the tree removal (which did not occur) showed a significant increase in native legumes (Figure 7). Compared with the control, none of our treatments can be interpreted to affect total cover of native legumes.

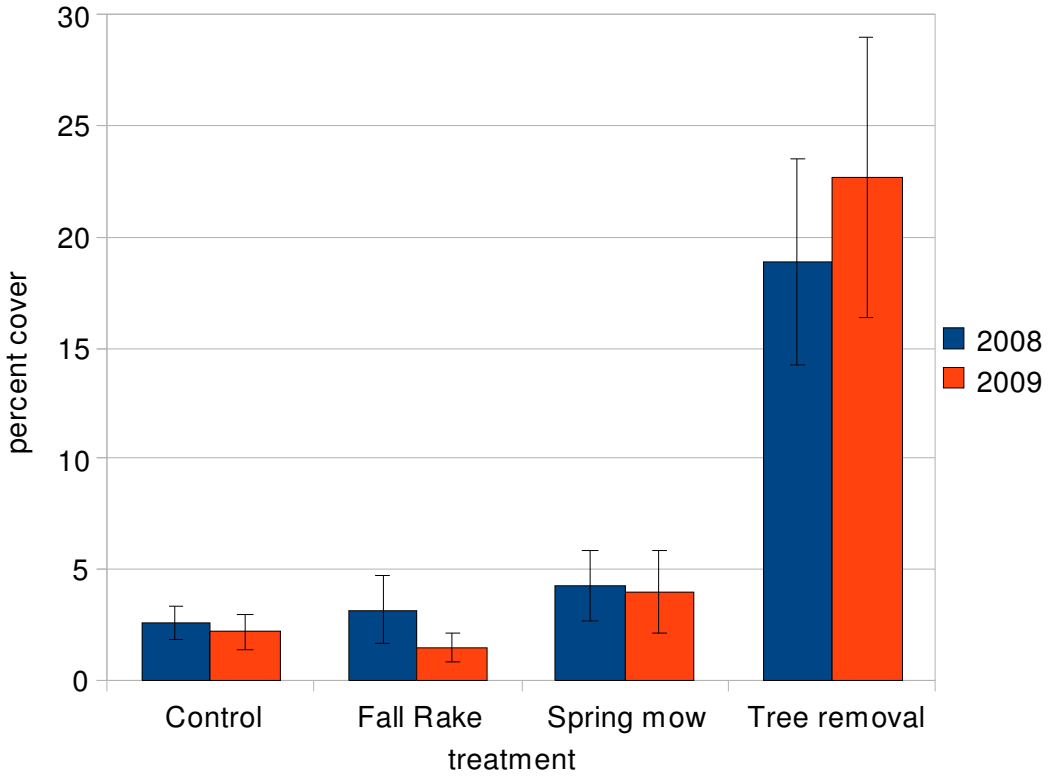
Figure 7: Percent Cover of Native Legumes ±90% CI



NATIVE PERENNIAL GRASSES

No difference was observed in the cover of native perennial grasses from 2008 to 2009 (Figure 8).

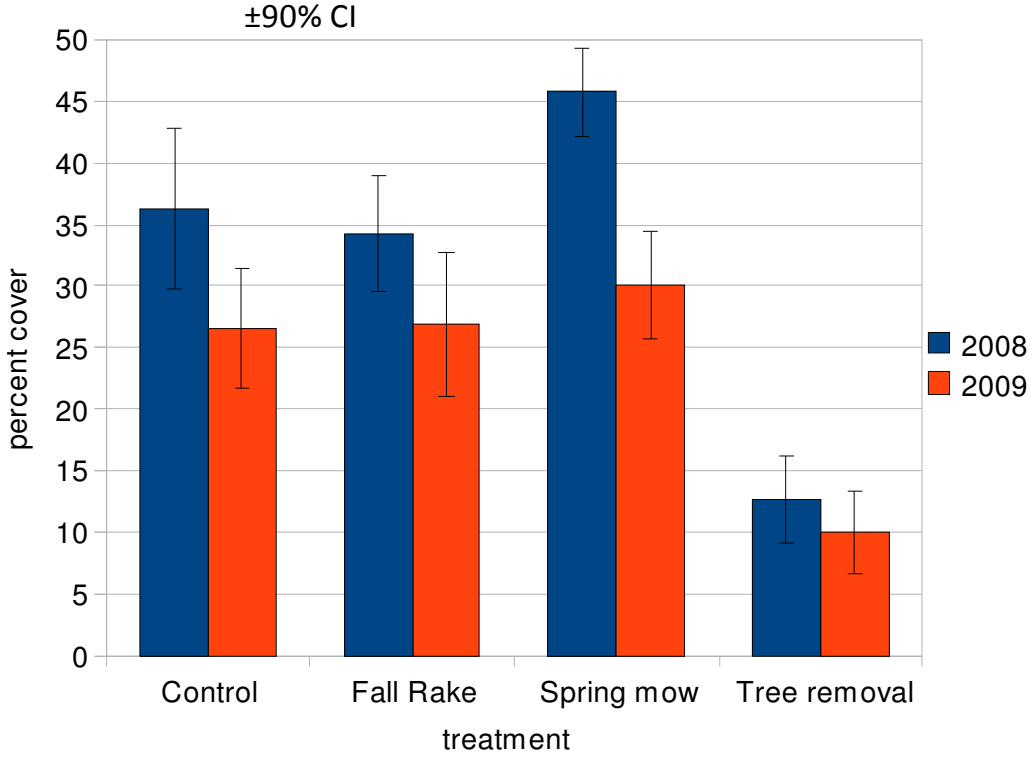
Figure 8: Percent Cover of Native Perennial Grasses
±90% CI



NON-NATIVE ANNUAL GRASSES

No significant effects on annual non-native grasses were recorded in three of the four treatments, but one year of spring mowing produced a significant reduction in cover of non-native annual grass (Figure 9). Cover was reduced from 45.8 ± 2.7 to 30.1 ± 2.1, which equates to roughly a 33% decrease in one year of treatment.

Figure 9: Percent Cover of Non-Native Annual Grasses ±90% CI



NATIVE AND NON-NATIVE PLANTS

Spring mowing was the only treatment to significantly increase native cover and significantly decrease non-native plant cover (Figures 10 and 11).

Figure 10: Percent Cover of Native Plants ±90% CI

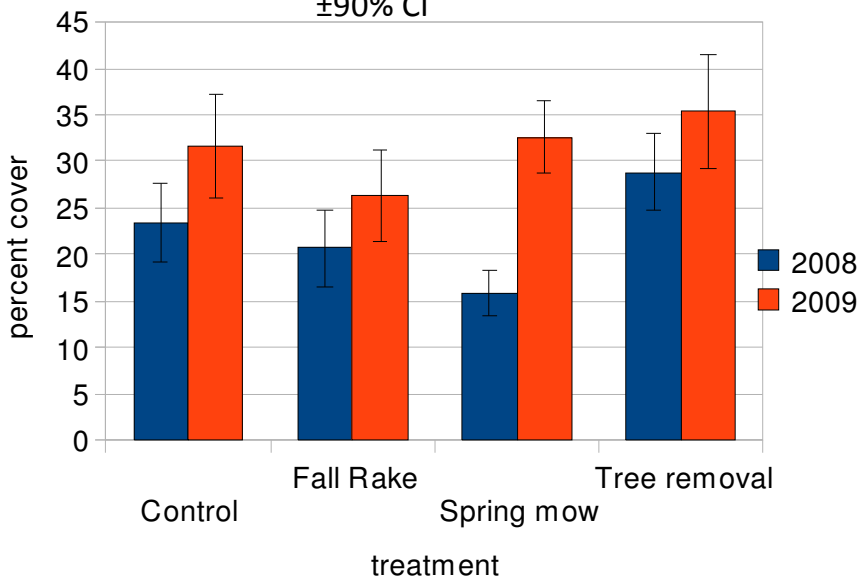
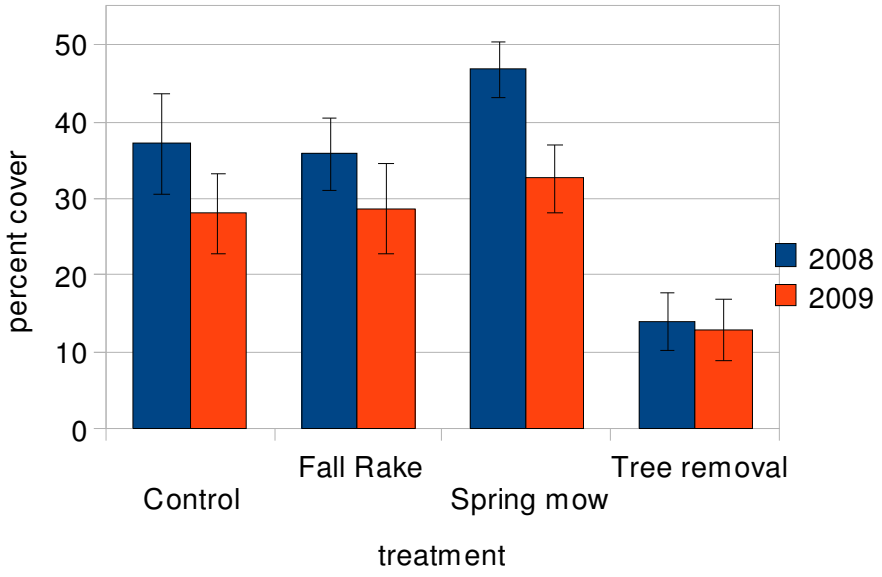


Figure 11: Percent Cover of Non-Native Plants ±90% CI



Discussion

Climate variability is an important factor that affects Presidio Clarkia. While 2008 and 2009 total precipitation was similar, spring precipitation was much higher in 2009. Clarkia population estimates for the macroplot increased nearly fivefold in 2009, similar to increases documented at the Presidio in San Francisco. Census data for the plots show that Clarkia increased in each treatment type, and individuals were seen in spring mow plots that were not observed last year.

The control plots showed a significant increase in Clarkia numbers (1229 to 3030) and native annual forb cover, including legumes.

Fall rake plots also showed a significant increase in Clarkia individuals, but not significantly different from the control. This treatment significantly increased bare ground and decreased thatch. Native forbs increased, but not significantly. Results from the second year of treatment will determine the effectiveness of raking for improving native plant cover.

The spring mow experimental treatment significantly reduced non-native annual grasses and thatch. Total native vegetation, native annual forbs, and bare ground increased in these plot treatments, indicating that desirable species or conditions were replacing the non-native annual grasses. Baseline data showed these plots to be statistically higher in non-native annual grasses, and lower in native forbs and overall native cover, when compared to Clarkia-occupied control plots. After a single year of treatment, the spring mow and control plots are statistically similar in these critical parameters.

Spring mow effects on Clarkia were mixed. No Clarkia was found during 2008 plot census (individual counts), although a few individuals were found in the sampling plots a week later (% cover). Presumably these plants were very small and were simply not detected in the tall untreated grass during the census. In 2009, census numbers increased throughout the entire mowing plot, although this effect was largely limited to plot S5. These counts were made *after* the 2009 mowing treatment, showing that individual Clarkia could survive and flower after two years of early season mowing. The sampling plots nested within the treatment plot showed a decrease in cover, however. This may illustrate a vegetation dynamic in which this plant's recruitment patterns change on a small scale in response to competition and other factors. Further monitoring of Clarkia response to spring mowing will address these issues in more detail.

Tree plots served as control plots with a conifer overstory, since no tree removal was completed before the surveys. Changes therefore appear to be weather-related. These shaded controls sometimes behaved differently than the official controls in the open grassland. Most notable was the 12-fold increase in Clarkia numbers, a much larger relative change than the control or any other treatment. Compared to the official control, these plots had smaller increases in native annual forbs, including legumes. This is

probably due to the very high perennial grass cover in these plots, which is not expected to be as responsive to annual climate differences as annual forbs.

Year 2 Proposals

Year two will begin to provide a clearer picture of effective methods for improving habitat for Clarkia and other native species. The effects of tree removal should begin to show, and the potential installation of a protective fence will provide another treatment to examine.

The Serpentine Prairie restoration plan acknowledges that restoration experiments in Presidio Clarkia habitat at the Presidio in San Francisco should inform decisions made at this site. Tree removal has been extremely successful at the Presidio, especially when coupled with Clarkia reseeding. Spring mowing in the Presidio has not been shown to significantly reduce annual grasses, perhaps because that site has a much stronger coastal influence. The increased moisture and longer growing period in the Presidio may make it more difficult to successfully use a single mowing treatment. Post germination treatments of flaming, tarping, and scraping have been very successful in reducing annual grasses. These same three treatments have also been successful in establishing Clarkia, but only in areas previously occupied by Clarkia, or where Clarkia was seeded in (Niederer and Weiss, Presidio Clarkia Habitat Restoration Project at Inspiration Point, 2009).

Based on site differences, the delay in tree removal and fence building, and the initial success of spring mowing, the three post germination treatments are not currently recommended, although they may be in the future.

Collecting Clarkia seed onsite for reseeding is highly recommended, based on the apparent lack of seedbank response in unoccupied areas. The range of Clarkia at the Presidio has been expanded relatively easily with such active dispersal. (Staff refer to treated and seeded areas as “Clarkia farms” due to the dense concentrations and robust individuals.) Seeds should be collected at different times in the season from throughout the prairie, from large and small individuals, to capture a range of genetic diversity. To avoid overcollecting, seeds could be limited to less than 1% of the seedset in the first year while efficacy is being tested. Areas to be seeded should have bare ground and low annual grass cover. The Hunt Field has these characteristics, and should be considered for reseeding after the protective fence is installed to prevent trampling.

Presidio Clarkia in foreground during research work at the Serpentine prairie.