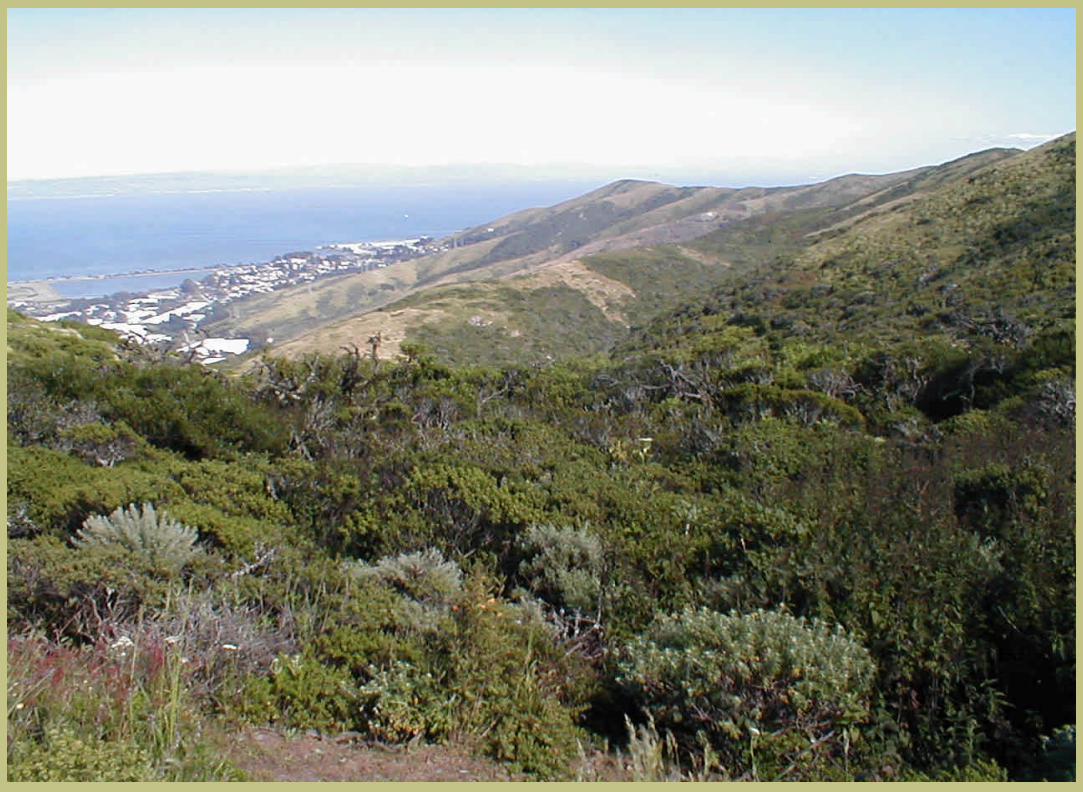
SAN BRUNO MOUNTAIN HABITAT CONSERVATION PLAN



Year 2005 Activities Report For Endangered Species Permit PRT-2-9818

Submitted to the United States Fish and Wildlife Service

by the
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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

GLOSSARY

ANOVA - A statistical procedure called Analysis of Variance. ANOVA allows us to test whether the mean (or average) for butterfly abundance for a given year or on a given transect is statistically different than another year or transect. The procedure will allow us to determine if our sampling efforts are sufficient to detect relative changes in MB/CS/SBE abundance between years and between transects.

Callippe Amendment - An Amendment to the San Bruno Mountain Habitat Conservation Plan. The purpose of the Callippe Amendment is to:

- Add the endangered Callippe silverspot butterfly, listed in 1997, hitherto a species of concern on San Bruno Mountain, to the Endangered Species Act (ESA) section 10(a)(1)(B) permit for incidental take, and appropriate conservation, monitoring, and funding measures.
- To reflect changes and new information regarding covered species status, habitat preservation, habitat restoration techniques, and changes in federal statute, regulation and policy governing HCPs that have occurred since 1983.
- To assess the effect of the HCP on the recently designated Bay Checkerspot butterfly critical habitat (2001).
- To add specificity to timelines and management goals for the conserved lands in the HCP.
- To assess the extent of the non-native species invasion and natural succession and its effect on the Callippe silverspot, Mission blue, and San Bruno elfin, and their habitat; include measures to address these effects.
- To address funding issues for the HCP.

Correlation - Tests for a relationship between two variables.

Endangered - any species which is in danger of extinction throughout all or a significant portion of its range, other than a species of the class Insecta determined by the Secretary to constitute a pest whose protection under the provision of this Act would prevent an overwhelming and overriding risk to man", (Federal Endangered Species Act, 1973).

Endangered Species Act - means the Federal Endangered Species Act (ESA) of 1973, as amended, 16 U.S.C. Sections 1531-1543. The State of California also has an endangered species act which is referred to as the California Endangered Species Act (CESA).

Invasive Species - species which have been introduced into local habitat from outside the United States and which often become pests, outcompeting native species.

Fixed transects - Permanently marked transects that are surveyed year after year. It provides a means to compare butterfly observations from year to year at specific locations using standard statistical procedures.

Fixed points - Permanently marked points that are surveyed year after year.

Habitat Conservation Plan (HCP) - the San Bruno Mountain Area Habitat Conservation Plan as adopted by the County Board of Supervisors on September 14, 1982 (Resolution No. 43770).

Habitat Islands – small areas of native habitat established in restoration sites. Native plantings are installed in relatively small islands where weeds can be controlled more easily. This approach cuts down on the area where maintenance is required. A recommended size for planting islands is from 0.1 - 0.25 acres.

Host plant - particular species of vegetation required by butterflies as an energy source for survival in the first stages of development, on which the adults will oviposit. For Mission Blue: the three *Lupinus* species; for Callippe: *Viola pedunculata*; for Elfin: *Sedum spathulifolium.*

Incidental observation - A butterfly observed outside of the transect (or point survey area) or in the transect (or point) vicinity during travel between survey areas is recorded as an incidental observation.

Management - treatment afforded portions of SBM to enhance or protect existing habitat or to reclaim habitat lost to construction or other disturbance.

Monitoring - the task, undertaken by the Plan Operator of regular observation of biological processes, development and conservation activities on San Bruno Mountain; the purpose is to assure compliance with the plan, and to measure the success of its implementation.

Prescribed burn - The process of burning an area of land in order to kill certain plant species and to favor the growth of others. Prescribed burns are also used to reduce fuel loads. The burn must be conducted during weather conditions optimizing temperature, humidity, and wind speed for burn efficiency and safety.

Regression - A line of best fit used to define the relationship between two variables.

Section 10a - a section of the Endangered Species Act which authorizes the Secretary of the Interior to permit, under such terms and conditions as he may prescribe, any act otherwise prohibited by Section 9 of the Act. The acts may be permitted for scientific purposes, or to enhance the propagation or survival of the affected species (16 U.S.C. Section 1539).

SUMMARY

In 2005, a variety of habitat and species management work was conducted on San Bruno Mountain to satisfy the requirements of the U.S. Fish and Wildlife Service (USFWS) Incidental Take Permit (PRT 2-9818). This work included monitoring the Callippe silverspot butterfly (*Speyeria callippe callippe*, CS), conducting invasive species control work and habitat restoration, monitoring development activities, and coordinating with volunteer groups and oversight agencies.

Covered Species Population Status and Take

Under the San Bruno Mountain Habitat Conservation Plan (HCP), the primary emphasis of the biological monitoring is to evaluate the population status of the endangered butterflies occurring on the Mountain. Special-status species that are monitored on San Bruno Mountain include the Mission blue (*Icaricia icarioides missionensis*, MB), Callippe silverspot, and San Bruno elfin (*Callophrys mossii bayensis*, SBE) butterflies.

Beginning in 2005, butterfly monitoring was modified to an every other year schedule. In 2005, fixed transects were used to assess that status of the Callippe silverspot butterfly on San Bruno Mountain. Mission blue and San Bruno elfin butterflies were not monitored, although incidental observations of Mission blues on the CS transects were recorded. Fixed transect data for CS were analyzed using Analysis of Variance (ANOVA).

In 2005, a total of 577 CS were observed on all of the fixed transects. This corresponds to a sightings per hour (S/H) of 14.53. This is slightly above the S/H calculated for 2002, and is greater than the annual S/H since 2001. A significant difference was found in S/H between years due to the relative abundance of CS in 2001. When data from 2001 are removed from the analysis, there is no significant difference between years.

A one-time survey of CS on the South Slope was performed in 2005. A total of 35 CS were observed, which corresponds to an average of 8.13 S/H. Although this data set is too small to draw conclusions from, it does make evident that CS are present at some extent on the South Slope, and in our snapshot survey, were sighted at a rate similar to that found across the last six years at the permanent transects.

Temperature and rainfall were examined with respect to CS abundance. No significant correlation was found between these variables and CS abundance, although a trend was observed of an increase in CS S/H following heavier rain years. Continued years of monitoring and comparison of CS data to weather data will allow for a more robust correlation analysis.

Abundance data from six consecutive years, although inadequate to detect long-term changes in population dynamics, can suggest trends of population increase or decline. Our data at this time suggests that the CS population on San Bruno Mountain exhibits year-to-year fluctuation in population size while maintaining a consistent size over time. As annual fixed transect data are not significantly different from one another (excluding 2001), they do not dictate specific CS management direction aside from what is currently performed. Maintenance of existing CS habitat through weed control and shrub containment, as well as expansion of CS habitat is of highest priority in managing CS. Monitoring of habitat quality, Viola distribution and weed control efforts can provide indirect evidence of butterfly success.

Invasive Plant Control and Restoration

In 2005, 678 acres of invasive plants were treated by hand or with herbicides. Many of these acres were treated many times over for repeat control of various species. The greatest efforts went into treating 1) fennel, gorse, French broom, eucalyptus and cotoneaster in the Saddle, 2) various species on the Northeast Ridge, with most effort spent on fennel and French broom, 3) various species in Wax Myrtle Ravine, and 4) Oxalis in upper Tank Ravine.

As part of the 2005/2006 fiscal year budget, special funding was approved for aggressive control of Oxalis. Efforts will be spent at three locations: above Hoffman Street, along the Ridge Trail, and within select stands at Tank Ravine. Locations were prioritized based on existing butterfly habitat. The Hoffman Street location supports MB habitat, the Ridge Trail location supports SBE habitat, and the Tank Ravine location supports CS habitat. Initial herbicide treatment was performed in December 2005, and follow-up treatment will be performed 2 to 3 more times in the winter/spring of 2006.

Other invasive control work performed in 2005 includes gorse control in the Saddle through a California State Parks Grant managed by the County of San Mateo, invasive species control on six parcels of Myers Development Co. property (South Slope) including the preparation of Juncus and Tank ravines for dedication to the County of San Mateo, invasive species control in various areas by the volunteer group San Bruno Mountain Watch, and restoration of the Colma Creek headwaters under a State Parks Grant managed by the County of San Mateo and performed by the Watershed Project.

Habitat restoration work conducted by Shelterbelt Builders focused on the maintenance of seven habitat islands in the Colma Creek, Dairy Ravine and the Saddle areas. Other habitat islands, funded by the San Francisco Water Department and Brookfield homes, were also maintained.

Grazing

Data from the 2003-2004 pilot grazing project were analyzed. Goat grazing was found to decrease the density of some herbaceous species, excluding grasses. Mowing was more successful in reducing grass density. Due to persistent seed banks, one year of grazing data is not sufficient to generate conclusions, however, observations were useful in providing lessons for future grazing projects. Goat grazing on San Bruno Mountain should target areas in which the goal is to beat back native or non-native scrub vegetation, to remove thatch, or in areas dominated by weeds such as thistle, radish, or fennel. The most cost effective use of grazing would be in areas in which stands of scrub are so large as to render hand removal or herbicide treatment unfeasible or uneconomical. In areas where continued and regular use of grazing is determined to be a sound management practice, establishment of permanent infrastructure would permit such a strategy. Potentially the most viable and long-term solution for managing grasslands and controlling non-native annual grasses is to introduce seasonal cattle grazing on the mountain. The benefits of both goat and cattle grazing over other methods of vegetation management are grazing's adherence to historical processes of vegetation management, a reduction in leftover biomass, reduced herbicide use, and reduced cost (when treating large areas and once infrastructure is intact).

Burning

No prescribed burns occurred on San Bruno Mountain in 2005, although there were three small wildfires, burning approximately 10 acres. CDF prison crews will conduct non-native shrub removal and piling in early 2006. These piles are scheduled to be burned by CDF in winter 2005/2006.

Coastal Scrub Succession

Since the cessation of cattle grazing in the early 1960's and the reduction in wildfires and controlled burning, native coastal scrub vegetation has been expanding on San Bruno Mountain and overtaking grasslands. This phenomenon has resulted in approximately 180 acres of grassland being lost to coastal scrub since the inception of the HCP in 1982. In addition to the loss of grassland, the build up of thatch within grasslands in the absence of burning and/or grazing can reduce native species composition and predispose grasslands to become more weedy over time. Management of expanding scrub communities will require a combination of burning, grazing, and/or mechanical removal to maintain grasslands. Application of any chosen management regime however, will be limited by the current level of HCP funds.

I. INTRODUCTION

This report describes biological and development related activities that took place on San Bruno Mountain under Endangered Species Act Section 10(a)(1)(B) Permit PRT 2-9818 for the 2005 calendar year. It provides information on the status of the butterflies of concern, habitat restoration, work on invasive species control and development activities. Appendices containing data collected in 2005 are located at the end of the report. Anyone interested in reviewing field data or other information collected by Thomas Reid Associates should contact Autumn Meisel at (650) 327-0429 ext. 86 or Sam Herzberg, Park Planner with the San Mateo County Parks and Recreation Division at (650) 363-1823. Previous annual activities reports and data are also available on-line at: http://www.traenviro.com/sanbruno.

With the implementation of the HCP, take of Mission blue butterfly (*Icaricia icarioides missionensis,* MB) habitat on San Bruno Mountain was authorized under the Endangered Species Act Section 10(a)(1)(B) Permit. Approximately 14% of the total MB habitat is allowed to be taken by development. As of 2005, 9% of this take has already occurred. If approved, future take would be limited by the HCP Callippe Amendment to only 2%, resulting in less take of MB habitat than was originally authorized (refer to Section IV for a summary of the status of the Callippe Amendment). Although take of 8% of Callippe silverspot (*Speyeria callippe callippe*, CS) butterfly habitat is allowable under the HCP, no take of CS or it's habitat (*Viola pedunculata*) has occurred or been authorized since the CS was listed as federally endangered in 1997.

As of 2005, 310 acres (9%) of San Bruno Mountain have been developed. This is approximately 77% of the total development originally allowed under the HCP. This includes approximately 25 acres that have been graded to reduce the risk of landslides and these slopes are subject to restoration. Within planned parcels, the remaining portion allowed for development is approximately 70 acres, including 23 acres that are to be disturbed temporarily (graded and then restored). Unplanned parcels, which are parcels that do not currently have a development plan, constitute a total of 305 acres. Most of these parcels are located in the Brisbane Acres.

A map of the San Bruno Mountain HCP management units is provided in Figure 1.

II. STATUS OF SPECIES OF CONCERN

Special-status species that are monitored on San Bruno Mountain include the Mission blue, Callippe silverspot, and San Bruno elfin (*Callophrys mossii bayensis,* SBE) butterflies. Special-status plants on the Mountain were not monitored in 2005.

Beginning in 2005, butterfly monitoring was modified to an every other year schedule. This change was implemented so that a greater proportion of funding resources could be allocated to exotics control, as non-native containment is agreed to be of primary concern in conserving butterfly habitat and the native plant species biodiversity of the Mountain. The butterfly populations have been monitored annually for 23 years and the distribution of all three endangered species is well known. Though monitoring on an every other year basis will require twice as long to detect trends in butterfly abundance on the Mountain, we believe that monitoring on such a cycle will not result in any loss of data that would potentially imperil the species. Because the butterfly populations are highly dependent on the quality of their habitat, protecting and enhancing their habitat is of utmost importance in preserving the species.

In 2005, fixed transects were used to assess that status of the endangered Callippe silverspot butterfly on San Bruno Mountain. Mission blue and San Bruno elfin butterflies were not monitored, although incidental observations of Mission blues on the CS transects were recorded.

A. Mission Blue Butterfly (*Icaricia icarioides missionensis*)

Mission blue butterflies utilize three larval host plants, all of which are present on the Mountain: *Lupinus albifrons var. collinus, Lupinus formosus var. formosus* and *Lupinus variicolor*. Early flying MB (March- April) are associated with *L. albifrons*, and late flying MB (May- June) are associated with *L. formosus*. *Lupinus variicolor* is used less commonly. Typically, MB begin adult flight in March, are most abundant in April, and observations begin to drop off by late May or early June.

Mission Blue butterflies were not monitored in 2005, although incidental observations made on Callippe transects were usually noted. In 2005, a total of 81 MB were recorded on the CS transects between the CS survey dates of May 11 and July 13 (Figure 2). Only MB that were quickly identifiable were logged, as field staff did not use CS monitoring time to follow and identify all blue butterflies. Therefore, it is presumed that more than 81 MB were encountered on the CS transects. A similar abundance was recorded in 2004, when a total of 84 MB were recorded on 12 CS transects. Monitoring of CS transects began 14 days later in 2005 than in 2004, thus catching less of the MB flight season.

Fixed transect data for MB was last collected in 2004 and can be reviewed in *San Bruno Mountain Habitat Conservation Plan Year 2004 Activities Report for Endangered Species Permit PRT-2-9819* (TRA 2005). It was found in 2004 that MB numbers per transect were high when compared to previous years. Of the seven years that Mission blue transect data has been collected and analyzed (1998-2004), 2000, which had the greatest number of MB observations, was found to be nearly significant ($p<.1$) from 1998. All other years are not significantly different from one another, and no significant trend across years was found using correlation or regression analysis. For correlations, 8 years is the minimum number before correlations across years would become significant (C Knight, pers. comm.). As of 2004, seven years of MB fixed transect data has been collected and analyzed. Therefore, continued monitoring will be necessary to detect a significant change in MB observations.

B. Callippe Silverspot Butterfly (*Speyeria callippe callippe*)

Callippe silverspot butterflies use one larval host plant, *Viola pedunculata* (Jonnny jump-up). The flight season for adult CS is typically from mid-May to mid-July.

Methods

Fixed transect surveys were monitored to provide a means with which to compare CS observations from year to year at specific locations using standard statistical procedures. Fixed transect locations were not chosen randomly but were placed in habitat areas with higher butterfly densities and that include a variety of slope exposures, nectar plants, and soil conditions (i.e. road cuts, ravines, and natural slopes). Even within high-density habitat locations, it is sometimes difficult to observe enough butterflies for statistical comparison. For this reason, fixed transects were located only in areas where there was a good chance of observing CS under desirable weather conditions. Transects vary in length from approximately 300 to 2100 meters and are permanently marked in the field. A total of 14 fixed transects were monitored in 2005. This includes two new transects that were added to the previous 12 CS transects monitored in prior years. Transects 13 and 14 were created east of the terminus of Carter Street at Guadalupe Canyon Parkway. This location was chosen in order to

learn more about potential Callippe presence and movement in grasslands north of Guadalupe Canyon Parkway and habitat at the west end of the Northeast Ridge, as residential development is proposed within planned parcels on the Northeast Ridge.

The monitoring program attempts to catch the beginning and end of the flight season and thoroughly document the observations on a weekly or biweekly basis during that period. It is not cost effective for crews to monitor the fixed transects prior to species emergence, or to continue monitoring transects after most of the observations have dropped off. As a result, the actual monitoring period does not precisely correspond to the flight season for each butterfly.

Ideally, each transect is monitored every 7-10 days during warm, calm weather when CS are most active. However, in practice, transects are often surveyed less frequently due to poor weather conditions (fog and/or wind). Efforts are made to complete an observation cycle (a survey of all fourteen transects) within one to two days. All butterflies observed outside of a transect or in the transect vicinity during travel between transects are recorded as incidental observations. It should be noted that because of the steep slopes, various microclimates and limited survey days, it is a challenge to monitor the butterflies on San Bruno Mountain in a consistent manner from year to year.

In 2003 we ran a regression analysis using four years of transect data. The analysis showed that wind speed ($p=0.11$, $F=2.65$) and temperature ($p=0.42$, $F=0.63$) are not significantly correlated with the probability of observing CS in flight (the number of CS sightings per hour). This result corresponds with field observations and therefore we do not limit the data analyzed based on weather parameters.

The number of CS sightings per hour is used for statistical analysis. To calculate the sightings per hour, the start and stop time for each transect is recorded, as is every CS observation made within this time. The number of CS observed for a particular transect is divided by the number of minutes it took to complete the transect survey. For each year, the average CS sightings per hour for all transects is taken and used to compare relative CS abundance between years.

Six years of CS fixed transect data was analyzed using a one-way ANOVA statistical test. Raw data is presented in Appendix A. Analyses to determine variation in CS abundance between year and transect were performed using the following criteria:

1. Incidentals were omitted.
2. For transects that were surveyed twice in one week (spaced less than 4 days apart), the survey with the least number of CS observations was deleted. (Note: This has rarely occurred during the 6 years of monitoring).

Results

The monitoring period for CS in 2005 lasted between May 11 and July 13. The first CS observations were recorded on May 11 on several transects. The last CS observations were recorded on July 13 on one transect. These dates are typical of those that have been recorded in past years (Table 1). For CS, the timing of the flight season appears to occur fairly consistently across years between mid-May and mid-July. The delay in the initiation of surveys following the first CS observation is generally due to the difficulty in scheduling monitoring days with the typical spring foggy weather.

In 2005, a total of 577 CS were observed on all of the fixed transects. Figure 3 shows the locations on the Mountain where these observations were made. This corresponds to a sightings per hour (S/H)

Table 1. Callippe silverspot flight season start and end dates: 1998-2005

Year	Date first CS observed	Date fixed transect surveys began	Date of last CS observation	Approximate length of flight season (Days)
1998	May 31	NA	July 15	42
1999	June 3	NA	July 22	49
2000	May 18	June 1	July 14	57
2001	April 4*	May 21	August 4	122
2002	May 8	May 17	July 9	62
2003	May 9	May 12	July 9	61
2004	April 27	April 28	June 15	49
2005	May 11	May 11	July 13	64

*Second CS sighting in 2001 occurred on May 8.

of 14.53. This is similar to the S/H figure calculated for 2002 (13.88; Figure 4). An ANOVA test found a significant difference in S/H between years ($F=5.317$, $p<0.0001$, Appendix A). This difference was primarily due to the relative abundance of CS in 2001. When data from 2001 are removed from the analysis, there is no significant difference between years ($F=2.100$, $p<.080$, Appendix A).

As expected, there was a significant difference between transects in 2005 for the average number of CS observed per hour ($F=2.932$, $p<0.0021$; Figure 5 and Appendix A). This difference is likely due to the variation in host plant abundance and topography between transect locations. The highest CS observations were recorded on transect 11, with an average of 37.56 S/H. Transects, 3, 5, 9, 10, and 12 averaged between 18 and 27 S/H. Transects 3 and 5 are both on the Northeast Ridge. Transects 9 and 10 are located down ridgelines above owl and buckeye canyon, and transects 11 and 12 are located on the Southeast Ridge. The transects with the lowest S/H observations include transect 1 (Dairy Ravine), transect 2 (Saddle), and transect 14 (across from Carter Street).

The majority of the Mountain's Viola population has been mapped (Figure 6), and this map can be crossed referenced with Figure 3 to reveal the abundance of Viola on or in the vicinity of the CS transects. Generally, the highest performing transects intersect the larger stands of Viola. Low performing transects, such as 1, 2 and 14 are located in areas where the Viola is sparser in its distribution and/or there is less hilltop topography. Much of transect 14 is within a stand of eucalyptus, and therefore the low number of CS. The reason for the placement of a transect here is due to potential, future development activities at this location, as described under methods, above. Transect 1 is located on Dairy Ravine where scrub has come to dominate over the lower portion of the transect. There is also little hilltop habitat on this transect. Transect 2 is in the Saddle and traverses grassland habitat with a significant scrub component. Both Transects 1 and 2 support fewer Violas then do transects that are restricted to grassland dominated areas.

A summary of weather data since 1998/1999 is provided in Table 2. We investigated whether there is a correlation between temperature and the observed CS sightings per hour. The highest performing transects, #3, 5, and 11, were analyzed. Sightings per hour on each sample day were plotted against both the average temperature that was recorded by field biologists on the transects and the average daily temperature as recorded at the San Francisco Airport (SFO) weather station. Weather data was gathered from the SFO weather station as this is the closest station to the Mountain that collects daily data. However, being further east of San Bruno Mountain and not subject to similar coastal wind and fog, average temperatures at SFO are on average higher than on the Mountain.

Table 2. Weather data for San Bruno Mountain: 1998-99 to 2004-05. Average mean daily maximum temperature and rainfall shown by month. Data was recorded at the County park entrance, (except in 2002-03 to 2004-05). Data shown is for the weather year recorded from July of one year to June of the next year.

Temp (^oF)	98-99	99-00	00-01	01-02	*02-03	**03-04	**04-05
July	66.5	64.9	62.7	70	72.1	71.3	72.1
Aug	68.5	65.5	65.7	65	72.4	73.9	74.0
Sep	67.6	66.3	73.7	70	74	76.0	77.2
Oct	65.9	68.4	61.0	68	69.7	72.4	68.2
Nov	56.2	59.1	54.7	60	64.8	59.9	61.6
Dec	50.7	55.6	56.0	52	57.9	57.1	58.1
Jan	52.2	53.8	52	51	57	55.1	49.7
Feb	52.0	54.7	53.3	57	56	58	55.0
Mar	53.4	57.9	59.2	57	59	68.5	57.2
Apr	57.9	60.7	56.5	58	57	68	56.8
May	57.0	71.7	67.6	63	64	67.6	61.5
Jun	62.0	65.7	68.2	67	66	68.9	61.9

Rain (inch)	98-99	99-00	00-01	01-02	*02-03	**03-04	**04-05
July	0.31	0.05	0.23	0.26	0	0	0
Aug	0.18	0.47	1.80	0.44	0	0	0
Sep	0.35	0.50	0.46	0.51	0	0	0.04
Oct	0.51	0.61	3.21	0.56	0	0	3.19
Nov	4.29	2.57	1.40	5.75	2.95	2.12	1.22
Dec	1.61	0.68	1.16	12.55	10.75	7.08	6.42
Jan	5.63	7.23	5.01	2.44	2.09	3.32	4.27
Feb	7.57	10.7	7.43	3.14	3.16	6.32	5.10
Mar	3.42	2.92	2.04	2.97	2.37	0.95	3.74
Apr	2.77	2.21	2.34	0.72	4.31	0.15	1.70
May	0.39	1.81	0.19	1.02	0.66	0	1.15
Jun	0.44	0.37	0.25	0.27	0.13	0	0.03
Total	27.5	30.1	25.5	31	26.4	19.9	26.86

Data were not available from the County Park and rainfall data were taken from Lake Merced weather station (*) or SFO weather station (**) for 2002-05. Based on a comparison of years, temperature data from SFO tends to be 2-3^o F warmer for the months January through May and 6-7^{o}F warmer for June through December compared to weather recorded at the Park entrance. Rainfall data from SFO tends to be 0.03-1.2 inches lower for the months January through May and 0.13-0.26 inches lower for June through December.

No significant correlation was found between transects 3, 5 and 11 and temperature recorded either at SFO or by TRA field biologists (Appendix B). In fact interestingly, all correlations had a negative p value (although insignificant), which corresponds to a negative relationship between the x and y variables. Thus as temperatures went up, a tendency was observed for the number of sightings/hour to decrease. However, as this is not statistically significant, this trend may be random. Anecdotal observations over the 20+ years of butterfly monitoring on San Bruno Mountain predict a positive relationship between temperature and sightings.

Increasing the data set to include all transects and all years of fixed transect data collection may detect trends not apparent in the chosen data set. However, limitations in the time allotted for preparation of this report prevent further analysis at this time. In the future, we would like to install weather stations at several locations on the Mountain so that we can begin to collect more accurate weather data. Data collected onsite using sophisticated equipment could bolster the power of any future temperature correlation analyses. More reliable weather data collected on site would also be useful in investigating the potential impact of global warming on the life cycle of the butterflies and their habitat on San Bruno Mountain.

South Slope Monitoring

The CS transects cover the summit, Southeast Ridge, Northeast Ridge, Owl and Buckeye Canyons, the Saddle, and Dairy Ravine. There are no transects along the South Slope of San Bruno Mountain, although Viola is present at higher elevations (Figure 6). In order to determine CS presence on the South Slope, we scheduled several days to walk the ridgelines and record all CS observed. However, due to continual wind and cool temperatures, many of these days were canceled, and in the end we were only able to walk 10 transects, each once (Figure 7). Callippes were observed on 7 of the 10 transects. A total of 35 CS were observed, which corresponds to an average of 8.13 S/H. Although this data set is too small to draw conclusions from, it does make evident that CS are present at some extent on the South Slope, and in our snapshot survey, were sighted at a rate similar to that found across the last six years at the permanent transects. However, given the single sample nature of this data, the S/H recorded cannot be extrapolated to overall abundance within this sampled area. Anecdotal sightings on the South Slope over the years that TRA has been working on the Mountain have repeatedly been lower in number than sightings on the north-facing slope or summit, which may be due to an undesirable microclimate, temporal availability of nectar plants, or resource (i.e host plant) accessibility.

In order to better understand the distribution of CS on the South Slope, a CS transect could be added down a ridgeline that intersects Viola habitat. In order to add a transect, an existing transect would need to be abandoned, as there is currently the maximum number of transects that can be surveyed within an available weather window for an individual survey event (1 to 2 days). Transect 14 is a newly added transect that is temporary. The creation of transect 14 was to allow for collection of data in an area that is proposed for development. Transect 14 will be surveyed again in 2006. Following this, we propose to abandon transect 14 and replace it with a new transect on the South Slope.

Rainfall and CS Abundance

Rainfall totals for years 1998-2005 is shown in Table 2. This weather data was collected at three different weather stations. Variation in rainfall among station locations makes a comparison of annual rainfall in Table 2 weak. However, we can look back at total annual rainfall at the SFO weather station since data was first collected in 1927 (NOAA 2005). The average rainfall at the SFO station over the past 78 years is 19.9 inches. The wet season of 2004/2005, with an average annual rainfall of 26.9 inches, was above average. Since the start of CS fixed transect data collection in 2000, the only other year to significantly exceed annual rainfall was 2001, which has a rainfall level of 26.1 inches at the SFO weather station (NOAA 2005).

Since the start of CS fixed transect data collection in 2000, CS sightings per hour were highest in 2001, with the next greatest year being 2005. This suggests that perhaps some increase in total rainfall is correlated with a greater abundance in CS in the spring/summer following the rain. In

order to investigate this, a least squares regression analysis was run using our CS sightings per hour data and the SFO weather station annual rainfall data. A significant correlation was not found ($r=0.743$, $p=0.091$), however these values are only slightly below that which would be significant and thus do indicate that there may indeed be a trend of increased CS abundance following wetter years. In order to best research this trend, we suggest that a weather station be erected on San Bruno Mountain so that CS abundance can be compared to onsite rainfall data. In the absence of this, continued years of monitoring and comparison of CS data to SFO Airport Weather Station data will allow for a more robust correlation analysis.

Management Implications for Callippe Silverspot

The San Bruno Mountain Habitat Conservation Plan, Biological Program (County of San Mateo, 1982, page III-20) states that (1) "monitoring should allow the Plan Operator (San Mateo County) to determine whether the populations are essentially stable in numbers, decreasing, increasing or fluctuating" and (2) "whether the distribution of the animals is shifting". To determine if butterfly populations are increasing or decreasing on the Mountain, a correlation or regression analysis must be employed. For correlations, 8 years is the minimum number before correlations across years would become significant (C. Knight pers. comm.). As of 2005, six years of CS fixed transect data has been collected and analyzed. Therefore, continued monitoring will be necessary to address this question. However, our data at this point does not reveal a significant difference in butterfly abundance between years.

For Callippe silverspot, sightings per hour in 2005 were approximately the same as in 2002, and above average for the years when 2001 is excluded. Of the six years that Callippe silverspot transect data has been collected and analyzed, 2001 was found to be significantly higher than all other years. No significant difference was found between all other years (2000, 2002, 2003, 2004 and 2005). Abundance data from six consecutive years, although inadequate to detect long-term changes in population dynamics, can suggest trends of population increase or decline. Our data at this time suggests that the CS population on San Bruno Mountain exhibits year-to-year fluctuation in population size while maintaining a consistent size over time. More years of data collection will allow us to determine if this short-term trend is accurate in predicting long-term population status.

Some transects have consistently produced higher CS numbers than others. Both in 2005 and 2004, transects 3, 5 and 11 had the highest S/H. Transects 3 and 5 are located on the south facing slope of the Northeast Ridge. It is on the Northeast Ridge that some of the more dense stands of *Viola pedunculata* have been mapped (Figure 6). Transect 11 follows the Ridge Trail on the Southeast Ridge, providing hilltop habitat flanked with Viola on either side of the trail.

Analyzing butterfly abundance on individual transects among the years of fixed transect data collection may provide information on potential change in the species' distribution. Data analysis reported in last year's activities report (TRA 2005) found that there is a significant interaction between year and transect, and that a transect that performs well in one year may produce significantly less CS the following year and vice versa. This corresponds to what is known of butterflies' variable use of microhabitats from year to year, influenced by environmental and climatic flux (TRA 1982). Given this expected variability of abundance within microhabitats, more years of data collection is needed to pick up potential changes in species distribution.

As annual fixed transect data are not significantly different from one another (excluding 2001), they do not dictate specific CS management direction aside from what is currently performed. Maintenance of existing CS habitat through weed control and shrub containment, as well as

expansion of CS habitat through outplanting of Viola (it should be noted that the success rate of nursery stock has been poor in most cases) is of highest priority in managing CS. Monitoring of habitat quality, Viola distribution and weed control efforts can provide indirect evidence of butterfly success.

Although continued monitoring of the same transects over the years is preferred in order to collect enough data for statistical analysis, some amount of flexibility would allow areas previously not intersected by transects to be monitored. Abandonment of a consistently low-performing transect for a new transect in an area that supports Viola may provide valuable data on CS distribution. A one-time snapshot survey of the entire mountain during the peak of the flight season could also generate new or updated information on CS distribution. This would require a significant volunteer effort, and is discussed under Recommendations, below.

It should be noted that though the transect data collected thus far may not indicate an upward or downward trend in butterfly abundance, this does not necessarily mean that the monitoring does not generate useful information. In the years since the start of the HCP, new weeds have been identified on San Bruno Mountain and some native grassland habitat has been lost to native scrub succession (see below). However, management of the Mountain has succeeded in protecting approximately 90% of the butterfly habitat on San Bruno Mountain, and habitat management has successfully maintained most habitat areas from being overtaken by weeds. It is possible then that trends in butterfly populations, either negative or positive, may not be occurring and therefore would not be detected. The monitoring therefore would need to provide enough statistical power to sufficiently detect trends in butterfly abundance, if occurring. At this point in time, the methodology for monitoring Callippe silverspot appears to provide this function, and with several more years of monitoring, will be able to provide more robust information on population status.

In the last 10 years, weather patterns on San Bruno Mountain appear to be becoming warmer and wetter, and this is consistent with global warming predictions for Northern California (The Wildlife Society 2004). Increasing rainfall favors coastal scrub and invasive brush over grassland. Since the inception of the HCP in 1982 it is estimated that approximately 180 acres of grassland habitat on San Bruno Mountain has been lost to coastal scrub expansion. This is a rough estimate based off of historical photos and a more precise calculation of changes in habitat type will be investigated in 2006. It is likely that the control of both native and non-native brush will be vital toward the protection of grassland habitat for the Callippe silverspot on San Bruno Mountain into the future.

C. San Bruno Elfin (*Callophrys mossii bayensis*)

San Bruno elfin are closely associated with their host plant, Pacific stonecrop (*Sedum spathulifolium*). San Bruno elfins occur where there are high densities of Sedum and in areas that are protected from strong winds. Higher elevation grasslands with a northeast to northwest aspect favor SBE. The flight season for SBE occurs between early March and mid April.

San Bruno elfin have been monitored at fixed monitoring points consecutively from 1998 to 2004. Results from 2004 SBE monitoring were presented in *San Bruno Mountain Habitat Conservation Plan Year 2004 Activities Report for Endangered Species Permit PRT-2-9819* (TRA 2005). San Bruno elfins were not monitored in 2005, but larval stage monitoring will be conducted in 2006.

All of the existing SBE butterfly habitat on San Bruno Mountain has been protected as open space within San Bruno Mountain State and County Park since 1975. Development that was approved through the San Bruno Mountain HCP did not affect this species, and therefore monitoring and management for this species and its habitat was not a requirement of the HCP permit. However, this

species' habitat partly overlaps with that of the Mission blue and Callippe silverspot, and is composed of some of the most pristine coastal prairie and coastal scrub habitat on the Mountain. Continued monitoring and management of SBE should continue to be a high priority on San Bruno Mountain because of the biological value of this species and it's habitat.

D. Monitoring Recommendations for 2006

1) Recommendations for MB monitoring were provided in the 2004 activities report. As MB monitoring was not performed in 2005, it is advised that these same recommendations are implemented during the next MB monitoring cycle

2) Replace CS transect 14 with a new transect along a South Slope ridgeline after the 2006 survey effort.

3) Maintain the number of CS fixed transect visits at a minimum of 5 visits per transect.

4) Continue to space the transect visits evenly across the entire flight season as best as possible, to ensure a consistent sampling effort and to better characterize the flight season.

5) Continue to make it a priority to complete an entire set of MB, SBE, or CS fixed surveys within 1-2 days.

6) Consider organizing a volunteer based, 1-2 day snapshot CS survey over the whole Mountain, timed to correspond with the average peak of the flight season. This would provide us with information on CS distribution on the Mountain in areas not intersected by transects. The challenge in this would be gathering enough knowledgeable volunteers to take part in such a survey. An alternative method, and something that was included as a recommendation in the 2004 activities report, is to establish a presence/absence butterfly monitoring program. This could include surveys of areas on the Mountain not currently surveyed during transect monitoring. Presence/absence monitoring could be targeted in areas in which there has been some environmental change (i.e. succession, intensive weed control, restoration) that may have an effect on butterfly abundance. Presence/absence monitoring would require a more substantial funding support than would a snapshot survey, and the benefit in such a survey would need to be considered in light of a resulting decrease in funding available for other management tasks on the Mountain, such as vegetation management.

7) Investigate the establishment of a permanent weather station(s) on the Mountain.

E. Bay Checkerspot Butterfly (*Euphydryas editha bayensis*)

A small population of the Bay checkerspot butterfly (BCB) was present on San Bruno Mountain (near the summit) up until the mid-1980's. This species has not been observed on SBM in over 20 years. No BCB (larvae or adults) were observed on San Bruno Mountain by field crew while conducting biological activities and overseeing development activities in 2005. In October 2000, the U.S. Fish and Wildlife Service (USFWS) proposed critical habitat for the BCB. The USFWS issued a Final Rule on the critical habitat designation in April 2001. The critical habitat designation includes the historic BCB habitat on the main ridge of San Bruno Mountain. This species must be taken into account when planning any activities that could impact BCB habitat.

F. San Francisco Garter Snake (*Thamnophis sirtalis tetrataenia*)

The San Francisco garter snake (SFGS) was identified in the San Bruno Mountain HCP (1982) as having potential habitat on San Bruno Mountain. No SFGS were observed on the Mountain by field crew while conducting biological activities and overseeing development activities in 2004. There have been no confirmed observations of SFGS on San Bruno Mountain in the 23 years of the HCP monitoring program. Based on the lack of significant ponds and other aquatic habitats, this species is unlikely to be present.

G. California Red-legged Frog (*Rana aurora draytonii*)

The California red-legged frog (CRLF) shares similar aquatic habitat with SFGS. Though it was not identified as a sensitive species at the time of the HCP, CRLF has since been listed as a Federally Threatened species. No California red-legged frogs (CRLF) were observed on San Bruno Mountain by field crews while conducting biological activities and overseeing development activities in 2005. There have been no confirmed observations of CRLF on San Bruno Mountain in the 24 years of the HCP monitoring program. Based on the lack of significant ponds and other aquatic habitats on San Bruno Mountain, it is unlikely this species is present.

H. Other Species

Seven to eight confirmed sightings of a mountain lion (*Felis concolor*) have been made in the Saddle area on the Mountain, since September 2004. The lion (or lions) may be moving through the Colma cemeteries as a corridor between Crystal Springs and the Mountain. A dead Mountain lion (road kill) was found on HWY 280 in Daly City a couple of years ago (according to Daly City Police). It is possible that the sightings are all one lion, and it is foraging in the Saddle as that is where most of the prey are concentrated (raccoons, skunks, feral cats) due to the incidence of garbage disposal and feral cat feeding in this area. County Park staff has placed signs up to alert park users to the potential presence of a mountain lion in the area.

In addition, one mule deer (*Odocoileus virginianus*) was seen near the Northeast Ridge water tank in the fall of 2005. To our knowledge, this is the first sighting of a deer on San Bruno Mountain since the early 1960s.

I. Plants of Concern

Several rare and listed plant species are found on San Bruno Mountain, although none were mapped in 2005. In previous years, colonies of listed plants or rare plants with a status of CNPS List 1B or higher (i.e. *Arctostaphylos imbricata imbricata*, *Lessingia germanorum*, *Silene verecunda ssp. verecunda*, and *Helianthella castanea*) were mapped using GPS. See previous annual reports (1999-2003) for maps showing the distribution of these rare plants on San Bruno Mountain.

J. San Bruno Mountain Community Resources

A cooperative website for San Bruno Mountain was developed by TRA in 2001 and is found at http://www.traenviro.com/sanbruno. This site serves as a center for information, contacts, references, and mapping resources for San Bruno Mountain. It is used by volunteers, professionals, government employees, and members of the public who are involved in preservation, restoration, biological monitoring, and planning at San Bruno Mountain. The site also includes postings of recent SBM activities reports that have been prepared by TRA.

III. VEGETATION MANAGEMENT AND RESTORATION

A. Invasive Species Control

The primary focus of habitat management activities since the inception of the HCP has been control of invasive species infestations through hand removal, mechanical removal, and herbicide treatment. The majority of this work on the Mountain has been performed by West Coast Wildlands (WCW), (under subcontract to TRA), and their work is described in detail below. In addition, other contractors such as Shelterbelt Builders and Restoration Resources, and numerous volunteers such as San Bruno Mountain Watch, conducted invasive species control in 2005.

Due to the large area of the Mountain that is subject to invasive species control work, (approximately 2,800 acres), and the expanding number of invasive species that require treatment, infestations must be prioritized as follows, based on their threat to sensitive habitat areas:

Priority 1: Small patches of invasive species within native habitat
Priority 2: Small patches of invasive species at the periphery of native habitat
Priority 3: Edges of large invasive species infestations
Priority 4: Large invasive species infestations

As a general rule, all Priority 1 and 2 infestations are treated using hand removal or backpack spray techniques. Priority 3 and 4 infestations are treated using a truck mounted herbicide spray rig (in combination with mechanical clearing (mowing) of vegetation in some cases).

Herbicide treatment has consisted of spraying targeted species with an herbicide solution containing either Garlon 4® (triclopyr ester) or Roundup® (glyphosate). These herbicides are used due to their high effectiveness, low toxicity rating, and short half-life in the soil. Garlon 4® herbicide is the preferred chemical since it does not harm monocots (grasses). Herbicide is applied one to four times per year in suitable weather (low wind, low humidity) for maximum plant uptake. The plants are left to decay in place, a process that takes from one to five years, depending upon the size of the plants. In sensitive areas (near butterfly habitat and within 150 feet of private property) mature stands of invasive plants are removed by chainsaw or mowing, followed by seeding and stump herbicide treatment.

<u>2005 HCP Invasive Plant Treatment Summary</u>

The primary focus of non-native species control has been on invasive shrubs and on the most invasive herbaceous species. Species that pose the greatest threat of displacing butterfly habitat and other native habitats are of highest priority. Woody plants that are treated most aggressively include gorse (*Ulex europaeus*), French broom (*Genista monspessulana*), Portuguese broom (*Cytisus scoparius*), cotoneaster (*Contoneaster sp.*), and eucalyptus (*Eucalyptus globulus*). Other woody plants, such as acacia (*Acacia sp.*), Scotch broom (*Cytisus scoparius*), Monterey pine (*Pinus radiata*), and myoporum (*Myoporum laetum*), although invasive, are not as abundant or do not display such rapid rate of spread on the Mountain.

Herbaceous species that received the greatest amount of control effort include fennel (*Foeniculum vulgare*), radish (*Raphanus raphanistrum*), mustard (*Hirschfeldia incana*), Himalayan blackberry (*Rubus discolor*), pampas grass (*Cortaderia jubata*) and oxalis (*Oxalis pes caprae*). Fennel in particular is treated as one of the highest priority weeds on the Mountain, and since the start of aggressive management, populations have been significantly decreased in some locations, such as on

the slope above Hillside School. However, a high level of follow-up maintenance is required for management of fennel. Stands may require several treatments a year for many years before the plant is eradicated. Hence, significant resources are required for continued treatment of a site, thus limiting the total area that can be adequately treated.

Though it has been difficult to eradicate weeds completely, significant control of target species such as eucalyptus and gorse has been realized. Since 1981, Eucalyptus forest has been stopped from advancing and reduced by approximately 30% (from 206 to 146 acres). Gorse, which was introduced to the Mountain in the 1920's, had expanded to cover 334 acres of the Mountain (mostly in the Saddle area) by 1981 (San Bruno Mountain HCP Volume 1). As of 2005, gorse expansion has been essentially stopped, and the infestation has been reduced by approximately 90% (from 334 to 35 acres). The remaining gorse on the mountain is localized in dense monoculture stands on the north and central part of the Saddle, and on the south side of the Brisbane Industrial Park. These areas have become more dense over time, as all surrounding areas have been controlled.

In 2005, 678 acres of invasive plants were treated by hand or with herbicides (Figure 8). Many of these acres were treated many times over for repeat control of various species. West Coast Wildlands maintains daily record sheets for all invasive species work conducted on the Mountain. The following species were recorded as having been treated in 2005:

Acacia sp. (acacia)
Carduus pycnocephalus (Italian thistle)
Cirsium vulgare (bull thistle)
Conium maculatum (poison hemlock)
Cortaderia jubata (pampas grass)
Cotoneaster sp. (cotoneaster)
Cytisus scoparius (Scotch Broom)
Cytisus striatus (Portuguese broom)
Delairea odorata (Cape ivy)
Eucalyptus globulus (blue gum tree)
Foeniculum vulgare (fennel)
Genista monspessulana (French broom)
Hedera helix (English ivy)
Hirschfeldia incana (mustard)
Lactuca serriola (prickly lettuce)
Lactuca virosa (wild lettuce)
Leucanthemum vulgare (ox-eye daisy)
Oxalis pes caprae (Bermuda buttercup)
Phalaris stenoptera (harding grass)
Picris echioides (bristly ox-tongue)
Pyrocantha crenato-serrata (pyrocantha)
Raphanus raphanistrum (wild radish)
Rubus crispus (curly dock)
Rubus discolor (Himalayan blackberry)
Ulex europaeus (gorse)
non-native thistles and grasses (species not identified)

This list was created from species that were recorded on WCW daily record sheets. However, additional species that were not the focus of a particular day's control effort are treated by WCW and not recorded. This is especially true when only a few individuals or a small patch are treated. Also, species not included in the above list may be targeted by Shelterbelt Builders during habitat island maintenance (Section B below) or by volunteer groups. Other species which are understood to have received some treatment include the following:

Avena spp. (wild oat)
Briza maxima (rattlesnake grass)
Bromus hordeaceus (soft chess)
Carpobrotus edulis (hottentot fig, iceplant)
Centaurea calcitrapa (purple star thistle)
Centaurea melitensis (Napa thistle)
Centranthus ruber (red valerian)
Chenopodium album (lamb's quarter)
Cupressus macrocarpa (Monterey cypress)
Digitalis sp. (fox-glove)
Erechtites arguta (New Zealand fireweed)
Holcus lanatus (velvet grass)
Hypochaeris radicata (hairy cat's ear)
Lobularia maritima (lobularia)
Lolium multiflorum (Italian wild rye)
Lythrum salicaria (purple loosestrife)
Myoporum laetum (myoporum)
Pinus radiata (Monterey pine)
Plantago lanceolata (plantain)
Rubus crispus (curly dock)
Rubus discolor (Himalaya blackberry)
Rumex acetosella (sheep sorrel)

Ehrharta longiflora (ehrharta)
Erodium cicutarium (filaree)
Helichrysum petiolare (licorice plant)
Scabiosa atropurpurea (pin-cushion plant)
Silybum marianum (milk thistle)
Solanum sp. (nightshade)

In 2005, the greatest efforts went into treating 1) fennel, gorse, French broom, eucalyptus and cotoneaster in the Saddle, 2) various species on the Northeast Ridge, with most effort spent on fennel and French broom, 3) various species in Wax Myrtle Ravine, and 4) Oxalis in upper Tank Ravine (treated in December as part of the Oxalis Control Project, described below).

In 2006, emphasis will continue to be placed on those areas and weeds that have been receiving the greatest effort. To abandon these areas in order to take on a new project would risk losing the substantial headway that has been made so far. Only with continued follow-up treatment and maintenance can an invasive infestation be managed. However, when small populations or individuals of particular concern are discovered in an area where they had not previously been seen or treated, it is noted and either WCW diverts funds to treat these if possible, or they are monitored and identified for control in the following year's budget. The resources to treat a few maverick broom plants is significantly less than what is required several years later when the plant has begun to spread. Examples of small infestations that were noted in 2005 and will be treated in 2006 are Erharta (*Ehrharta longiflora*) in Owl Canyon and pampas grass below Pacific rock. Treatment in 2006 will also focus on the recent expansion of pincushion plant (*Scabiosa atropurpurea*).

Oxalis Control Project

As part of the 2005/2006 fiscal year budget, special funding was approved for aggressive control of Oxalis. Oxalis has been proliferating on the Mountain and is of concern as it can form dense mats on the ground, outcompeting native plant species for light and space. Oxalis has also been found to inhibit the germination of native species (Brooks 2001). On San Bruno Mountain, the greatest concentration of Oxalis is found in the Poison Oak Ravine and Hillside management areas (which includes the Tank Ravine management area). Oxalis is also found along the Ridge Trail growing under scrub vegetation, along a ridge trail from the Ranger's Station to nearby the terminus of Hoffman Street (Daly City) and in other scattered locations (Figure 9).

With the special budget provided for Oxalis control, efforts will be spent at three locations: above Hoffman Street, along the Ridge Trail, and within select stands at Tank Ravine. Other, smaller infestations (Dairy Ravine, Radio Road, and below Brisbane Water Tank) are already treated as part of the general 05/06 budget and work plan. The total area that can be treated as part of the Oxalis Control Project is limited by the funds that were made available, and therefore locations were prioritized based on existing butterfly habitat. The Hoffman Street location supports MB habitat, the Ridge Trail location supports SBE habitat, and the Tank Ravine location supports CS habitat. Appendix C contains the estimate for treatment provided by West Coast Wildlands, who is performing the control work, as well as maps that delineate what areas are being treated.

Initial herbicide treatment was performed in December 2005, and follow-up treatment will be performed 2 to 3 more times in the winter/spring of 2006. Photos of the sites before and after treatment are being taken to monitor progress. A report on the outcome of this project along with documenting photos will be provided in the 2006 activities report. A portion of the Oxalis Control Project budget (approximately 30%) has been reserved for continued follow-up work in fiscal year 2006/2007.

Weed Control Performed by CDF Crews

Planning for the use of CDF crews (staffed by non-violent crime inmates) to remove invasive shrubs such as French and Portuguese broom and gorse in select areas on the Mountain has been initiated. Work will begin after the start of 2006 and will be reported on in that year's activity report.

Additional Invasive Species Control Work (not funded by the HCP)

Several supplemental invasive species control projects are currently being implemented on San Bruno Mountain in addition to the work funded through the HCP (Figure 10). Some of these projects are very large in scope, and have resulted in a significant reduction in invasive weeds.

1) Through a California State Parks Grant, a four-year project was initiated in 2004 to control gorse in the Saddle. The lead consultant for this work is Shelterbelt Builders, with May and Associates, Restoration Resources and West Coast Wildlands contributing as subconsultants. Twenty-two acres of dense gorse and 26 acres of scattered gorse have been removed. In 2005, the project was in its first year of follow up work and monitoring. The overall objective of the project is to reduce gorse and Himalayan blackberry cover within treatment areas to 5% by the end of the project, such that only minimal maintenance will be required to keep gorse from returning to the project area. A small wetland restoration project will be initiated in 2006 that will include both weed control and native species outplanting, using existing intact native communities as a template for revegetation. For a summary of this project, see Appendix D.

2) West Coast Wildlands has conducted invasive species control on six parcels of Myers Development Co. property within Phase II (The Woods) and III (Mandalay Point) of Terra Bay (including the Preservation Parcel) and within the Tank & Juncus Ravine property. Management and restoration plans have been prepared for these areas (Forbert 2001). The treated mature fennel surrounding the Phase II and III development was reduce by 90% as required. Methods include hand and mechanical removal and herbicide application.

Mature fennel within the Tank/Juncus Parcel was reduced by 95% using the same methods as at Phase II & III. Control of Oxalis on the south slope of lower Tank Ravine began in 2002 and ended in 2005. Over 10,000 native perennial grasses were planted on the south slope after the dieback of the treated oxalis site. The grass plugs included *Nasella pulcra, Bromus carinatus*, and *Festuca rubra*.

The remaining funds for the Myers property is $25,000. This amount will be transferred to a trust account when the property is deeded to the San Mateo County Parks and Recreation Department as part of the San Bruno Mountain State and County Park.

West Coast Wildlands also controls gorse on the slopes above the Carter Street Quarry Development extending to the Saddle Ridge Development owned by Standard Pacific Homes. The Gorse in and above Carter Street Quarry storage facility has been treated since 2003 and the property is owned by the PCI Investment Group. The efforts to treat the site will continue through 2006.

3) The volunteer group San Bruno Mountain Watch's 2005 invasive species control program targeted weeds in Wax Myrtle Ravine, lower Devil's Arroyo, lower Red Tail Canyon, and Owl Canyon extending east to Buckeye Canyon, Lipman School, and the Brisbane Acres. Details of work in these areas conducted in partnership with Shelterbelt Builders as part of a California Coastal Conservancy Grant are provided in Appendix F. San Bruno Mountain Watch also began work on the

South San Francisco Preservation Parcel, where a cooperative agreement to help steward the newly acquired land took effect between Mountain Watch and the County.

The following invasive species were removed from these areas: black mustard, poison hemlock (*Conium maculatum*), bristly ox-tongue (*Picris echioides*), Italian thistle (*Carduus pycnocephalus*), bellardia (*Bellardia trixago*), French broom, cotoneaster, pincushion plant (*Scabiosa purpurea*), Himalayan blackberry, bull thistle (*Cirsium vulgare*), gorse, fennel, and Cape ivy (*Delairea odorata*). New populations of yellow star thistle (*Centaurea solstitialis*) around the Brisbane Baylands were monitored and repeatedly mowed to prevent spread to the mountain. Total volunteer time for 2005 was roughly 1400 hours. Extensive work in the same areas of the mountain (except Preservation Parcel) was conducted by Shelterbelt Builders in the final phases of Mountain Watch's Coastal Conservancy-funded project.

4) Under a State Parks Grant, managed by the County of San Mateo, the Watershed Project is carrying out "Heart of the Mountain" directed by Joe Canon, which is a project working toward the restoration of the Colma Creek headwaters. The Heart of the Mountain project in 2005 lead 23 volunteer workdays, which included 284 individual volunteer visits and 932 volunteer hours worked on the site. The work accomplished by these workdays included the planting of 3,250 native plants and the clearing of approximately 11,000 sq. ft. of Himalayan blackberry, Cape and English ivies and numerous invasive herbaceous species and grasses. Additionally, 27,000 square feet of invasives were removed by San Mateo County Fire Safe crews over four separate visits to the site. Eucalyptus removal in the channel is tentatively scheduled for August 15 through September 30, 2006.

B. Restoration of Habitat

For purposes of clarity, we use the term "restoration" to refer to areas planted and/or reseeded with native plant species. Restoration sites also receive invasive species control through the use of herbicide, mowing, hand weeding and/or other tools to maintain the planted areas. As areas that are restored will generally require ongoing maintenance, "restored" is understood to mean that the goals and objectives of the restoration project were met, regardless if ongoing maintenance will be required. Restoration is a measurement used by the County of San Mateo for their Outcome Based Management.

Early attempts at large scale restoration on disturbed slopes on San Bruno Mountain were largely unsuccessful due to the difficulty in maintaining areas against a large influx of weeds. As a result, a strategy of creating small habitat islands (up to ½ acre in size) was developed. Since 1997 this approach has been implemented in several areas of the Mountain and has proven to be successful in Eucalyptus cut areas, former gorse patches, and on graded slopes disturbed by development.

It should be noted that the Mission blue's host plants (lupines) are often patchy in their distribution, and will colonize disturbed roadcuts, landslides, and trails. Mission blues utilize these patches, and can easily move between patches that are 100 meters apart (Arnold 1983), and have been recorded moving distances up to 1/4 mile (TRA 1981) between habitat patches. In contrast, CS utilize much larger areas of habitat due to their larger size and stronger flying ability. Callippes can move several hundred feet within a few minutes when traveling across terrain searching for Viola and appropriate hilltopping habitat (personal observations). The CS host plant, *Viola pedunculata*, typically occurs in much larger, denser patches than lupines do, though Viola can also on occasion be found in small patches and in disturbed areas.

Because the Callippe's habitat is typically found in much larger patches, it is more important to protect grassland habitat that contains Viola than to direct significant funds into replanting Viola. For example, if one were to create a habitat island with 50 lupines, this is likely to provide habitat that will be utilized by MB as this is similar to the lupine patch size that can support MB on the Mountain. However, if one creates a habitat island with 50 Viola plants, it is unlikely CS would utilize this habitat area as their habitat more often consists of a slope with 500-5,000 Viola plants. Given the much greater expense of propagating Viola due to the need to grow this plant longer in the nursery (18 months or more), and it's lower survival rates than other plants, it is more important and more cost efficient to protect the existing CS habitat on the Mountain from weeds or coastal scrub expansion, rather than focus significant effort in creating CS habitat islands. Though restoration is important, the first priority should always be protecting the existing habitat, because that is the best use of funds for ensuring the long-term survival of both MB and CS on San Bruno Mountain (Biological Program, HCP Volume I, 1982).

In the spring of 2004 and 2005, Viola was mapped within approximately 95% of the grassland areas on the Mountain (Figure 6). This work revealed extensive patches of Viola on the Mountain on the Northeast Ridge, Owl and Buckeye Canyons, Brisbane Acres, Southeast Ridge and the South Slope.

Habitat Islands Created within the Conserved Park Areas

Since 1995, seven habitat restoration islands have been created and are now established within former eucalyptus and gorse sites. These sites are located in the Botanic Garden (1 island), Colma Creek (2 islands), Dairy Ravine (3 islands), and the Saddle (1 island). These islands have been planted with Mission blue host and nectar plants and were routinely weeded to help the native species establish. To date, two habitat islands have had confirmed presence of Mission blue butterflies (Colma Creek #1 and Colma Creek #2).

Shelterbelt Builders, subcontractor to TRA, maintains the restoration islands. The oldest island in Dairy Ravine and the two Colma Creek islands are for the most part only monitored at this time as they are well established. Other islands still have active weed control and planting programs associated with them. See Appendix F for a summary report on the HCP habitat restoration activities conducted by Shelterbelt on San Bruno Mountain in 2005.

Shelterbelt has also created two habitat islands along the San Francisco Water Department (SFWD) easement area, near Mission blue transect #3 (HCP Management unit 1-05), to offset impacts to MB from the re-graveling of an SFWD access road. This project was funded by SFWD and has resulted in several hundred lupines (primarily *L. formosus*) and Mission blue nectar plants being successfully installed and monitored.

Status of Restoration on Development Slopes

As part of most development projects, grading has occurred on adjacent slopes in order to maintain slope stability. These temporarily disturbed slopes are required in the HCP to be restored to grassland habitat. At this time, several areas (totaling approximately 10-20 acres) that were disturbed for slope stabilization have not been restored to grassland butterfly habitat. In 2006 TRA plans to GPS these areas so that we can better understanding and monitor lands that remain to be restored.

Restoration of butterfly habitat has been successful on some development slopes, such as the Linda Vista development slopes and on portions of the Northeast Ridge development slopes. Shelterbelt

Builders has created seven restoration islands on property owned by Brookfield Homes on the Northeast Ridge.

Though developer-funded restoration work has resulted in extensive weed control on the Mountain and established a few habitat islands, some disturbed slope areas have become overgrown by dense weed infestations due to ongoing disagreements over who is responsible for conducting the control work. These areas are predominantly on the South Slope above the Terrabay Phase I and II developments and on the north side of Guadalupe Canyon Parkway above the Bay Ridge development. Regardless of who is responsible for these areas, this issue needs to be resolved so that habitat restoration work can be reinstated on these slopes, as required by the HCP.

With continued maintenance of the existing planting islands and continued creation of additional planting islands each year within the park and on disturbed slopes associated with development projects, it is possible to restore (and possibly surpass in time) the amount of butterfly habitat taken by development through the HCP. For this to occur, however, an expanded HCP budget would be needed because most of the annual HCP budget is allocated for the maintenance of undisturbed butterfly habitat within the conserved habitat areas.

Restoration guidelines for MB and CS

HCP funded restoration work in the form of weed control, erosion control and planting has been ongoing on the mountain since the mid-1980's. The primary goal of the restoration work is the establishment of high quality habitat for the MB and CS butterflies. Because the HCP does not specify what is required for successful restoration, (i.e. number of host plants established, percent cover of natives, etc.) *The Habitat Restoration Guidelines for MB and CS* were produced in November 2000 by TRA to help define what is needed to provide suitable MB and CS butterfly habitat, and therefore assist restoration professionals with accomplishing the habitat goals of the HCP. The guidelines include suggested methods on how to select appropriate restoration sites, recommended host plant densities to support the endangered butterflies, and propagation methods. They are to be used in conjunction with the *Standards for Acceptance of any Dedicated Lands by the County of San Mateo in Accordance with the San Bruno Mountain Area Habitat Conservation Plan*, prepared by Roman Gankin (in *San Mateo County Parks Draft Master Plan, Appendix 1*).

Eucalyptus-cut areas (including Wax Myrtle Ravine)

In 1995, 63 acres of Eucalyptus trees were clear-cut on San Bruno Mountain. The 63 acres are broken up into five different restoration sites: Dairy Ravine (22.4 acres), Wax Myrtle Ravine (6.4 acres), Hoffman Street (5 acres), Colma Creek (4.8 acres), and April Brook (3.6 acres). The Pacific Nursery site (20.8 acres) was not treated and has returned to Eucalyptus forest. The Botanic Garden site (4 acres) is within the Dairy Ravine site and is managed by the Friends of San Bruno Mountain.

The goals of the Eucalyptus removal and native habitat restoration on San Bruno Mountain are to provide corridors and restored grassland habitat for the three endangered butterflies on the Mountain (MB, CS, and SBE), and to restore native habitats for other native wildlife species.

Since the initial Eucalyptus cutting, eucalyptus regrowth control has been performed on approximately 42 acres (Dairy Ravine, Botanic Garden, April Brook, Colma Creek, Hoffman Street, and Wax Myrtle Ravine). Extensive invasive species control work has been performed in Wax Myrtle Ravine, Colma Creek, and Dairy Ravine.

In July 2003 a 4-acre controlled burn escaped control lines and burned a 72.5-acre area, which included all of Wax Myrtle Ravine. The fire burned through Eucalyptus slash and regrowth, and 2 large (approximately one acre each) stands of gorse. Prior to the burn, the dense slash and gorse in the ravine formed an impenetrable thicket, and that combined with the steep slopes, made access into the ravine for invasive species control and restoration work impossible.

In 2005, West Coast Wildlands conducted follow up herbicide work and hand pulling in Wax Myrtle Ravine to prevent invasive species from sprouting and re-establishing within the ravine. Eucalyptus, Ehrharta, fennel, Himalayan blackberry, gorse, poison hemlock, bristly ox-tongue, pampas grass, French broom and other invasive species were treated. West Coast Wildlands is currently treating the area 2-3 times per year.

C. Grazing

The use of livestock animals for grazing of open space lands has become a common tool for managing vegetation as the understanding of the historical ecological role that ungulates (such as elk) played in maintaining grasslands has increased. Grazing animals present before European settlement and cattle brought in post settlement provided a process by which vegetation was managed. Similar to a top-level predator controlling the abundance of prey species, grazing animals maintained vegetation density and even composition.

The most common grazing livestock utilized as a tool for meeting vegetation management goals include cattle, goats, and to a lesser extent, sheep. Each animal type, as well as the grazing regime (stocking density, duration, rotation of use, etc.) will influence the resulting vegetation composition and level of residual dry matter (RDM).

A stewardship grazing plan was written for the Mountain in April 2002 (D. Amme 2002), and funding for a 3-year pilot goat grazing project was approved by the HCP Trustees in January 2003. The grazing project was implemented in 2003 and 2004, but was not approved for year 3 due to funding limitations in the HCP budget. This goat grazing study was initiated to study how best to apply grazing for controlling invasive plant species and is summarized in the 2004 activities report. Due to the cessation of funding, data from the grazing project was not analyzed until this year, when a TRA intern processed the data.

Data was collected in the spring of 2003 prior to grazing and at the same time the following year, after one year of grazing. Data was collected from grazed, mowed and control plots. Appendix G contains a document produced in January, 2004 that includes study design and methods. As data was collected after only one year of grazing (which included two individual grazing events), conclusions that can be drawn from the study are limited. Soil seed banks can remain viable for years and even decades for some species. When removing vegetation, be it by grazing, mowing, burning, or herbicide application, the seed bank must be flushed out by repeat treatment of the control strategy before the success of the control effort can truly be measured. However, a few trends were noted that deserve discussion.

Data on some of the more prevalent species in the treatment areas prior to initiation of the pilot grazing project were analyzed. Graphs were created to show the percent cover of each species recorded in sample plots for three treatments (control, graze, and mow) before and after year one of the project.

Grazed plots had a decrease in cover of wild oat, Italian thistle, mustard and fennel, although only with Italian thistle and fennel was cover in grazed plots decreased significantly more than in control

plots (Figures 11-14). Cover of vetch increased slightly in the grazed plots after year one of the project, although to a lesser extent than in the control plots (Figure 15). Italian ryegrass was denser in both the grazed and control plots after 2003 (Figure 16). Mowing seems to have had a greater impact on cover after one year than did grazing for mustard and Italian ryegrass, and for these species as well as Italian thistle when compared to the control plots (Figures 12, 13, and 16).

Several years of either treatment is preferred to best determine the effect on vegetation composition and density. Our limited data however do offer some predictive power of the benefits and cautions with goat grazing. Preliminary observations of the pilot grazing project, summarized in the 2004 HCP Activities Report, support our data. Firstly, goat grazing appears not to have had an impact on cover of the non-native annual grasses. This is not surprising as goat diets when grazing are composed of only about 10% grass (from the "Goat Summit" workshop held in San Francisco, January 25, 2005). Grazing was more successful in controlling some non-native perennials, and in terms of management, goat grazing would be best suited for sites dense in non-native perennials, sub-shrubs, and shrubs. Areas dense in thistle, fennel, or scrub are good candidates for goat grazing.

For some plant species, change in cover after year one was not significantly different between the control and grazed plot. Either these are species that were not preferred by the goats, or ones that will require several years of grazing before changes are detected. Consideration of what species are preferred by goats should be made, as these will be grazed before the undesirable species. Goats will show preference in vegetation grazing, and grazed species will vary in their recovery based on their growth form (rhizomatous or bulbous species such as Oxalis will rebound quickly), seedbank reserve, and ability to resprout.

When planning for grazing projects, enough funds should be secured to allow for several years of follow up grazing. Ideally, following a pilot project, a permanent grazing regime would be developed and initiated that would incorporate lessons learned. Monitoring would allow for adaptive management to ensure that the project remains on target for selected goals.

As goats will also graze native perennials (*San Bruno Mountain HCP 2004 Activities Report*), selection of areas to be grazed by goats must take into consideration the presence of native plants. In areas in which native cover is significant or where the goal is to reduce non-native grasses, mowing or grazing by another animal such as sheep or cattle is more likely to yield desired results. As was summarized in last year's activity report, mowing vegetation was most effective in controlling weeds while still maintaining natives. However, mowing does not remove biomass, and unless vegetation is raked and pile burned or hauled off site, there will be the problem of accumulation of thatch. Mowing and raking is a sensible option for small areas, particularly around sensitive habitat, such as the restoration islands.

Future goat grazing on San Bruno Mountain should target areas in which the goal is to beat back native or non-native scrub vegetation, to remove thatch, or in areas dominated by weeds such as thistle, radish, or fennel. In areas such as these, goat grazing is a viable means by which to meet vegetation management goals while minimizing left-over biomass, reducing chemical use, and staying within typical cost estimates for vegetation removal (goats, at $750/acre, are cost competitive with other invasive species control methods such as mowing and herbicide). Scrub habitat areas that are good candidates for a goat grazing project are illustrated in Figure 17. Within these areas, sections that support butterfly host plants would be corralled off, so that goats would be contained in areas that are predominately scrub. A thorough consideration of vegetation composition prior to grazing, and the desired condition post-grazing should be given. Precautions such as

ensuring that goats do not move new non-native species into areas grazed via manure or hooves are necessary. Funding for follow-up grazing and monitoring is recommended.

Potentially the most viable and long-term solution for managing grasslands and controlling non-native annual grasses is to introduce seasonal cattle grazing on the mountain. Cattle grazing would most closely mimic the historic elk grazing that occurred throughout the Bay Area before European settlement and development. Rotational cattle grazing has been used successfully to manage grasslands at Kirby Canyon for the Bay checkerspot butterfly (Peterson, pers. comm.) and for managing East Bay Regional Park District lands. A potentially good candidate site for rotational cattle grazing is on the South Slope, where there is an abundance of non-native grasses. Figure 17 illustrates potential areas for cattle grazing.

For both goat and cattle grazing, infrastructure is needed that would allow for fencing and water troughs for the animals. Organization and funds to provide for this infrastructure are of first order in establishing future grazing programs. Although the initial cost is substantial, establishment of permanent infrastructure in areas where continued, rotational grazing is recommended would reduce long term costs and allow for quicker utilization of grazing when needs dictate. Further consideration of those areas delineated in Figure 17 would allow managers to narrow down grazing selection areas and target a few areas for initial establishment of permanent infrastructure.

D. Burning

Three small wildfires were started on the Mountain in August. The largest of these (approximately 9.5 acres) occurred on the slope below the Northeast Ridge watertank and above the Louis Raphael Co. parking lot in the Brisbane Industrial Park, at 100 West Hill Road. This fire started from a downed power line resulting from a vehicle accident in Brisbane. The lower portion of Callippe Silverspot fixed transect #6, and a recently installed Mission blue habitat island burned in this fire. Visual estimations of the effect this fire had on vegetation and lupine in particular will be made in the spring of 2006.

A second, very small fire (approximately 2,500 square feet) occurred within the Bay Vista parcel, just above the terminus of Schwerin Street. The cause of this fire is unknown. A third fire was not on park land, but within the Brisbane Acres, on the Ing parcel located on Thomas Street (approximately 2 acres). This fire is believed to have been started by illegal fireworks. North Coast Fire Authority was unable to provide specific dates for these fires, but estimated that they all occurred in the second and third weeks of August.

In 2005, no prescribed burns were set on the Mountain. CDF prison crews will conduct non-native shrub removal and piling in early 2006. These piles are scheduled to be burned by CDF in winter 2005/2006 and will be reported on in the 2006 Activities Report.

E. Coastal Scrub Succession

Since the cessation of cattle grazing in the early 1960's, and the reduction in wildfires and controlled burning, native coastal scrub vegetation has been expanding on San Bruno Mountain and overtaking grasslands. This phenomenon has resulted in approximately 180 acres of grassland being lost to coastal scrub since the inception of the HCP in 1982. In addition to the loss of grassland, the build up of thatch within grasslands in the absence of burning and/or grazing can reduce native species composition and predispose grasslands to become more weedy over time. Management of expanding scrub communities will require a combination of burning, grazing, and/or mechanical removal to maintain grasslands. Because the regulatory requirements and liability concerns over prescribed

burning have reduced the feasibility of using this tool on the Mountain, grazing and mechanical removal (with biomass disposal) are more likely to be the tools used for scrub removal. Continued monitoring of scrub succession, using land and aerial photography, will aid managers in determine where to prioritize scrub control efforts. Application of any chosen management regime however, will be limited by the current level of HCP funds.

IV. ADMINISTRATION

5-Year Plan and Callippe Amendment

A Draft Five Year Plan has been developed for San Bruno Mountain, however formal approval of the plan has been delayed while funding is identified to complete the Callippe Amendment process. When approved, the plan will provide goals and objectives for the following activities: 1) invasive species control, 2) sensitive species population monitoring, 3) habitat restoration, 4) development activities, and 5) public participation.

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All TRA documents/ resources available on-line at http://www.traenviro.com/sanbruno/ *or from County of San Mateo Parks and Recreation Division.*

Personal Communications:

Mike Forbert, West Coast Wildlands. Communications re: Invasives control

Charley Knight, California Polytechnic State University, and Wendy Knight. Communications re: MB, CS, SBE data analysis.

Peterson, Tay. Senior Biologist. Thomas Reid Associates. Communications re: cattle grazing at Kirby Canyon.

VI. STUDY PARTICIPANTS

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Native Plant Restoration: Shelterbelt Builders, Inc. Mark Heath, Supervisor.

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Sam Herzberg
Gary Lockman
Michael Murphy (County Counsel)

North County Fire Authority
Angela Peterson

The Friends of San Bruno Mountain
Doug Allshouse, Leroy French, and FSBM volunteers

San Bruno Mountain Watch
Philip Batchelder and SBMW volunteers

Watershed Project, Heart of the Mountain
Joe Cannon and CNPS volunteers

FIGURES

Figure 1. San Bruno Mountain Habitat Conservation Plan Management Areas

Figure 2. Mission Blue Observations on the Callippe Silverspot Transects: 2005

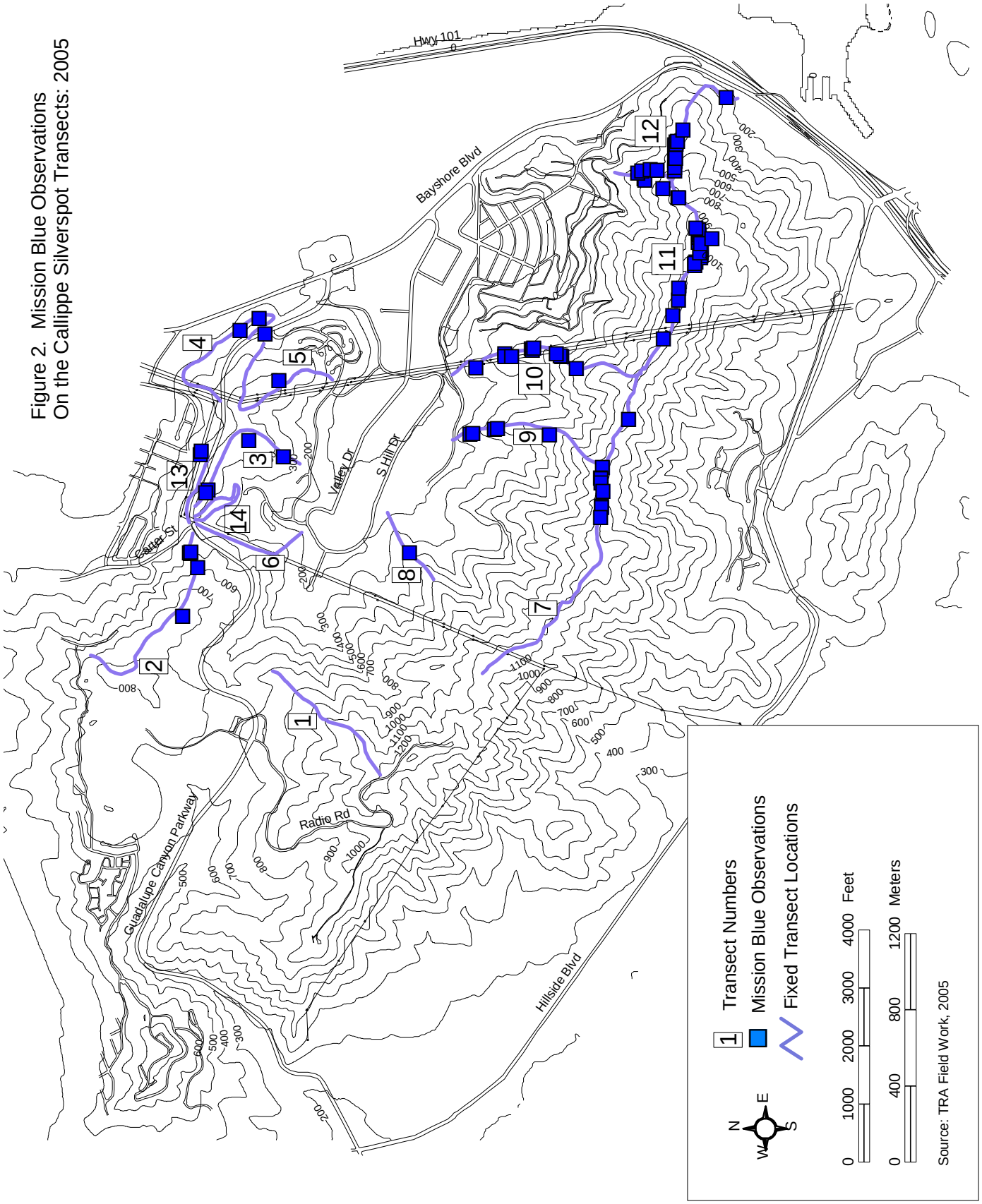


Figure 3. Callippe Silverspot Fixed Transects and Observations: 2005

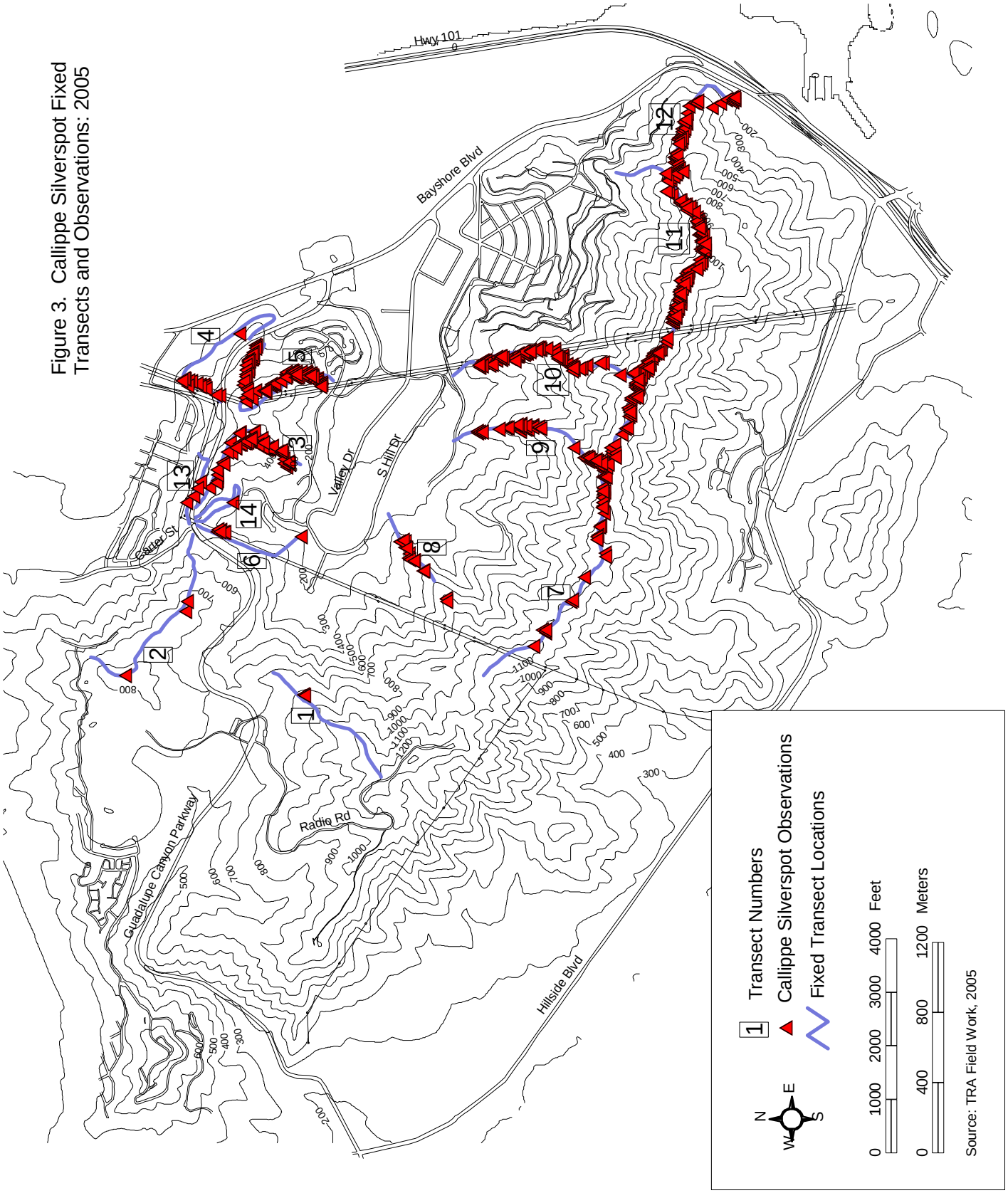


Figure 4. Average Number of CS Observed/hour, 2000-2005

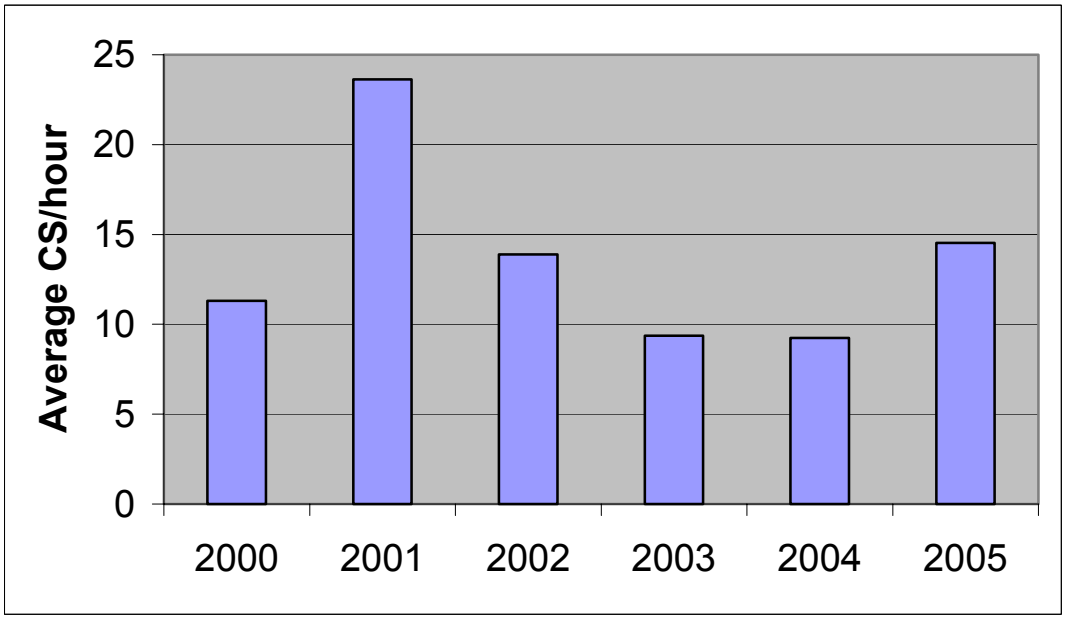


Figure 5. Average Number of CS Observed/hour, Transects 1-14, 2005

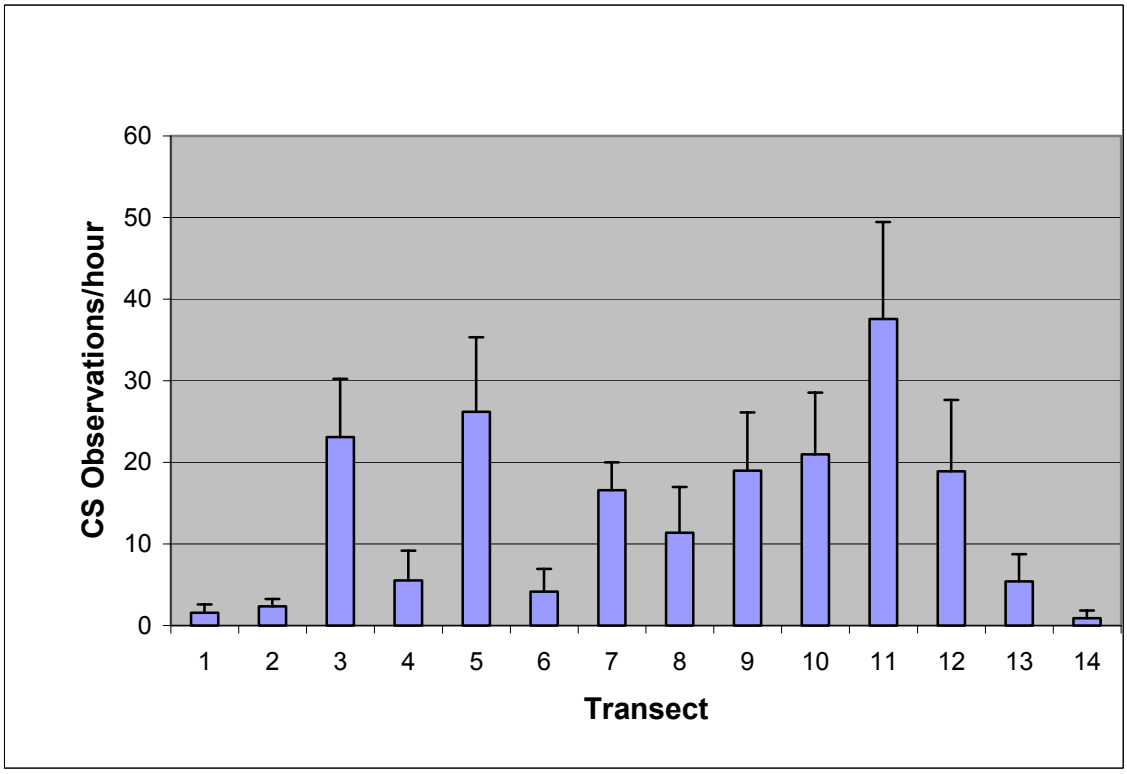


Figure 6. 2005 Viola Map For San Bruno Mountain, Mapped in 2002, 2004, & 2005.

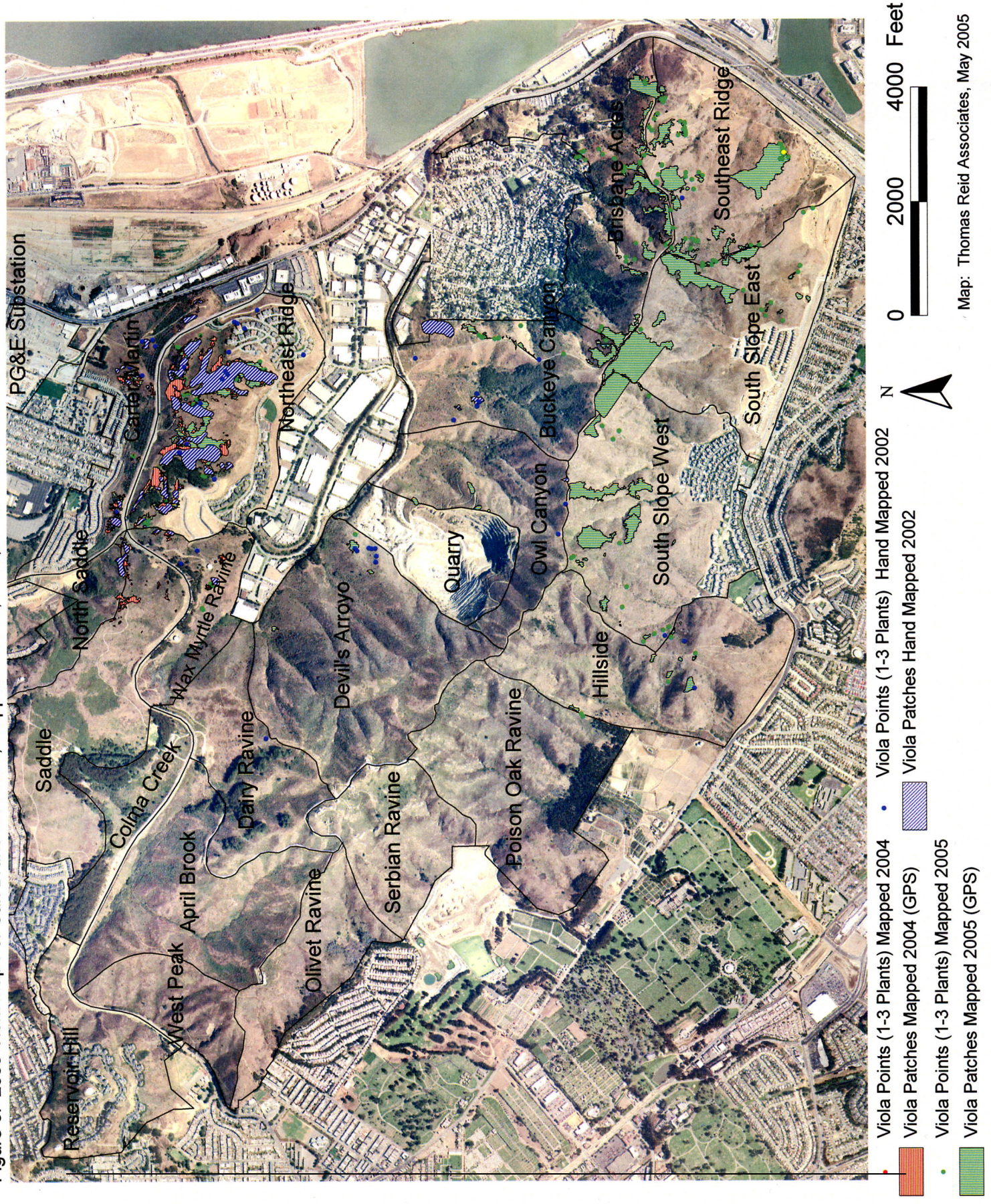


Figure 6. 2005 Viola Map For San Bruno Mountain, Mapped in 2002, 2004, & 2005.

Figure 7. One-time Callippe Transects on South Slope: 2005

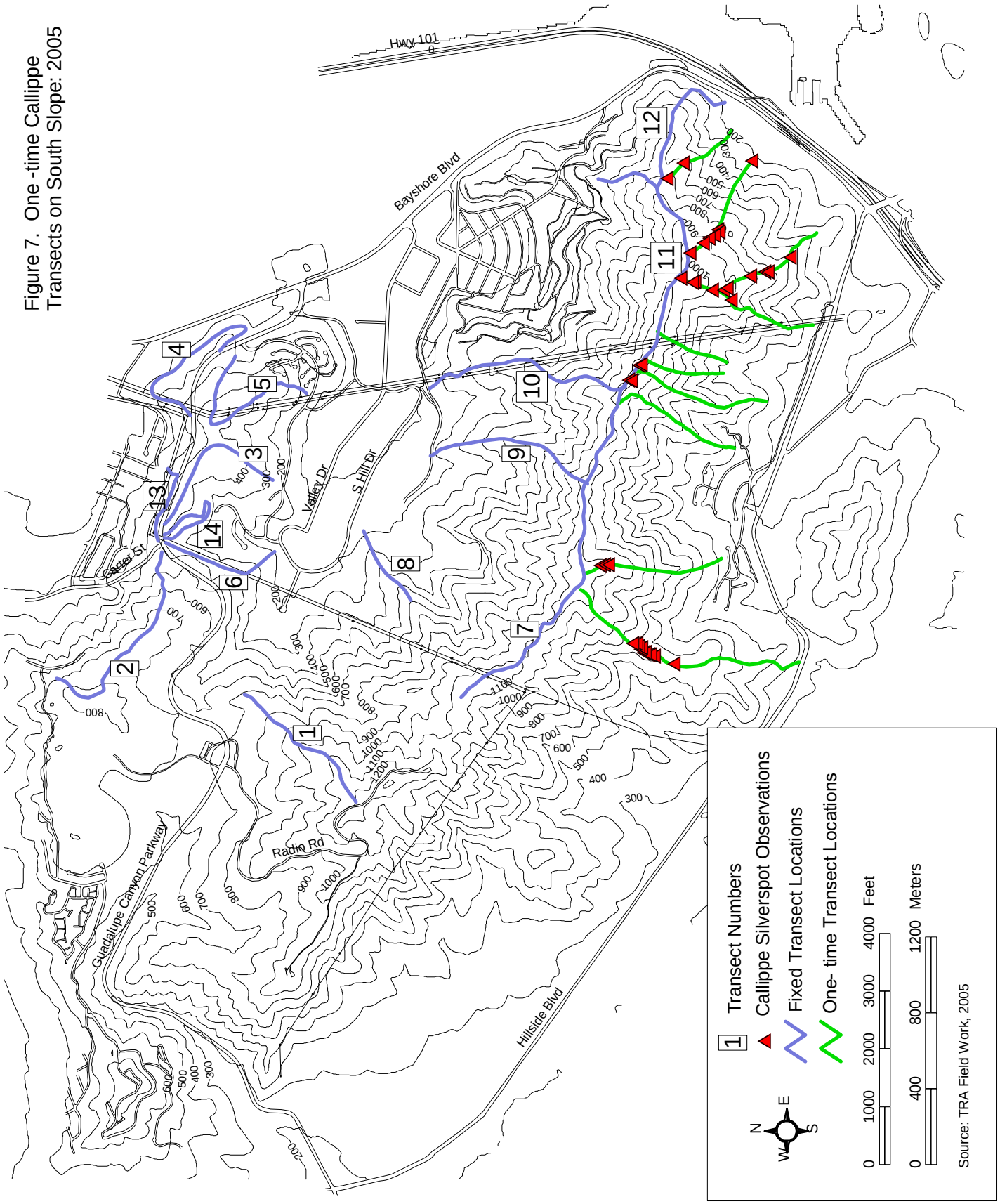


Figure 8. HCP Hand and Herbicide Exotics Control Work

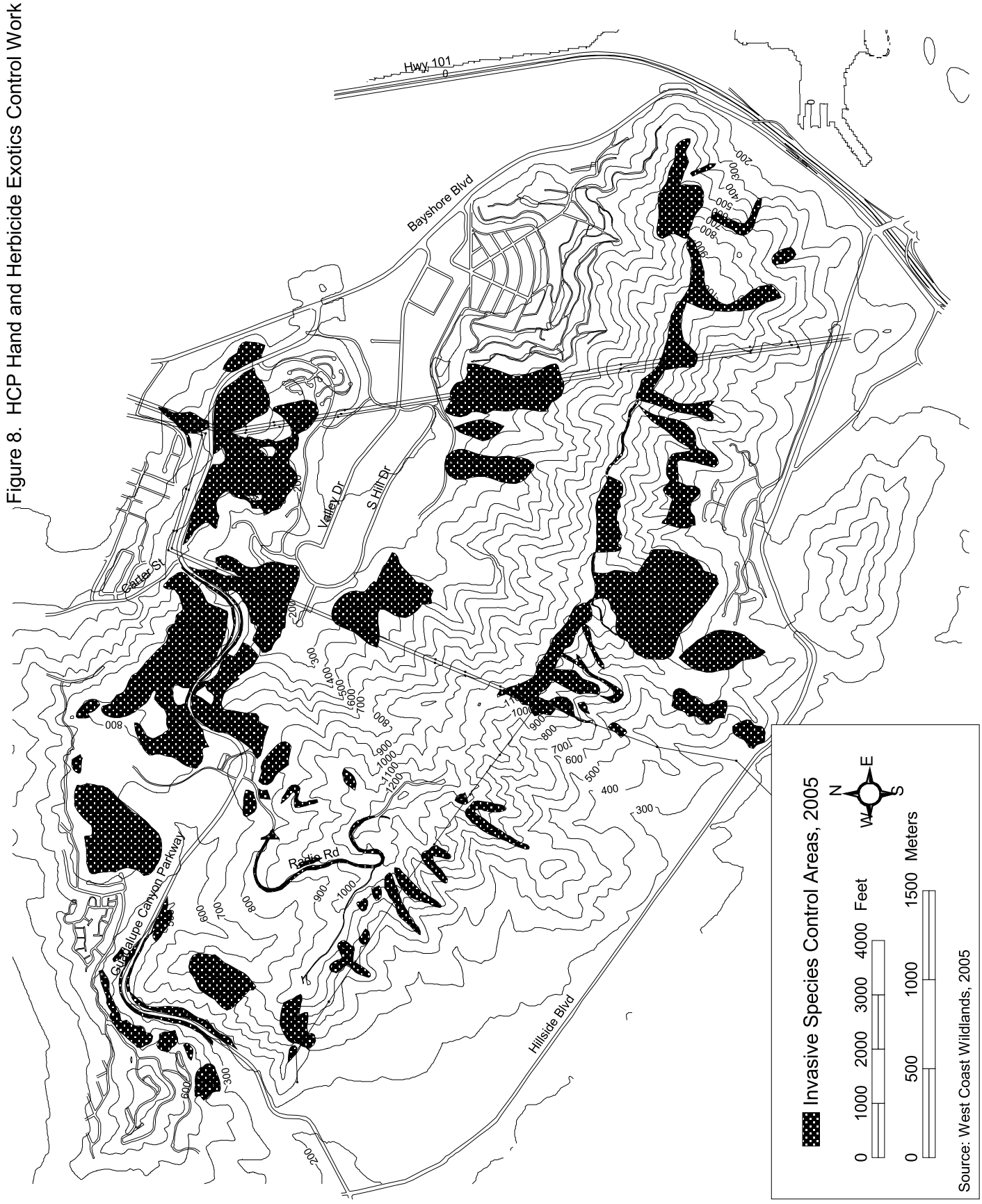


Figure 9. Known Distribution of Oxalis on San Bruno Mountain

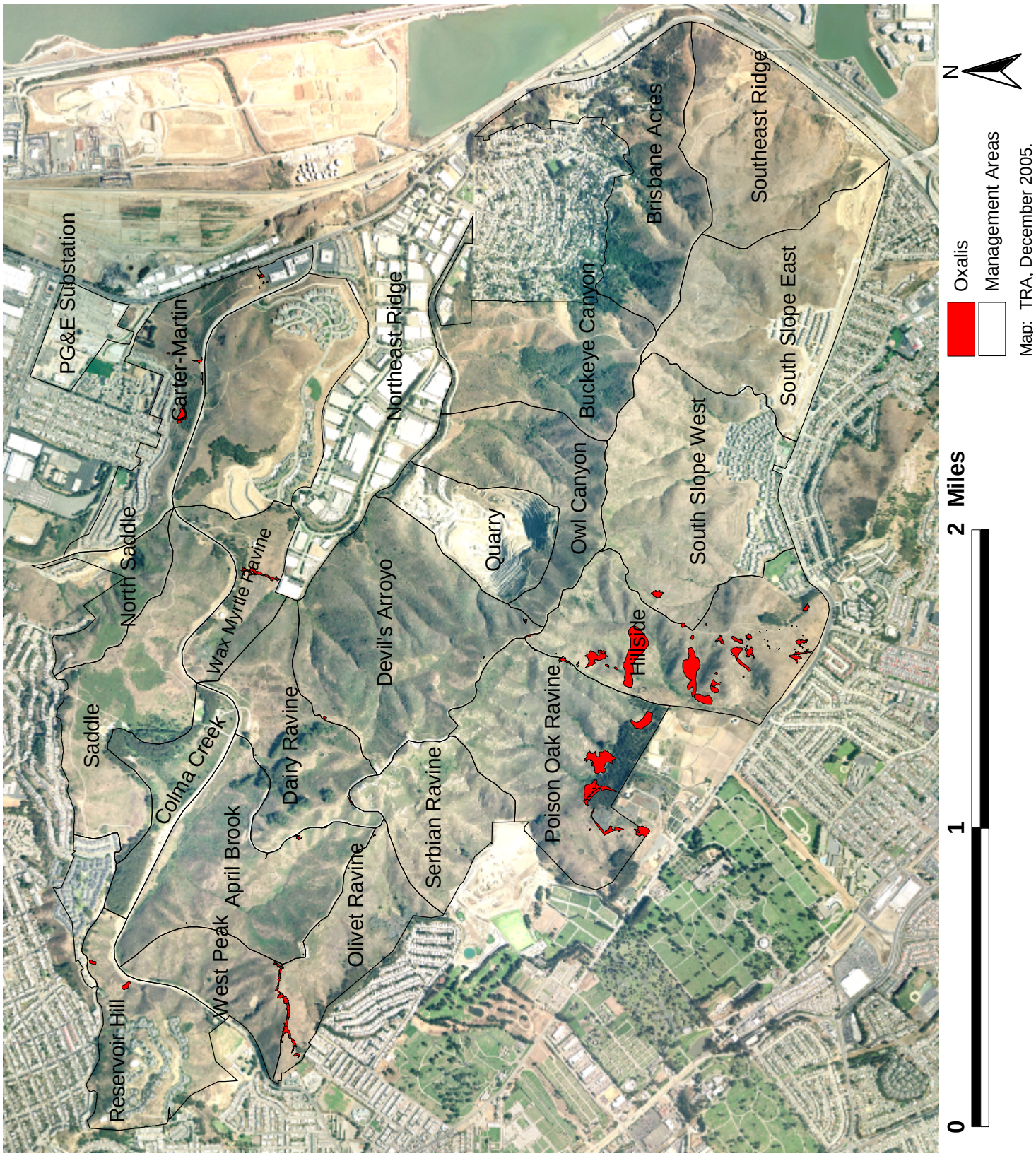


Figure 9. Known Distribution of Oxalis on San Bruno Mountain

Figure 10. Habitat Restoration Projects

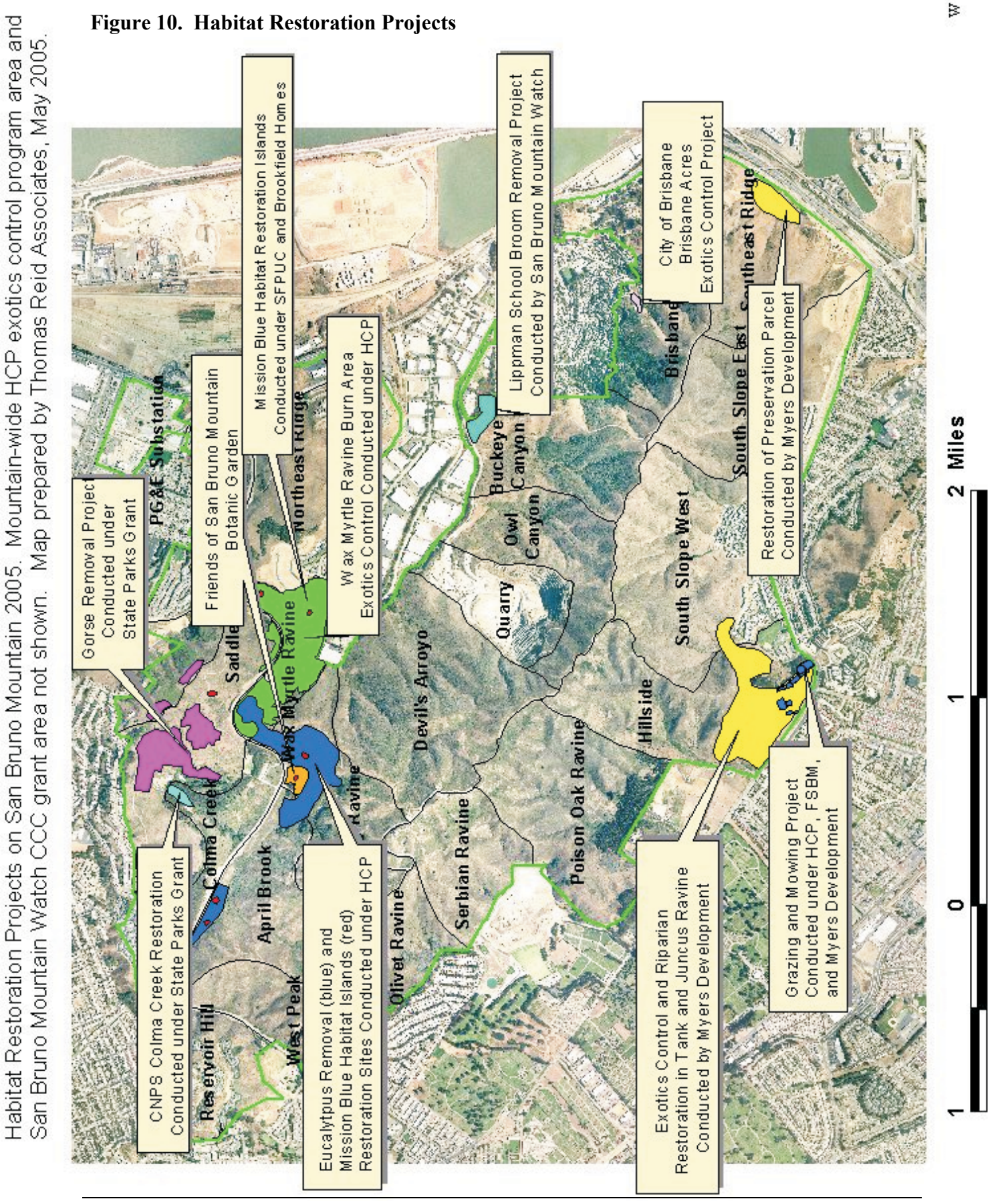


Figure 11. Wild oat (*Avena barbata*) Cover, Pilot Grazing Project

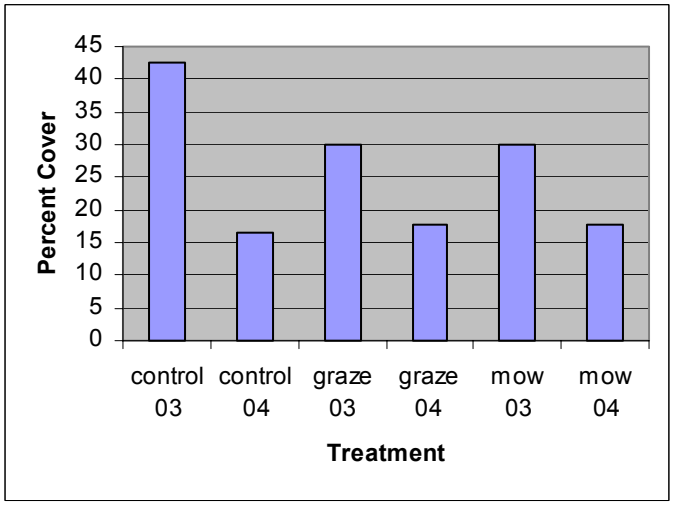


Figure 12. Italian thistle (*Carduus pycnocephalus*) Cover, Pilot Grazing Project

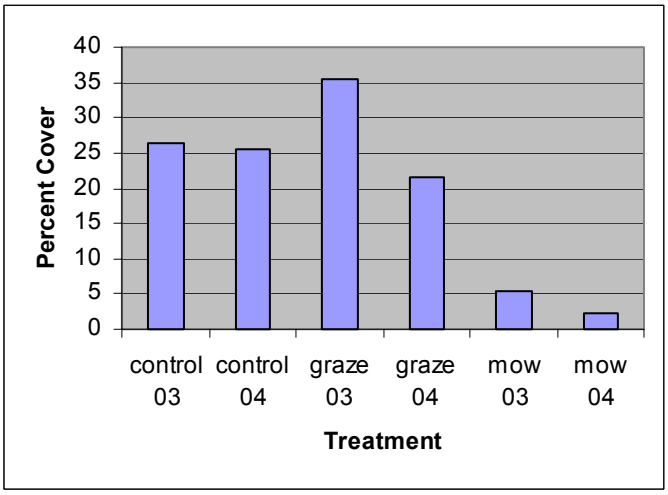


Figure 13. Mustard (*Hirschfeldia incana*) Cover, Pilot Grazing Project

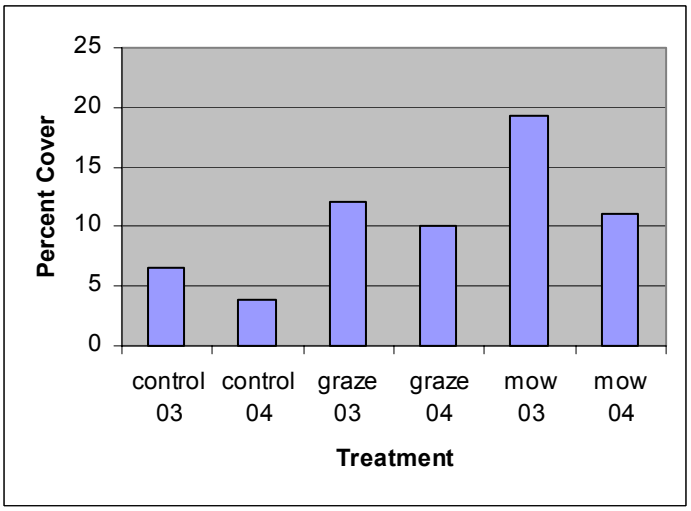


Figure 14. Fennel (*Foeniculum vulgare*) Cover, Pilot Grazing Project

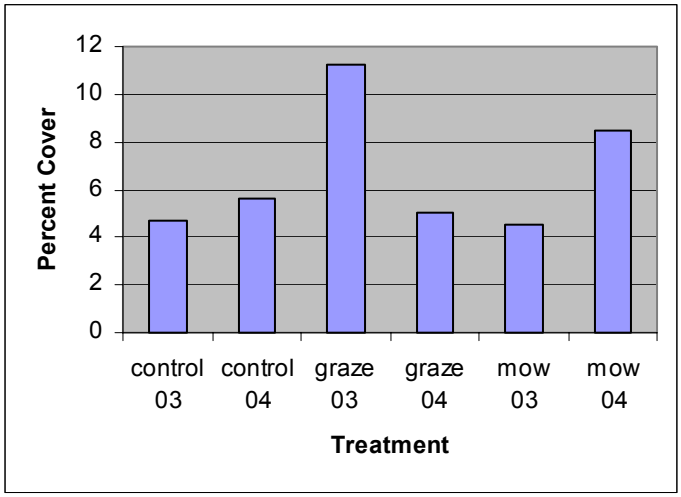


Figure 15. Vetch (*Vicia sp.*) Cover, Pilot Grazing Project

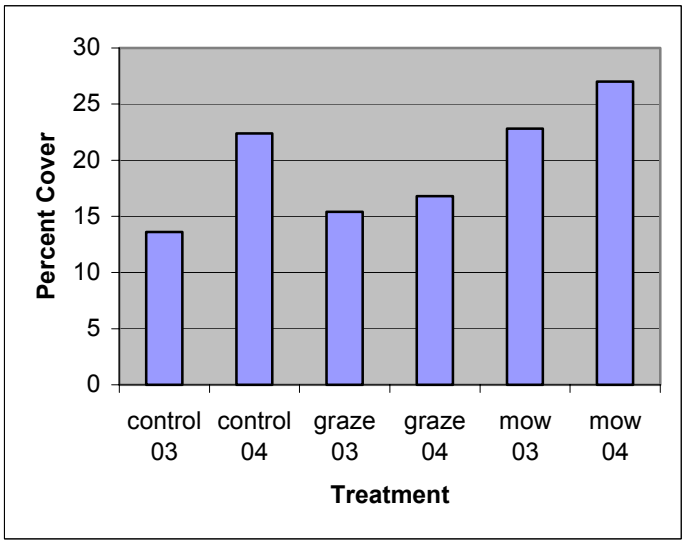


Figure 16. Italian ryegrass (*Lolium multiflorum*) Cover, Pilot Grazing Project

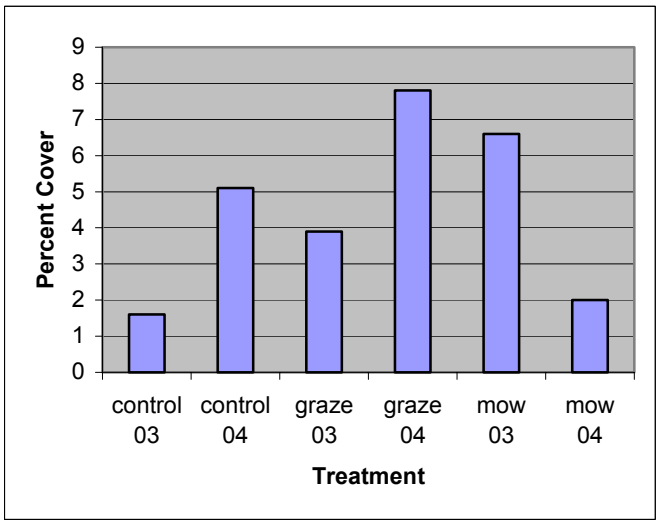
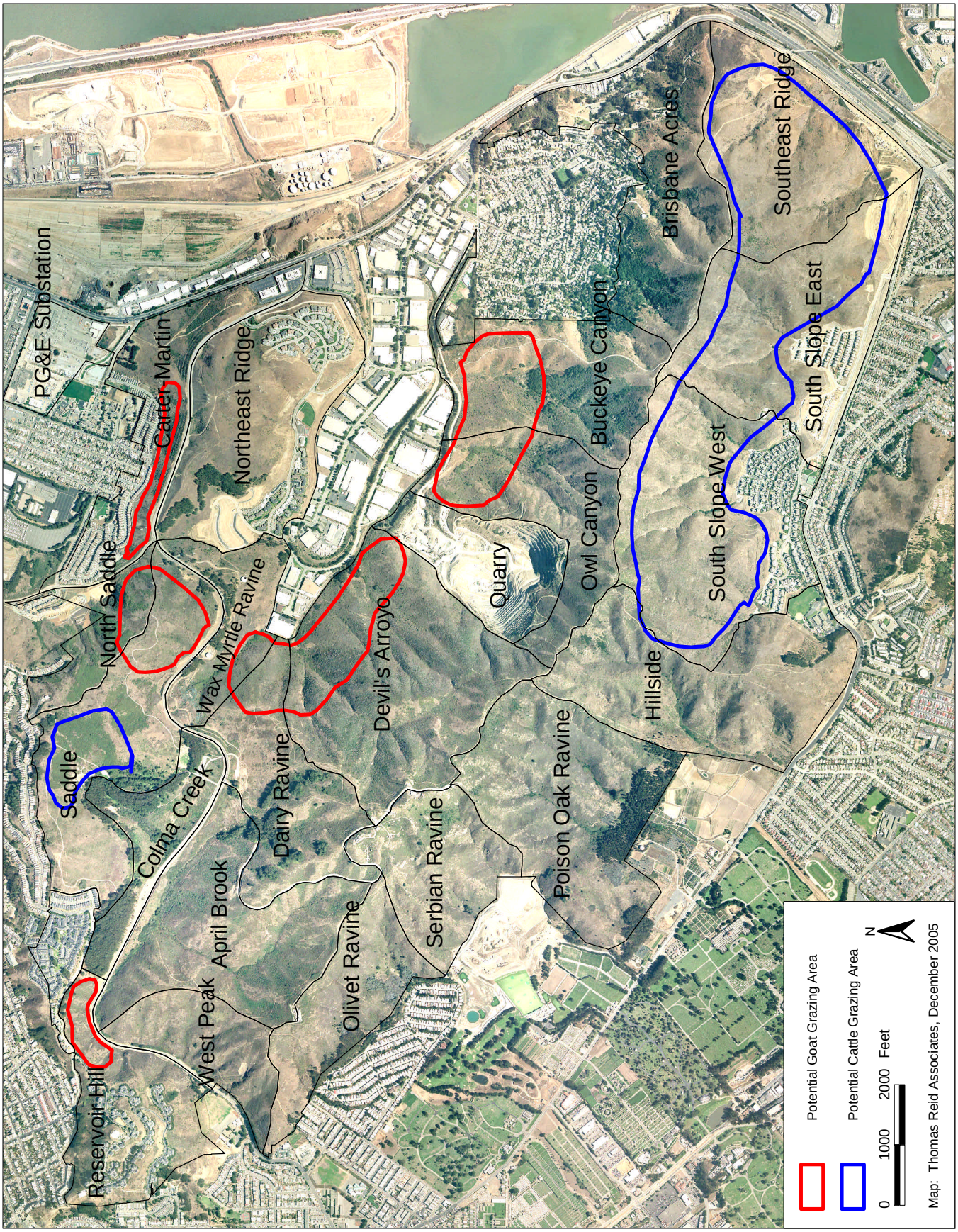


Figure 17. Potential Areas for Future Grazing



Appendix A. 2005 Callippe Silverspot Fixed Transect Data

ANOVA Results: Sightings/hour, Years 2000-2005

The results of a ANOVA statistical test performed at 17:44 on 13-DEC-2005

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	7683.	5	1537.	5.317
error	9.1611E+04	317	289.0	
total	9.9294E+04	322		

The probability of this result, assuming the null hypothesis, is 0.0001

Group A: Number of items= 41
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.22 2.22 2.31 3.16 3.24 3.33 3.67 4.14 4.44 4.62 5.63 6.00 6.15 7.50 7.89 8.28 9.64 10.3 12.0 12.0 13.1 14.5 17.6 20.4 23.0 27.9 28.3 30.0 34.3 35.2 38.4 43.6 47.1

Mean = 12.0
95% confidence interval for Mean: 6.761 thru 17.21
Standard Deviation = 13.4
High = 47.1 Low = 0.000E+00
Median = 6.15
Average Absolute Deviation from Median = 9.69

Group B: Number of items= 42
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.43 2.35 4.19 4.29 5.63 5.88 7.69 8.08 10.0 10.6 11.5 12.3 13.4 13.5 14.7 20.6 23.6 27.2 28.7 32.3 32.6 33.2 35.4 45.0 48.8 51.3 53.5 53.6 54.3 58.5 60.0 120. 131.

Mean = 24.6
95% confidence interval for Mean: 19.49 thru 29.81
Standard Deviation = 30.1
High = 131. Low = 0.000E+00
Median = 12.9
Average Absolute Deviation from Median = 20.6

Group C: Number of items= 44
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.20 2.00 2.00 2.31 2.61 2.73 4.00 4.14 4.62 5.45 6.00 6.32 6.98 7.20 7.50 8.00 8.57 10.0 12.0 15.4 16.7 16.8 16.9 17.8 18.9 19.4 20.0 20.4 20.6 22.9 25.2 25.7 28.0 30.0 33.6 33.6 38.7 48.5 56.5

Mean = 14.3
95% confidence interval for Mean: 9.257 thru 19.34
Standard Deviation = 13.6
High = 56.5 Low = 0.000E+00
Median = 9.29
Average Absolute Deviation from Median = 10.6

Group D: Number of items= 61
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 1.46 1.82 1.82 2.00 4.29 4.50 4.74 4.80 5.14 5.66 7.20
8.57 9.80 10.4 10.8 10.9 11.3 12.2 12.9 15.7 16.0 16.7 16.7 17.4 17.4 18.3 20.0 20.5 20.5
20.8 21.3 24.0 25.0 27.4 34.3 42.0 50.3

Mean = 9.09
95% confidence interval for Mean: 4.808 thru 13.37
Standard Deviation = 11.3
High = 50.3 Low = 0.000E+00
Median = 4.74
Average Absolute Deviation from Median = 8.49

Group E: Number of items= 55
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.560 1.46 1.54 1.62 2.14 2.22 2.40 2.61 2.86 3.00 3.24 3.75 4.07
4.62 4.86 6.49 7.74 8.00 8.00 9.23 10.0 10.6 11.1 12.7 15.0 15.0 16.0 17.8 18.9 19.5 19.6
20.9 24.3 28.2 30.0 31.7 33.6 39.1 42.2

Mean = 9.03
95% confidence interval for Mean: 4.523 thru 13.54
Standard Deviation = 11.2
High = 42.2 Low = 0.000E+00
Median = 3.75
Average Absolute Deviation from Median = 8.10

Group F: Number of items= 80
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.88 2.00 2.07 2.40 3.33 4.29 4.50 4.62
4.80 5.00 5.45 5.45 6.00 6.15 6.67 6.67 6.92 8.37 9.00 9.23 9.60 11.3 12.0 12.0 12.0 12.6

15.0 16.0 17.6 17.8 18.3 18.8 20.0 20.0 21.9 22.1 23.1 24.0 26.7 29.0 32.1 33.0 33.7 34.3 35.0 35.5 39.6 41.7 43.5 45.6 47.6 60.0 62.5 62.5 77.1

Mean = 14.4
95% confidence interval for Mean: 10.61 thru 18.09
Standard Deviation = 17.8
High = 77.1 Low = 0.000E+00
Median = 6.67
Average Absolute Deviation from Median = 12.7

ANOVA Results: Sightings/hour, Years 2000 and 2002-2005

The results of an ANOVA statistical test performed at 17:49 on 13-DEC-2005

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	1667.	4	416.7	2.110
error	5.4500E+04	276	197.5	
total	5.6167E+04	280		

The probability of this result, assuming the null hypothesis, is 0.080

Group A: Number of items= 80
0.000E+00 1.88 2.00 2.07 2.40 3.33 4.29 4.50 4.62 4.80 5.00 5.45 5.45 6.00 6.15 6.67 6.67 6.92 8.37 9.00 9.23 9.60 11.3 12.0 12.0 12.0 12.6 15.0 16.0 17.6 17.8 18.3 18.8 20.0 20.0 21.9 22.1 23.1 24.0 26.7 29.0 32.1 33.0 33.7 34.3 35.0 35.5 39.6 41.7 43.5 45.6 47.6 60.0 62.5 62.5 77.1

Mean = 14.4
95% confidence interval for Mean: 11.26 thru 17.45
Standard Deviation = 17.8
High = 77.1 Low = 0.000E+00
Median = 6.67
Average Absolute Deviation from Median = 12.7

Group B: Number of items= 55
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.560 1.46 1.54 1.62 2.14 2.22 2.40 2.61 2.86 3.00 3.24 3.75 4.07 4.62 4.86 6.49 7.74 8.00 8.00 9.23 10.0 10.6 11.1 12.7 15.0 15.0 16.0 17.8 18.9 19.5 19.6 20.9 24.3 28.2 30.0 31.7 33.6 39.1 42.2

Mean = 9.03
95% confidence interval for Mean: 5.302 thru 12.76
Standard Deviation = 11.2
High = 42.2 Low = 0.000E+00
Median = 3.75
Average Absolute Deviation from Median = 8.10

Group C: Number of items= 61
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 0.000E+00 0.000E+00 1.46 1.82 1.82 2.00 4.29 4.50 4.74 4.80 5.14 5.66 7.20
8.57 9.80 10.4 10.8 10.9 11.3 12.2 12.9 15.7 16.0 16.7 16.7 17.4 17.4 18.3 20.0 20.5 20.5
20.8 21.3 24.0 25.0 27.4 34.3 42.0 50.3

Mean = 9.09
95% confidence interval for Mean: 5.548 thru 12.63
Standard Deviation = 11.3
High = 50.3 Low = 0.000E+00
Median = 4.74
Average Absolute Deviation from Median = 8.49

Group D: Number of items= 44
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 1.20 2.00 2.00 2.31 2.61 2.73
4.00 4.14 4.62 5.45 6.00 6.32 6.98 7.20 7.50 8.00 8.57 10.0 12.0 15.4 16.7 16.8 16.9 17.8
18.9 19.4 20.0 20.4 20.6 22.9 25.2 25.7 28.0 30.0 33.6 33.6 38.7 48.5 56.5

Mean = 14.3
95% confidence interval for Mean: 10.13 thru 18.47
Standard Deviation = 13.6
High = 56.5 Low = 0.000E+00
Median = 9.29
Average Absolute Deviation from Median = 10.6

Group E: Number of items= 41
0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00
0.000E+00 1.22 2.22 2.31 3.16 3.24 3.33 3.67 4.14 4.44 4.62 5.63 6.00 6.15 7.50 7.89
8.28 9.64 10.3 12.0 12.0 13.1 14.5 17.6 20.4 23.0 27.9 28.3 30.0 34.3 35.2 38.4 43.6 47.1

Mean = 12.0
95% confidence interval for Mean: 7.664 thru 16.30
Standard Deviation = 13.4
High = 47.1 Low = 0.000E+00

Median = 6.15
Average Absolute Deviation from Median = 9.69

ANOVA Results: Sightings/hour, Transects 1-14, 2005

The results of an ANOVA statistical test performed at 17:54 on 13-DEC-2005

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	9155.	13	704.2	2.932
error	1.5855E+04	66	240.2	
total	2.5010E+04	79		

The probability of this result, assuming the null hypothesis, is 0.0021

Group A: Number of items= 6
0.000E+00 0.000E+00 0.000E+00 0.000E+00 3.33 6.00

Mean = 1.55
95% confidence interval for Mean: -11.08 thru 14.19
Standard Deviation = 2.55
High = 6.00 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 1.55

Group B: Number of items= 5
0.000E+00 1.88 2.07 2.40 5.45

Mean = 2.36
95% confidence interval for Mean: -11.48 thru 16.20
Standard Deviation = 1.96
High = 5.45 Low = 0.000E+00
Median = 2.07
Average Absolute Deviation from Median = 1.19

Group C: Number of items= 6
0.000E+00 12.0 12.6 33.0 35.5 45.6

Mean = 23.1
95% confidence interval for Mean: 10.48 thru 35.75
Standard Deviation = 17.5
High = 45.6 Low = 0.000E+00
Median = 22.8
Average Absolute Deviation from Median = 14.9

Group D: Number of items= 5
0.000E+00 0.000E+00 0.000E+00 9.23 18.3

Mean = 5.51
95% confidence interval for Mean: -8.327 thru 19.35
Standard Deviation = 8.20
High = 18.3 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 5.51

Group E: Number of items= 6
0.000E+00 5.45 26.7 29.0 33.7 62.5

Mean = 26.2
95% confidence interval for Mean: 13.57 thru 38.83
Standard Deviation = 22.3
High = 62.5 Low = 0.000E+00
Median = 27.8
Average Absolute Deviation from Median = 15.5

Group F: Number of items= 6
0.000E+00 0.000E+00 0.000E+00 0.000E+00 9.00 16.0

Mean = 4.17
95% confidence interval for Mean: -8.467 thru 16.80
Standard Deviation = 6.82
High = 16.0 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 4.17

Group G: Number of items= 6
2.00 12.0 17.8 21.9 22.1 24.0

Mean = 16.7
95% confidence interval for Mean: 4.017 thru 29.28
Standard Deviation = 8.36
High = 24.0 Low = 2.00
Median = 19.9
Average Absolute Deviation from Median = 6.04

Group H: Number of items= 6
0.000E+00 0.000E+00 6.67 6.67 20.0 35.0

Mean = 11.4
95% confidence interval for Mean: -1.243 thru 24.02
Standard Deviation = 13.7
High = 35.0 Low = 0.000E+00
Median = 6.67
Average Absolute Deviation from Median = 9.17

Group I: Number of items= 6
0.000E+00 4.80 8.37 23.1 34.3 43.5

Mean = 19.0
95% confidence interval for Mean: 6.365 thru 31.63
Standard Deviation = 17.5
High = 43.5 Low = 0.000E+00
Median = 15.7
Average Absolute Deviation from Median = 14.6

Group J: Number of items= 6
4.29 4.50 11.3 18.8 39.6 47.6

Mean = 21.0
95% confidence interval for Mean: 8.367 thru 33.63
Standard Deviation = 18.5
High = 47.6 Low = 4.29
Median = 15.0
Average Absolute Deviation from Median = 14.3

Group K: Number of items= 6
5.00 6.92 32.1 41.7 62.5 77.1

Mean = 37.6
95% confidence interval for Mean: 24.93 thru 50.19
Standard Deviation = 29.1
High = 77.1 Low = 5.00
Median = 36.9
Average Absolute Deviation from Median = 22.9

Group L: Number of items= 6
0.000E+00 6.15 9.60 17.6 20.0 60.0

Mean = 18.9
95% confidence interval for Mean: 6.267 thru 31.53
Standard Deviation = 21.4
High = 60.0 Low = 0.000E+00
Median = 13.6
Average Absolute Deviation from Median = 13.7

Group M: Number of items= 5
0.000E+00 0.000E+00 0.000E+00 12.0 15.0

Mean = 5.40
95% confidence interval for Mean: -8.439 thru 19.24
Standard Deviation = 7.47
High = 15.0 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 5.40

Group N: Number of items= 5
0.000E+00 0.000E+00 0.000E+00 0.000E+00 4.62

Mean = 0.924
95% confidence interval for Mean: -12.92 thru 14.76
Standard Deviation = 2.07
High = 4.62 Low = 0.000E+00
Median = 0.000E+00
Average Absolute Deviation from Median = 0.924

Callippe Silverspot 2005 Fixed Transect Data

Week	Date	Transect	#CS	Minutes	CS/Hour	Average Wind	Average Temperature
1	5/11	1	0	15	0.00	8.25	16.1
1	5/11	2	1	32	1.88	4.35	23.2
1	5/11	3	13	22	35.45	3.85	19.6
1	5/11	4	0	31	0.00	1.9	25
1	5/11	5	14	29	28.97	1.4	21
1	5/11	6	0	16	0.00	2.75	24.4
1	5/11	7	1	30	2.00	9.5	25.1
1	5/11	8	0	10	0.00	3.55	22
1	5/11	9	0	35	0.00	4.8	26
1	5/11	10	2	28	4.29	2.7	24.4
1	5/11	11	3	26	6.92	1.8	30
1	5/11	12	4	39	6.15	1.6	25.8
1	5/11	13	0	16	0.00	2	27.55
1	5/11	14	0	17	0.00	3	23.6
3	5/24	1	1	18	3.33	1.65	19.1

3	5/24	2	1	25	2.40	2.45	23.6
3	5/24	3	11	20	33.00	2.05	21.85
3	5/23	4	0	25	0.00	5.8	29.2
3	5/23	5	23	41	33.66	5.95	27.6
3	5/24	6	3	20	9.00	1.8	24.2
3	5/23	7	11	37	17.84	3.1	23.1
3	5/23	8	7	12	35.00	1.9	24.4
3	5/23	9	6	43	8.37	0.7	21.2
3	5/23	10	3	40	4.50	0.7	21.2
3	5/23	11	25	36	41.67	1.9	22
3	5/23	12	10	34	17.65	2.1	22.6
3	5/23	13	0	14	0.00	5.1	26.5
3	5/24	14	0	11	0.00	1.5	18.9
4	6/1	1	0	16	0.00	7.2	16.9
4	6/1	2	1	29	2.07	1.75	20
4	5/31	3	19	25	45.60	2.9	27.9
4	5/31	4	4	26	9.23	1.95	21
4	5/31	5	51	49	62.45	2.65	25.2
4	6/1	6	4	15	16.00	1.7	24.2
4	6/1	7	15	41	21.95	2.65	21.7
4	6/1	8	6	18	20.00	6.75	25.5
4	6/1	9	20	35	34.29	2.25	23.3
4	6/1	10	35	53	39.62	4.2	25.6
4	6/1	11	45	35	77.14	4.2	25.6
4	6/1	12	31	31	60.00	0.07	30
4	5/31	13	3	12	15.00	2.05	21.9
4	5/31	14	1	13	4.62	2.4	21.75
6	6/13	1	2	20	6.00	1.55	24.3
6	6/13	2	0	26	0.00	4.55	24.25
6	6/13	3	4	19	12.63	5.45	28.6
6	6/13	4	11	36	18.33	3.1	28.1
6	6/13	5	8	18	26.67	3.5	25.3
6	6/13	6	0	14	0.00	3.45	25.7
6	6/13	7	16	40	24.00	1.4	23.7
6	6/13	8	1	9	6.67	1.3	26.7
6	6/13	9	21	29	43.45	1.15	79.5
6	6/13	10	23	29	47.59	1.25	25.25
6	6/13	11	15	28	32.14	2.8	23.6
6	6/13	12	11	33	20.00	1.3	22.2
6	6/13	13	3	15	12.00	3.1	28.1
6	6/13	14	0	20	0.00	3.1	28.1
8	6/30	1	0	18	0.00	3.8	18.5
8	6/30	3	5	25	12.00	6.6	23.7
8	6/30	5	2	22	5.45	1	31.15
8	6/30	6	0	22	0.00	2.9	24.8
8	6/30	7	14	38	22.11	1.6	25.1
8	6/30	8	2	18	6.67	2.5	29
8	6/30	9	10	26	23.08	2.2	26.7

8	6/30	10	10	32	18.75	1.35	27.3
8	6/30	11	25	24	62.50	1.75	26.1
8	6/30	12	4	25	9.60	2.15	24.7
10	7/12	1	0	20	0.00	3	24.9
10	7/13	2	1	11	5.45	5.4	22.05
10	7/13	3	0	16	0.00	2	26
10	7/13	4	0	22	0.00	6.3	22.8
10	7/13	5	0	23	0.00	3	24
10	7/13	6	0	17	0.00	3.2	26.75
10	7/12	7	7	35	12.00	1.2	28.6
10	7/12	8	0	11	0.00	3.85	33.5
10	7/12	9	2	25	4.80	5.75	26.25
10	7/12	10	3	16	11.25	1.2	34.6
10	7/12	11	3	36	5.00	1.55	32.9
10	7/12	12	0	38	0.00	1.1	30.8
10	7/13	13	0	12	0.00	8	24
10	7/13	14	0	18	0.00	6.75	24

Appendix B. Correlation Analysis: CS Sightings per hour and Temperature

Correlation r: closer to value of 1.0= perfect fit
Sign of r (+ or-) is direction of association
x=temperature, y=sightings/hour

TRANSECT 3

TRA weather Data

The results of a QuickFit performed at 15:52 on 28-DEC-2005
6 data pairs (x,y):
(19.6 , 35.5); (21.9 , 33.0); (27.9 , 45.6); (28.6 , 12.6); (23.7 , 12.0); (26.0 , 0.000E+00);
y = *a* + *b*x where:
a= 54.3 (σ_a = 36.)
b= -1.27 (σ_b = 1.6)
degrees of freedom = 4
r = -0.256 (p = 0.624)

SFO weather data

The results of a QuickFit performed at 15:58 on 28-DEC-2005
6 data pairs (x,y):
(59.5 , 35.5); (65.0 , 33.0); (62.5 , 45.6); (67.0 , 12.6); (63.5 , 12.0); (64.5 , 0.000E+00);
y = *a* + *b*x where:
a= 253. (σ_a = 70.)
b= -3.61 (σ_b = 1.1)
degrees of freedom = 4
r = -0.526 (p = 0.283)

TRANSECT 5

TRA weather data

The results of a QuickFit performed at 16:04 on 28-DEC-2005
6 data pairs (x,y):
(21.0 , 29.0); (27.6 , 33.7); (25.2 , 62.5); (25.3 , 26.7); (31.1 , 5.45); (24.0 , 0.000E+00);
y = *a* + *b*x where:
a= 63.7 (σ_a = 43.)
b= -1.46 (σ_b = 1.6)
degrees of freedom = 4
r = -0.224 (p = 0.670)

SFO weather data

The results of a QuickFit performed at 16:01 on 28-DEC-2005

6 data pairs (x,y):
(59.5 , 29.0); (61.0 , 33.7); (62.5 , 62.5); (67.0 , 26.7); (63.5 , 5.45); (64.5 , 0.000E+00);
y = *a* + *b*x where:
a= 189. (σ_a = 1.11E+02)
b= -2.59 (σ_b = 1.8)
degrees of freedom = 4
r = -0.306 (p = 0.555)

TRANSECT 11

TRA weather data
The results of a QuickFit performed at 16:12 on 28-DEC-2005
6 data pairs (x,y):
(30.0 , 6.92); (22.0 , 41.7); (25.6 , 77.1); (23.6 , 32.1); (26.1 , 62.5); (32.9 , 5.00);
y = *a* + *b*x where:
a= 155. (σ_a = 44.)
b= -4.41 (σ_b = 1.5)
degrees of freedom = 4
r = -0.616 (p = 0.193)

SFO weather data
The results of a QuickFit performed at 16:08 on 28-DEC-2005
6 data pairs (x,y):
(59.5 , 6.92); (61.0 , 41.7); (62.5 , 77.1); (67.0 , 32.1); (63.5 , 62.5); (67.5 , 5.00);
y = *a* + *b*x where:
a= 132. (σ_a = 2.32E+02)
b= -1.49 (σ_b = 3.6)
degrees of freedom = 4
r = -0.164 (p = 0.756)

Appendix C. 2005-2006 Oxalis Control, Scope of Work
Prepared by: West Coast Wildlands

HOXA: Hoffman/Ridge Trail Proposed Estimate Oxalis pes-caprae Herbicide Treatment 2005/2006

2005/2006 Initial Application Costs

Table A. Proposed work-scope and costs for *Oxalis pes-caprae* control San Bruno Mountain. Site locations are shown in attached Figure 1 & 2. Each site will be visited 3-4 times during the Winter 2005 to early Spring 2006. The rates for equipment, hand labor, spray labor, and herbicides are cited below.

Site	Exotic species[1]	Backpack Days	Spray Rig Days		Herbicide (Gal)	
					Roundup	Garlon
1. Hoffman Trail (~2.0 Acres)	BB	2.0 (2000.00)	1.0 (1200.00)		100 (200.00)	100 (350.00)
2. Ridge Trail (1.0 Acres)	BB	1.5 (1500.00)	1.5 (1800.00)		75 (150.00)	75 (262.50)
Totals		**$3,500.00**	**$3,000.00**		**$350.00**	**$612.50**
Total Cost						**$7,462.50**

1. Exotic Species
BB= Oxalis pes-caprae

Exotic pest plant control rates for 2005

Backpack spray (3 person)	$1000/day+herbicide
Spray rig (3 person)	$1200/day+herbicide (includes $200/day spray rig charge)
Hand Control (3 person crew)	$1000 /day
Spray Supervisor (SS)	$60/hr
Field Supervisor (FS)	$50/hr
Field Crew (FC)	$37.50/hr
Aquamaster (2% solution):	$2.25 /gal
Garlon 4 (2% solution):	$3.50 /gal
Roundup Pro(2% solution):	$2.00 /gal

HOXA: Tank/Juncus Ravine Parcel Oxalis pes-caprae Herbicide Treatment

2005/2006 Initial Application Costs

Table B. Proposed work-scope and costs for exotic species control within Tank/Juncus Ravine. Site locations are shown in attached Figure. 2005 rates for equipment, hand labor, spray labor, and herbicides are cited below.

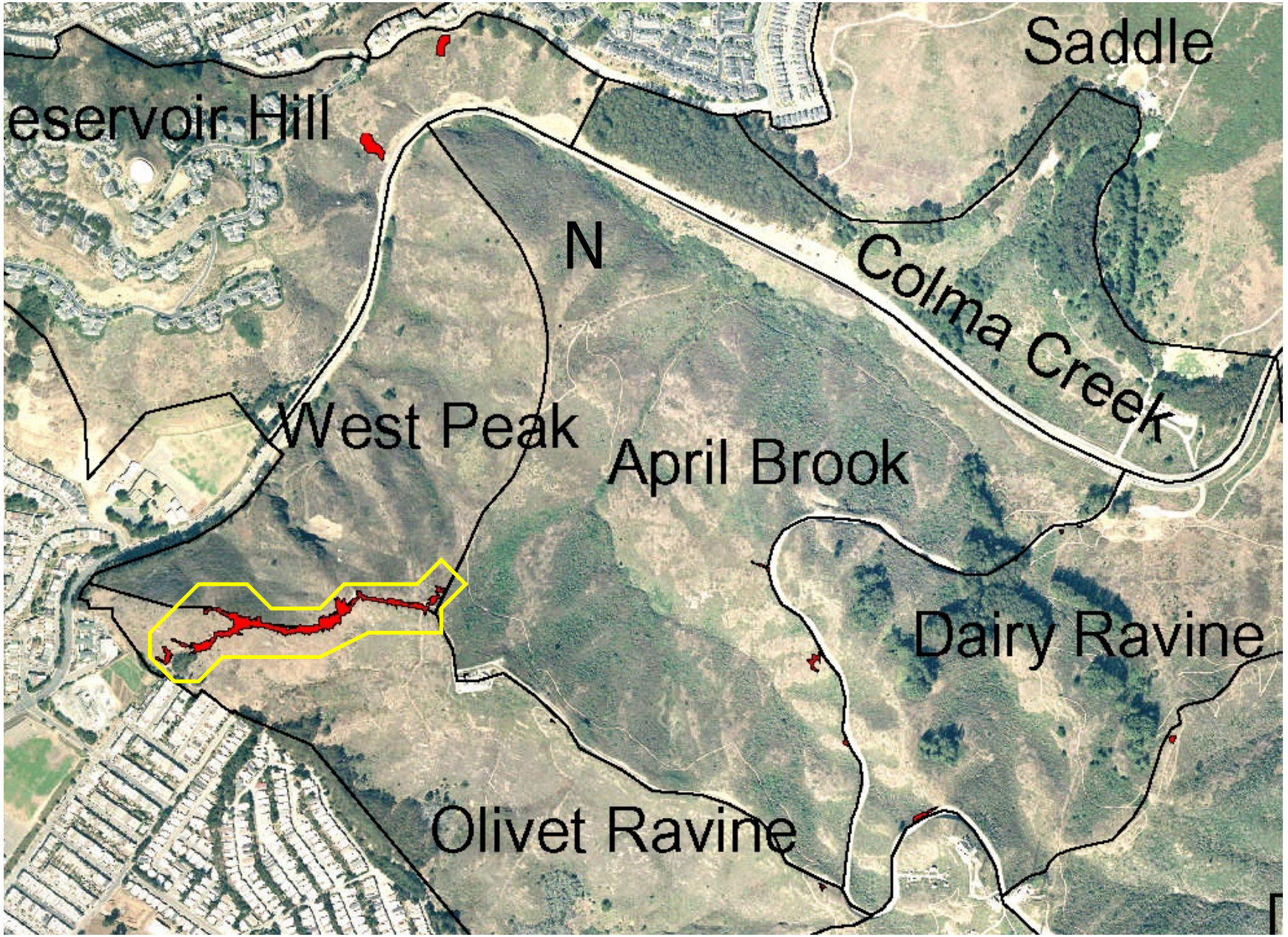
Site	Exotic species[1]	Backpack Days	Spray Rig Days		Herbicide (Gal)	
					Roundup	Garlon
2. Site 2 (3.5 Acres)	BB	3.0 (3000.00)	1.0 (1200.00)		250 (500.00)	250 (875.00)
3. Site 3 (4.0 Acres)	BB	4.0 (4000.00)	1.5 (1800.00)		350 (700.00)	350 (1225.00)
Totals		**$7,000.00**	**$3,000.00**		**$1,200.00**	**$2,100.00**
Total Cost						**$13,300.00**

1. Exotic Species
BB= Oxalis pes-caprae

Exotic pest plant control rates for 2005

Backpack spray (3 person)	$1000/day+herbicide
Spray rig (3 person)	$1200/day+herbicide (includes $200/day spray rig charge)
Hand Control (3 person crew)	$1000 /day
Spray Supervisor (SS)	$60/hr
Field Supervisor (FS)	$50/hr
Field Crew (FC)	$37.50/hr
Aquamaster (2% solution):	$2.25 /gal
Garlon 4 (2% solution):	$3.50 /gal
Roundup Pro(2% solution):	$2.00 /gal

Figure 1: Hoffman Trail Oxalis on San Bruno Mountain

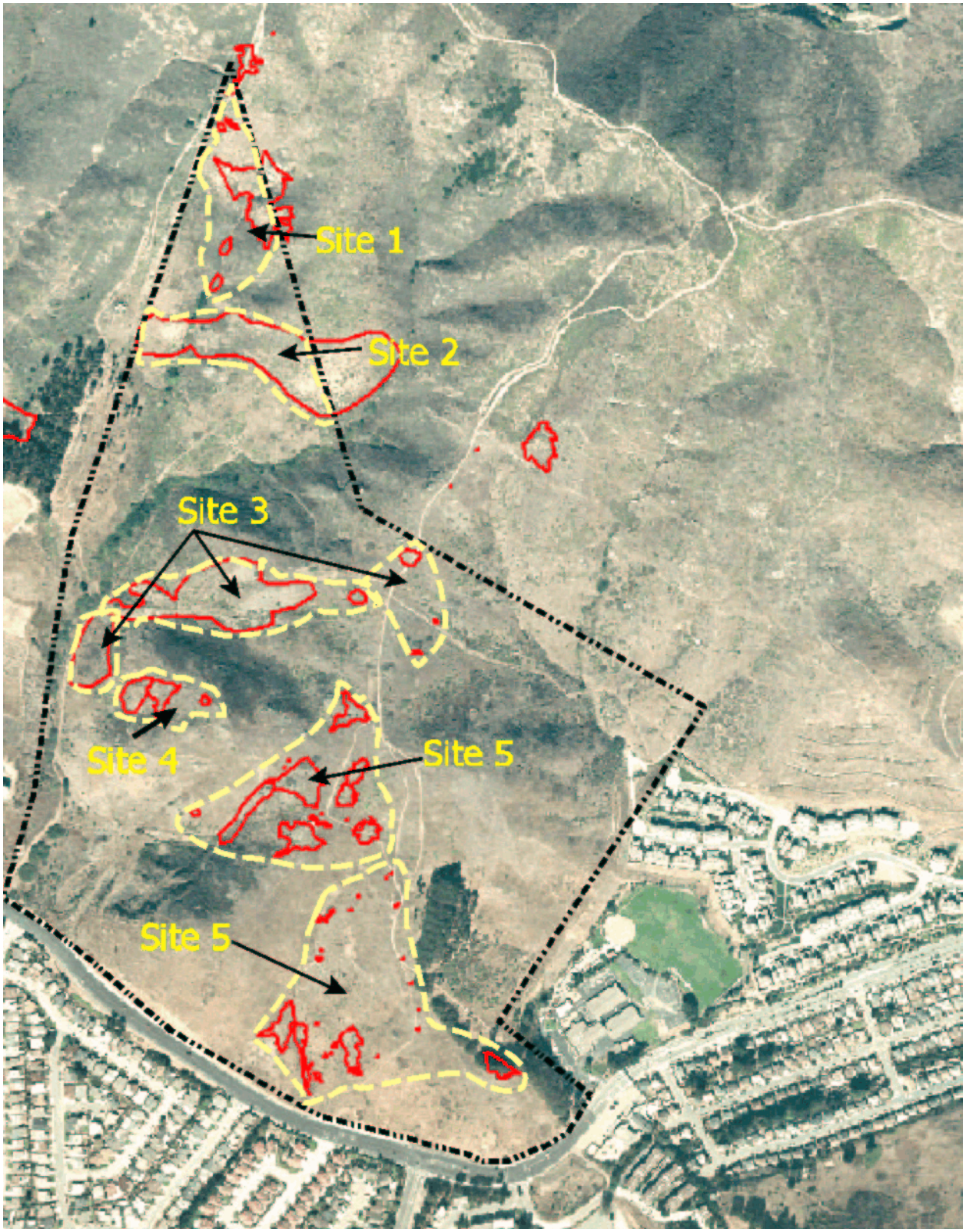


Treatment site 2005/2006

West Coast Wildlands 09/05

Figure 2: Ridge Trail Oxalis on San Bruno Mountain

Figure 3: Tank/Juncus Ravine Oxalis on San Bruno Mountain



Appendix D. Quarterly Report, Gorse Removal and Revegetation Project
Prepared by: May and Associates

Quarterly Report
San Bruno Mountain Gorse Removal and Revegetation Project
Work Performed from November 1, 2005 to January 31, 2006

Program Management

- Provided work oversight to subcontractors.
- Conducted site visits to monitor contractor performance.
- Conducted final monitoring and assessment of 2004-05 retreatment activities, and signed off Restoration Resources.
- Conducted photomonitoring.
- Submitted Final Vegetation Monitoring Plan to County.
- Prepared draft Revegetation Plan.

Gorse Removal

- Final retreatment of gorse site by Restoration Resources was completed by November 2005.

Future Activities

Spring 2006:

- Revegetation plan will be finalized, following review.
- Gorse removal areas will be monitored for efficacy of treatment and annual work plan developed.
- Revegetation site will be treated for secondary invasive species.

Baseline Photos – August 2004	Photomonitoring – November 2005
1B	
	
2A	
	
2B	
	
2G	
	

Baseline Photos – August 2004	Photomonitoring – November 2005
4B	
	
5B	
	
7	
	
10C	
	

Appendix E. San Bruno Mountain Watch Costal Conservancy Grant Report
Prepared by: Shelterbelt Builders

Final Project Report

San Bruno Mountain Exotic Weed
Mapping And Control Project
2003 to 2005

Prepared for: **CA Coastal Conservancy**
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Oakland, CA 94612

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Mark Heath, Principal
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January 4, 2006

Introduction

The northeastern canyons and ridges of San Bruno Mountain are some of the most botanically rich and precious resources in the San Francisco Bay region. A project was initiated in 2001 with the primary goal of identifying, mapping and controlling small populations of invasive weeds in remote locations of these biologically rich areas. Funded by the California Coastal Conservancy, this work would support the general invasive plant management program by the County and other agencies by specifically addressing smaller populations of weeds in remote areas. Early identification and control of these invasives would help the County and other agencies/organizations to focus on their invasive control programs in other restoration areas and in areas where the protection of endangered butterfly habitat was a primary concern. Early detection and eradication is the most cost effective means of managing invasive plants in natural areas. This project would use a modest budget to prevent the expansion of the most invasive plants on San Bruno Mountain thereby preventing large costly control efforts in the future and protect biodiversity to the maximum extent possible. The project also identified and mapped weed populations so volunteer stewardship or resource management agencies could follow-up the work and insure its completion.

A second California Coastal Conservancy Grant was awarded to San Bruno Mountain Watch (SMBW) and Shelterbelt Builders Inc (SBI) in 2003. This grant allowed us to continue to monitor, map and treat isolated exotic weed populations in the northeastern canyons of San Bruno Mountain for an additional 3 years. This funding allowed for critical follow-up work on the initial treatments started during 2001-2002. Follow-up work, increased development of volunteer stewardship and improved mapping with GPS were specific goals of the new project. Specifically, more comprehensive control work was completed in sensitive riparian areas of the project area, all previous work was thoroughly monitored for regrowth and maintained as necessary, SBMW and Shelterbelt developed a volunteer stewardship focus project near the Lipman School area of Brisbane, mapping data was standardized and incorporated into the County's GIS, SBI and SBMW coordinated all work with other weed management organizations and new areas were explored for incipient populations of invasive weeds.

Work Detail by Canyon (East to West):

Brisbane Acres

During the project period, the City of Brisbane's Open Space and Ecology Committee developed an invasive species management plan which included a component of volunteer stewardship. This allowed the City to directly manage their properties. This program focused on the removal of *Eucalyptus* trees, French broom and fennel in City-owned parcels of the Brisbane Acres. During two organized Earth Day broom pulling events, hundreds of volunteers were organized to pull large stands of broom and fennel near the Brisbane water tank. San Bruno Mountain Watch supported the event by helping to organize volunteers and donate tools for the Earth Day events. All of the broom removal was done using weed wrenches. Under a separate contract, the City hired Shelterbelt to follow-up and maintain areas where volunteer pulling projects occurred.

Through the Coastal Conservancy grant, Shelterbelt was able to support the City's efforts by monitoring the outer perimeter of the Brisbane Acres. Here, our work in the western sections of Brisbane Acres focused on French and striated broom (*Genista monospessulana & Cytisus striatus*) removal, though fennel (Foeniculum vulgare), cotoneaster (*Cotoneaster sp.*), mustard (*Raphanus sp.),* and radish (*Brassica sp.*) were also controlled. Only a few small populations of these plants were managed near the County park border and the Brisbane Acres. These areas were very remote and would be difficult to control with volunteer labor. Invasives were not mapped in the Brisbane Acres as the City had hired a consultant (West Coast Wildlands) to map the weeds separately.

Buckeye Canyon

The largest portion of the work done by SBI for the project occurred in Buckeye Canyon. Buckeye Canyon has long been a focus area for the volunteers of San Bruno Mountain Watch and a spiritual center for the organization. Volunteers have managed the expansion of broom and fennel in the lower grasslands, pulled hemlock in the creek and coastal scrub and curbed the expansion of Italian thistle and pincushion flower canyon-wide. Buckeye Canyons botanical diversity is perhaps unrivaled by any other single location on the mountain.

The Lipman School community stewardship focus project is located at the base of Buckeye Canyon. A very large patch of French broom (*Genista monospessulana*) wraps around the entire schoolyard and spreads out to the County park boundary where the perimeter has been maintained by Habitat Conservation Plan weed work. Over the years, the Lipman School property has become denser and denser with broom. Only a few pocket grasslands remain with good stands of perennial native grasses and forbs.

This large patch was the focus for the first phase of our work here. Shelterbelt crews worked in phases with SBMW volunteers to break down the walls of broom. Shelterbelt provided support to volunteer workdays by breaking down impenetrable stands of broom with chainsaws so volunteers could gain access and pull out stumps with weed wrenches. SBMW organized regular weekend workdays for pulling broom and also organized large school groups from Lipman School to work during the week throughout the entire project period. SBI followed-up each volunteer workday by organizing and bucking up piles of pulled broom. This insured piles of pulled broom would break down quickly and not be a fire hazard. Some piles were incorporated into erosion control wattles in bare soil areas. SBI also removed broom in areas where poison oak was thick and volunteers couldn't be used. Supportive work was also performed along the perimeter of the infestation. Isolated broom plants were removed in the perimeter flanks of the infestation in native coastal scrub. Working together, paid professional crews from Shelterbelt and volunteers organized by San Bruno Mountain Watch controlled about a third of the dense broom infestation and managed the surrounding native vegetation to be broom free for the last three years.

Fennel (*Foeniculum vulgare*) was removed from deep soil areas with Pulaskis throughout the canyon, including ravines and slopes coming down from both sides of PG&E ridge road. Most of the ridgeline populations were difficult to treat with hand methods as they grew in thin, rocky soils. Shelterbelt coordinated with Thomas Reid Associates (the HCP manager) and their subcontractor West Coast Wildlands to treat the large patches in rocky soils with herbicides under the HCP invasive plant control program. Shelterbelt and SBMW provided a supportive role by cleaning up any individual plants missed by herbicide by clipping the seed heads so the plants wouldn't continue to spread.

Italian thistle (*Carduus pyncnocephalus*) was also removed from the entire Buckeye

Creek drainage, including the upper forks and the network of trails snaking through the forested areas. These thistles were hand pulled, bagged and hauled off site for disposal as they had already gone to seed.

The patch of Cape ivy (*Delaria odorata*), found in the upper reaches of the forested section of Buckeye Canyon was treated for the first time and monitored for regrowth. Cape ivy is one of the most habitat devastating invasive weeds in coastal California. Its ability to persist in the environment, spread from small fragments and rapidly cover native riparian habitat made it a high priority for control. Additionally, it was the only known population in a significant wildland area in the project area. The 60 square meter patch was located below a large California bay laurel tree (Umbellularia californica), adjacent to the trail that follows the south-eastern creek drainage up towards the upper ridge of the mountain. No evidence of why it had established there could be found. The patch was discovered during the previous 01/02 grant project and a containment line was established to prevent it from spreading throughout the botanically rich riparian area.

A prime goal for this project was to completely remove the Cape ivy patch which threatened to spread throughout the entire watershed of Buckeye Creek. Shelterbelt staff consulted with San Mateo County, the State Water Quality Control Board, the Army Corps of Engineers and the Department of Fish & Game early in the project to obtain the necessary permits for implementing control. The initial control was implemented when all the permits had been obtained. This control included the scraping of the entire site to bare earth. All vegetative debris was piled into a single sacrifice pile that would be managed (composted) until Cape ivy was no longer a threat. The Department of Fish & Game required supplemental erosion control measures to limit sediment transport in the watershed. Shelterbelt field staff had to pack in weed free rice straw bales and straw wattles on their backs over a ½ mile of rugged terrain to implement the erosion control measures. Shelterbelt staff followed up the initial removal by revisiting the site every month to pull any resprouts.

SBI has also spent considerable time removing stands of poison hemlock (C*onium maculatum*) located in the lower meadow areas reaches of the canyon with the use of weed wrenches. Additionally, SBMW volunteers have mowed hemlock, Italian thistle (*Carduus pyncnocephalus*) and bull thistle (Cirsium vulgare) stands in the lower Buckeye Canyon area.

The debris was piled within native scrub to reduce its obtrusiveness and to facilitate its decomposition.

Finally, a large patch of Himalayan blackberry (*Rubus discolor*), adjacent to the lower reaches of Buckeye Creek, was removed using hedge-trimmers and pitchforks. The plants were carefully cut away from the native vegetation and mulched in place. By removing most of the aboveground biomass of this stand, follow-up work on any resprouts will now be feasible using SBMW volunteer labor.

Owl Canyon

French broom (*Genista monospessulana*) remains the most prevalent plant invader in Owl Canyon. The Quarry Slag area is an impenetrably solid stand of this invasive and continues to be a source of seed dispersed eastward into the rest of the canyon. Our efforts in the Quarry Slag area were focused on the eastern, downslope portions, closest to the neighboring coastal scrub and native grassland areas. Because the adjacent meadow and scrub areas were being overtaken by the slag broom, we focused on the containment of the infested slag area by removing outlying individuals and patches. Thereby, we hoped to prevent any expansion of the broom outside of the Quarry slag pile itself. Methods for broom control included hand pulling when the soil was loose and moist and stump cutting/peeling for larger, more deeply rooted plants. All debris was consolidated into piles, compressed by chainsaw mulching and piles were placed in mature scrub areas.

We monitored jubata grass in the areas bordering the main meadow at the canyon entrance, from where it was previously removed. No evidence of resprouting was observed. However, some individuals may remain in the upper creek channel, where they are hard to spot, let alone eradicate. Continued monitoring is essential to prevent any reestablishment.

The abandoned road cuts on the adjacent private quarry property continue to be major sources of seed dispersal to the adjacent Owl Canyon areas. Notably, silver bush lupine (*Lupinus albifrons*) was found on slopes just above this patch. Dozens of large cotoneaster, jubata, and French broom plants proliferate. For the larger plants, removal would entail cutting and peeling or even herbicide application. The highly-disturbed nature of these road cuts make native colonization difficult and restoration would require substantial re-grading and other

earthwork. These well-established stands will continue to provide new invasive colonists for the valley below unless properly addressed. We did remove other individuals and patches of French broom, fennel, and small Monterey pines from the upper slopes above this road cut which should help control dispersal to the valley below.

Devil's Arroyo

Large stands of broom and gorse (*Ulex* europaea) have colonized the lower industrial park slopes near the base of Devil's Arroyo and Wax-Myrtle Ravine. These plants probably originated during the initial grading and development of the industrial park. Most of the stands occur on private lands and are bleeding into the native scrub habitat of the County Park. Permission was obtained from private landowners to control invasives on their land. A core goal of this project was to consolidate these dense stands and contain their spread into the County Park. Most of the Scotch and striated broom (*Cytisus scoparius* and *striatus*) patches were removed in the upper reaches of Devil's Arroyo. Working from the top down, small patches were removed proceeding towards to the industrial park infestation. A defensible "buffer zone" was cut between the continuous stands of weeds and the native scrub areas. The majority of the work was done using chainsaws to cut down the large individual shrubs and then bucked down and hidden in the existing brush. Broom stumps were peeled to prevent them from re-sprouting. Re-visiting the site in early December 2005 showed annual grasses and other plant species starting to establish themselves were striated broom was once present

Some of the striated broom follows a PGE gas line right-of-way that bisects the Mountain. This right-of-way was avoided as a separate contract from PGE/West Coast Wildlands will cover its control and maintenance. Careful monitoring of this right-of-way it important to prevent the striated broom from colonizing pocket grasslands and coastal scrub areas in the remote reaches of upper Devil's Arroyo and Red-tail Canyon.

Additionally, a dense infestation of fennel in the alluvial fan at the base of the arroyo was managed through the combined effort of SBI employees, SBMW volunteers and West Coast Wildland's HCP weed work. These efforts will help to support a Mission blue butterfly habitat island enhancement project planned in 2006 by Thomas Reid Associates.

Wax Myrtle Ravine

Prior to the large wildfire of 2003, this site was dominated by large stands of broom, gorse (*Ulex europaea*) and *Eucalyptus* along the canyon slopes. After the fire, it has been possible for SBI to perform a limited amount follow-up work at this site to help prevent gorse and broom from reestablishing itself. The majority of the work was done to help support Thomas Reid Associate's post-burn restoration plan. Shelterbelt focused weed work around native plants that had been planted as part of restoration and re-vegetation efforts after the fire. Gorse and broom sprouts were removed using Pulaskis, weed wrenches, and hand pulling. The post-burn restoration plan for Wax Myrtle Ravine is a *large* project. SBI/SBMW's hand methods for weed control have a very limited reach in such a large, complex project. This entire watershed will be a continued focus area for the Habitat Conservation Plan restoration work.

During the beginning of the project period, many striated and striated broom seedlings were plucked from the lower sections of the burn area. This area is of management importance because it supports many silver lupine (*Lupinus albifrons*) - the larval host plant for the endangered mission blue butterfly and Johnny-jump ups (*Viola pedunculata*) – the larval host plat to the endangered Callippe silver spot butterfly. Later in the project period, the HCP subcontractor West Coast Wildlands took over the broom maintenance for the site.

Fennel was removed in some areas of the upper middle slopes of the burn area. Fennel removal was accomplished by digging out the root with Pulaskis. The soils throughout Wax Myrtle tend to be deeper than most of the other areas fennel occurs on the mountain, hence hand control may be relatively effective here. The fennel control along the remaining areas of Wax Myrtle Canyon is maintained by West Coast Wildlands and Brookfield Homes.

Conclusion

Over the last three years, isolated stands of invasive plants were identified, mapped and controlled in the most remote areas of San Bruno Mountain's northeastern ridges and valleys. The early detection and rapid response weed control methods demonstrated with this project are the most cost effective means to controlling the spread of invasive plants throughout San Bruno Mountain. Additionally, the supportive follow-up work, development of volunteer

stewardship, and improved mapping and agency coordination all helped enhance the overall weed management goals on San Bruno Mountain public and private lands.

Beyond the physical weed control work, each of the exotic plant populations in the project area have been accurately mapped and input into a GIS database. This data is stored in a standardized shapefile format with descriptive attributes and it will allow future community-based volunteer groups and other weed management agencies and organizations to better monitor and control the weed populations in the area. These data and maps will be distributed to all weed managing entities on the mountain to enhance future exotics control and help plan new projects. Hopefully, a standardized data collection format will emerge and be adopted to allow a central agency or group of agencies to manage and update this important information.

Shelterbelt and SBMW have successfully maintained the exotics control work that was started during the 2001-02 grant project for the last three years. An increased level of volunteer stewardship was developed within San Bruno Mountain Watch that will help the organization maintain much of the work that was accomplished with this project. New relationships were forged between San Bruno Mountain Watch and the other weed management organizations and agencies on San Bruno Mountain further enhancing the degree of weed control possible on the Mountain. Since most of these invasive weeds have a seed bank longer than 2 or even 5 years, it is imperative that this work is followed up with a coordinated effort to insure the biological integrity of these canyons in perpetuity. We hope that our joint efforts have sufficiently catalyzed the community and other managers to effectively work towards the continued management of these biologically rich and diverse canyons.

Appendix F. 2005 Butterfly Island Year End Report, San Bruno Mountain
Prepared by: Shelterbelt Builders

2005 Butterfly Island Year End Report
SAN BRUNO MOUNTAIN

January 17, 2006

Prepared by

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2004/05 (Year 6) Island Planting Summary

Colma Creek Watershed

The Colma Creek planting islands continue to establish on their own with little need for additional management. Lupine seedlings have been observed establishing from parent plants at CC1 and mission blue butterfly larvae have been observed at CC2. After the excellent survivorship of lupine in the first year (1999/2000), we planted additional host and nectar plants at each site in year 2 (2000/2001) and year 3 (2001/2002). Year 4 (2002/2003); year 5 (2003/04); and year 6 (2004/05) required no additional plants, as each island is sufficiently dense with butterfly host and nectar plants. Six species of nectar plants were planted at both sites; they include Chilean aster (*Aster chiloensis*), brownie thistle (*Cirsium quercetorum*), seaside daisy (*Erigeron glaucus*), coast buckwheat (*Eriogonum latifolium*), golden aster (*Heterotheca sessiflora*) and CA horkelia (*Horkelia californica*). Coast buckwheat and golden aster established very well at each of the sites.

In 2004/05 the plants were regularly monitored for health and vigor. Since no radical changes were observed, no census monitoring was performed. Annual grasses in the islands were mown twice during the spring growing season to help suppress their growth. Reducing the height and density of annual grasses helps the native perennials grow longer and stronger throughout the growing season.

Dairy Ravine

The Dairy Ravine butterfly island sites are scattered throughout the Dairy Ravine restoration area. The islands with the least amount of weed competition, especially annual grasses, tend to have the best establishment. Dairy Ravine 1 (DR1) is situated on a saddle with shallow, rocky soils and it has become a model for the area. Chilean aster, brownie thistle, seaside daisy, coast buckwheat and CA horkelia have been planted at DR1. Coast buckwheat and seaside daisy have both established very well throughout the island.

Dairy Ravine 2 and 3 (DR2/DR3), which were created in 2000 and 2001, have both been abandoned. Annual grass competition was so severe that very few lupine were able to establish in these islands. Dairy Ravine 4 (DR 4 - or sometimes called Elfin Ridge) is the only San Bruno elfin butterfly habitat island installed to date. This island now has very dense stands of moss stonecrop (*Sedum spathulifolium*), both naturally occurring and planted. The enhancement planting of moss sedum extended the San Bruno elfin butterfly habitat up along the ridge separating Dairy Ravine from Wax Myrtle canyon. There are very few invasive weeds impacting this moss sedum population so no annual monitoring or weed control is done at this site. This island is considered stable and established.

Two new mission blue islands were created in 2002/03. Dairy Ravine 5 (DR5) was created downslope from DR1. This island , like DR1, has shallow rocky soils along a ridge line with little annual grass competition. Dairy Ravine 6 (DR6) was created in the

Friends of San Bruno Mountain Botanical Garden in lower Dairy Ravine. Both islands had high survivorship during their first year. Two new weed maintenance techniques were incorporated into these islands. Thick rice straw mulch was applied around lupines in DR5 and pre-emergent herbicide was used at DR6. Each method provided excellent annual grass control during the first year establishment period.

DR1, DR5 and DR6 islands are all managed and monitored each year. In 2004/05 the plants were regularly monitored for health and vigor. Census monitoring was done for the new islands - DR5 and DR6 - only. Annual grasses in the islands were mown twice during the spring growing season to help suppress their growth. Wild radish (*Raphanus* sp.) was pulled within the interior of DR5 and it was mowed along the perimeter of the island. The spread of radish throughout lower Dairy Ravine continues to plague DR5.

DR6 was mowed twice to reduce cover of annual grasses (*Lolium* sp.) and bristly ox-tongue (*Picris echioides*) that have aggressively taken over much of the planting island. These weeds and others have been unleashed as pre-emergent herbicide was not reapplied during the 04/05 budget year. A coordinated application of pre-emergent herbicide by West Coast Wildlands in 05/06 might help the remaining lupine survive. The lupine population in DR6 crashed down to only 5 remaining plants. This was probably due to the reestablishment of the *Lolium* and *Picris* at the site, though other factors may be responsible as well.

Dairy Ravine 5 (DR5)

Total Lupine Planted	Size	Years Planted	Current Surviving Lupine	Survivability
311	D16	3	142	46%

Dairy Ravine 6 (DR6)

Total Lupine Planted	Size	Years Planted	Current Surviving Lupine	Survivability
100	D16	3	5	5%

Saddle

After two years of great lupine establishment without much weed competition, annual grasses and other exotic annuals continue to increase at the Saddle island (S2). The thick gorse mulch that prevented the annual weed establishment for the first two years is breaking down rapidly and allowing many weedy annuals to establish. The spring of 2003 revealed that annual grasses could be problematic at the island and they continue to spread within the island. Hand weeding, selective mowing and the additional planting of native perennial grasses will be the short-term solution until the island can establish good native cover.

Native cover is critical for the long term success of this island. During the first 2 years

we took advantage of the lack of annual weeds to outplant hundreds of native perennial bunch grass plugs and sow native grass seed. 750 additional grass plugs were installed in 2002/03 to fill in gaps in previous year's planting and seeded areas. The grasses have established very well. 89 additional lupine were added in 2002/03 to supplement previous year's plantings. The lupine and nectar plants were very robust and grew very quickly in the nitrogen enriched post-gorse soils. CA phacelia (*Phacelia californica*) and coast buckwheat were the two top performing nectar plants at the site. Natural recruitment was recorded for both nectar species and lupine during the second year.

The early heat spell in 2004 resulted in much plant stress and die back in this island. Many of the lupine and nectar plants examined in the summer of 2004 appeared dead. Many had been well established plants that were several years old. In 2004/05 the plants were monitored. Drought stressed plants observed in 2004 appear to be making a comeback and many are resprouting at the base of the crown. Annual grasses in the islands were mowed twice during the spring growing season to help suppress their growth. Some gorse seedlings were removed from the islands if they threatened nearby lupines or nectar plants. Otherwise, the annual control of gorse with herbicide by West Coast Wildlands appears to be preventing the spread of emerging gorse plants within the island.

Weed management and Stewardship

GCP Site

The GCP site continues to be mowed throughout the spring growing season. After five years of mowing, many annual weeds still remain. The focus continues to be on slowing the establishment of these invasive at the neighboring S2 island. Coyote brush (*Baccharis pilularis*) and bee plant (*Scrophularia californica*) continue to spread throughout the area from existing stands.

Colma Creek

The restored coastal scrub between CC1 and CC2 continues to mature. Five successive years of weed management have reduced the amount of radish, mustard (*Brassica* sp.), hemlock (*Conium maculatum*), and thistle (*Cirsium* sp.) on the site. A few more years of weed management will allow the scrub to fill in completely with few dominant weed patches. The reduction of weeds in this area insures the Colma Creek butterfly islands continue to remain free of large competitive exotics.

Wax Myrtle Ravine

Following the burn in Wax-Myrtle Ravine in 2003, a post-burn revegetation plan was developed for the area to promote native plant recovery. The native plant palette for restoration was largely determined by the species available at the Friends of San Bruno Mountain's Mission Blue Nursery. The following plants were installed in the burn area per the plan:

Coastal Scrub Planting Zone

Species	Number Planted	Size	Survivability**
Rhamnus californica	53	1 gallon	52% over 2 years
Heteromeles arbutifolia	86	1 gallon	6% over 2 years
Artimisia californica	22	1 gallon	86% over 2 years
Eriophyllum staechadifolium	17	1 gallon	29% over 2 year
Prunus ilicifolia	10	1 gallon	10% over 2 years
Monardella villosa	12	1 gallon	8% over 2 years

Riparian Tree Planting Zone

Species	Number Planted	Size	Survivability**
Cornus californica	12	1 gallon	na
Cornus californica	4	5 gallon	na
Salix lasiolepsis	8	5 gallon	na
Salix lasiolepsis	30	pole cuttings	na
Myrica californica	6	D16	na

Wetland Seep Planting Zone

Species	Number Planted	Size	Survivability**
Tellima grandiflora	12	4 inch	na
Juncus effusus	25	2 inch	na
Sisyrinchium bellum	12	2 inch	na
Mimulus guttatus	5	2 inch	na
Rumex ilicifolia	12	D40	na

Grassland Planting Zone

Species	Number Planted	Size	Survivability**
Festuca idahoensis	47	plug	na
Deschampsia caespitosa	360	plug	na
Elymus glaucus	1260	plug	na
Festuca rubra	200	plug	na

Bromus carinatus	940	plug	na

**Survivability based on subsampling of area - *Not a complete census of the restoration plantings.*

Survivability was higher for most shrub species than originally recorded in the first year. Most of the plants observed during monitoring have established very well and they are very robust. The monitoring data is likely to be under representing the surviving plants. Walking and navigating through the thick and weedy regrowth is very challenging and census-type survivorship monitoring is nearly impossible to perform. Since the fire, invasive thistles, grasses and forbs have colonized the site. These new invaders have grown unusually large and dense from nutrients and other resources released from the burn. Native and non-native perennials, shrubs and trees have also resprouted adding to the complexity of the site. Shelterbelt spent two full crew days breaking trail through the dense, weedy thickets of the site in an attempt to monitor survivorship. We recorded what species could be found but only half of the restoration site was surveyed. Intermediate weed control is crucial for the restoration of Wax-Myrtle Ravine. The thick melange of weedy plants prohibit access, weed control, restoration planting establishment and monitoring of the site.

Appendix G. Grazing and Mowing Experiment at Hillside/Juncus Parcel
San Bruno Mountain, 2003

Preliminary Results

Prepared by Thomas Reid Associates
January, 2004

SUMMARY

A 3-year pilot grazing and mowing experiment at Hillside/Juncus Parcel on San Bruno Mountain was begun in March, 2003. Baseline data was collected in March, 2003 prior to the grazing and mowing treatments. Preliminary results presented in this report include observation data on the feeding habits of goats, impact to thatch levels, and response of native and non-native species to grazing and mowing. A comparison of before and after data in the grazed, mowed and control plots will be reported in the San Bruno Mountain 2004 Annual Report.

INTRODUCTION

Grazing, mowing, and/or burning have been identified as important tools for vegetation management in managing native grasslands. (Weiss, 2002; Hayes & Holl, 2003; Pollak & Kan, 1998). The grassland plant community on San Bruno Mountain evolved with both grazing and fire, and research in similar grassland communities in California suggests that grazing and fire provide important functions toward the health of this plant community (i.e. nutrient cycling, regeneration of fire adapted species, and biomass removal). Successful management of the grassland plant community on San Bruno Mountain is especially important due to the existence of three endangered butterflies and several sensitive plant species within this habitat.

In 1982 the San Bruno Mountain Habitat Conservation Plan (HCP) was adopted which created approximately 2800 acres of open space on San Bruno Mountain and provided annual funding to manage these lands. Since that time, the vegetation management program on the mountain has primarily relied on the methods of hand and herbicide control work for maintaining the grassland habitat. Reliance on these methods has been partially due to their cost effectiveness and the need to prioritize work on the most serious weed threats. It has also been due to the lack of information available on grazing (specifically goats and sheep) impacts to coastal grasslands, and the difficulty in obtaining the necessary permits and inter-agency cooperation to conduct controlled burns.

The hand and herbicide weed control methods have proved effective at reducing perennial invasive shrubs and trees such as French broom, gorse, and eucalyptus from invading and overtaking grassland habitat on San Bruno Mountain. However herbaceous weed and grass invaders such as wild oat (*Avena barbata*), Bermuda buttercup (*Oxalis pes-caprae*), and Italian thistle *(Carduus pycnocephala*) are much more prolific, and the ability to treat large areas of these ubiquitous weeds using hand and/or herbicide work is expensive and difficult. In addition,

in the absence of burning and grazing, native coastal scrub vegetation has expanded and overtaken grassland habitat. For this reason, the future of vegetation management on San Bruno Mountain is likely to require the use of grazing and burning to help reduce the threat from both herbaceous and grass weeds as well as limit the expansion of coastal scrub into native grasslands.

In April, 2002, a Stewardship Grazing Plan was written for San Bruno Mountain by David Amme**,** to address the vegetation changes that threaten the grassland habitat of the mountain. In March 2003 a 3-year pilot grazing project was initiated on the mountain in the Hillside area/ Juncus Ravine parcel to test the efficacy of grazing as management tool. Both mowing and grazing were incorporated into the experiment to test these methods. The experiment also includes burning, but a moratorium on burning as of fall 2003 by CDF has prevented this portion of the experiment from occurring.

The experiment is located on land owned by Myer's development. This land is planned for dedication to the County park after exotics control work has been completed to the satisfaction the HCP Plan Operator (San Mateo County). This project as proposed is a combined project utilizing the funding provided by the HCP trust fund and Myers Development Corporation to accomplish the mutual goals of each entity. The goals of this program are consistent with the goals of the HCP and the Habitat Restoration Plan for the Juncus Ravine Dedication Parcel (Myers Development Corporation, November 2001). Assistance with data collection has been provided by volunteers with the Friends of San Bruno Mountain.

Project Goals

The goal of the pilot grazing and mowing experiment is to test the efficacy of controlled livestock grazing as a tool to enhance and restore the health and diversity of native grassland plant communities. Specifically, the program will target rank annual grasses and weeds that suppress the diverse native herbaceous and perennial grassland plant community and reverse the encroachment of coastal scrub into grassland areas. The pilot grazing and mowing program includes moving livestock to and from the mountain during one to two seasons a year, as well as the labor and material to manage the animals full time, move fencing, provide water and supplemental feed. The program includes mowing and grazing treatments, once-a-year monitoring of plant species composition within treatment and control plots, and annual reporting of the results.

<u>Goals</u>

1) Reduce targeted annual weeds;
2) Increase the abundance of native plant species;
3) Reduce/ control expansion of coastal scrub vegetation;
4) Increase the habitat value for the endangered butterflies of San Bruno Mountain.*

The Hillside/ Tank Ravine area is ideal for this experiment because this site has easy access, and has many of the invasive vegetation problems that are facing the rest of the mountain including: 1) extensive infestations of invasive European annual grasses; 2) invasive forbs such as Italian

thistle, fennel (*Foeniculum vulgare*) and Bermuda buttercup; and 3) coastal scrub.

Areas with *Viola pedunculata*, the host plant for the endangered Callippe silverspot butterfly, were excluded from the grazing and mowing treatment areas because this species is not currently covered under the HCP take permit for San Bruno Mountain. The experiment includes grassland areas that are similar to callippe habitat in species composition and exposure, and therefore it is likely that results from the grazing and mowing experiment will be applicable to Callippe silverspot habitat.

Hand and Herbicide control work may be incorporated into the treatment areas to determine the best possible combination of methods for controlling exotic species and increasing native plant cover. All work conducted will be recorded and costs determined at the end of the experiment.

METHODS

All areas chosen for the experiment are dominated by ruderal grassland with varying levels of exotic infestations, (except GSCRUB which is a mix of coastal scrub and grassland). Figure 1 shows the location of the treatment plots and monitoring transects on the mountain. Table 1 shows a description of each treatment and control area.

Temporary grazing areas were installed which ranged from approximately 1/4-acre to two acres in size. The animals typically grazed in each paddock for approximately one day, and were moved once the vegetation was taken down to bare earth or nearly so. Prior to grazing on San Bruno Mountain, goats were fed on a diet of alfalfa and brush to prevent the goats from bringing in any new weeds to the Mountain. A shepherd was provided for twenty-four hour supervision of the goats. The goats were moved with cattle dogs into enclosures created with mobile electric fences. Water requirements were provided either through the vegetation, or through the use of a mobile water tank and trough.

A herd of 120 goats grazed from March 19 through March 30, 2003. Three months later 470 Goats were brought in to graze the treatment areas again between July 22 to July 27, 2003. (Using a higher number of goats in the second grazing event necessitated keeping the goats in the paddocks for less time). A grazing treatment is planned for the winter of 2003 to treat oxalis areas, and in the following spring and/or summer depending upon the vegetation response and monitoring results in March 2004.

Mow plots included two plots, a single mow plot and a double mow plot. Mow plots were mowed on March 17, 2003 followed by raking on March 20, 2003. The native and non-native grasses were mowed along with the non-native forbs. Native perennials were avoided by flagging before mowing. These included Mission blue butterfly host and nectar plants (i.e. silver lupine *(Lupinus albifrons)*, coast buckwheat *(Eriogonum latifolium)* and checkerbloom *(Sidalcea malviflora*) as well as long-petaled iris (*Iris longipetala)* and Douglas iris (*I. douglasiana*. The double mow plot was mowed and raked again on May 1, 2003. The plots were mowed with string cutters followed by raking with metal bow rakes. The clippings were hauled out and deposited outside of the plots.

Monitoring

The experimental design and monitoring program were determined after research and meetings with County park staff, consultants, and the Friends of San Bruno Mountain in February, 2002. The experiment utilizes a matrix of treatment groups and controls to test each treatment independently. Monitoring transects were established in the grazed plots, in mowed plots and within control areas.

Monitoring data collected prior to the initial grazing and mowing in March 2003 consisted of:
1) percent cover data within quadrats
2) lupine counts on rocky outcrops
3) plant species richness within grazing areas
4) residual dry matter.

Percent cover data was taken within 0.25-meter quadrats placed every 5 meters along 50 meter transects within each of the grazing, mowing and control areas (with the exception of GSCRUB). A total of 108 quadrats were inventoried for species and percent cover (data can later be lumped into native and nonnative categories for analysis). Lupine counts were taken at six rocky outcrops (30-foot radius) to measure the number of lupine plants before and after grazing and mowing. Species richness (number of species) within the grazed areas was recorded prior to the grazing experiment. Residual dry matter was measured at random locations within grazed areas and control areas. Data collection will occur once per year in March.

RESULTS (preliminary)

Grazing

Data collection

Residual dry matter, plant percent cover, species richness, and lupine counts were done prior to the goat grazing. This data will be collected again in March 2004 and preliminary comparisons will be reported in the 2004 annual report. It is likely that it may take 2-3 years of treatments before a significant change in plant species composition is observed in the grazed areas (personal communication David Amme).

The residual dry matter (RDM) data that was collected prior to the grazing and mowing treatments was found to be extremely high (Figure 2). This is likely due to the lack of burning and/or grazing in the hillside/Juncus area for several years. The high amount of thatch is likely suppressing the growth of native annual and perennial wildflowers. The grazing impact to thatch appeared to be significant, especially after the second grazing episode (personal observation).

Observations

The goats appeared to prefer broadleaf plants (eating flower heads, leaves and stalks). They fed immediately and heavily on brush and herbaceous plants when first introduced into the corrals. Plants favored by the goats included natives and nonnatives alike such as: fennel, coyote brush

(*Baccharis pilularis*), soap plant (*Chlorogalum pomeridianum*), Bermuda buttercup, checkerbloom, bristly ox-tongue (*Picris echioides*), mustards (*Brassica sp./Hirschfeldia incana*), common mallow (*Malva sp*.), Italian thistle, sow thistle (*Sonchus sp*.) and vetch (*Vicea sp*.) The goats avoided lupines (*L. albifrons*) at first but later, apparently after more palatable plants were eaten, they ate the lupines as well. In the scrub plot, they appeared to avoid California sagebrush, and this may have been due to the timing of the grazing and the strong oils in the plant during the spring and summer (personal communication, Jared Lewis). The goats appeared to avoid most grasses, especially rip-gut brome, They did eat some wild oat (*Avena* sp.), primarily focusing on the seed heads. They appeared to partly avoid fillaree *(Erodium botrys*) and wild lettuce (*Lactuca* sp.). They appeared to avoid eucalyptus at first, but did strip the saplings of this species after other plants were depleted. The goats did not eat the woody stems of shrubs.

After the initial grazing and mowing events plants were observed coming back in all corals on April 25, 2003. This included natives and non-natives alike: (soapplant, silver lupine, checkerbloom, fennel, coast buckwheat, California poppy (*Escholtzia californica*), vetch, oxalis,and Italian thistle). Based on the recovery of the plants after one month it appeared that the initial grazing did not thoroughly kill off any plants. This was good to see for the natives, but the invasives were also rebounding. The most noticeable re-bounders were soapplant of the natives, and fennel for the invasives. Oxalis had also recovered partially after the first grazing event. Thatch levels still appeared to be high in some locations after the first grazing event.

A second more intensive grazing treatment was done in July, 2003 and this included incorporation of native grass seed and hay into the corrals. Native grasses were seeded in during the grazing period so the animals could incorporate the seed with their hooves into the soil. The goats also fed on native grass hay while they were grazing and in this way native seed is incorporated into the soil through the animal droppings (personal communication Jared Lewis).

After the second, more intensive grazing treatment, thatch levels appeared to be much lower. Fennel was observed to be returning to the grazed areas, however after grazing opened up the areas, it makes this plant much easier to see and to spray with herbicide. Preliminary observations suggest that grazing in combination with herbicide and hand work follow up will provide an effective method for reducing invasive species cover.

Mowing

Data collection:

Residual dry matter, plant percent cover, species richness and lupine counts were done prior to the mowing. This data will be collected again in March 2004 and preliminary comparisons will be reported in the 2004 annual report. It is likely that it may take 2-3 years of treatments before a significant change in plant species composition is observed (personal communication David Amme).

Observations:

The mow plots are located upslope of the grazed plots in an area that has a greater dominance of native grasses. Dense stands of California brome (*Bromus carinatus)* are especially evident within the mow plots. Data that is collected will document the change (before and after treatment), and it this change that is the important statistic to compare, rather than comparing the mowed plots directly to the grazed plots.

Perennial natives such as lupines and checkerbloom appeared to be doing well within the mow plots (personal observation). These species were avoided during the mowing application. Grasses such as *Nassella pulchra*, *Mellica californica* and *Bromus carinatus* all produced an abundant amount of seeds within eight weeks following the first mowing. The seeds were collected and propagated and are being planted within the perennial grass planting islands at Tank Ravine. At the double mow plot, the perennial grasses showed seed production later in the year (personal communication Mike Forbert).

Table 1. Grazing, Mowing, and Control Plots Established on San Bruno Mountain in 2003.

Grazing Area, paddocks	Transect	Size	Dates and Duration	Primary target	Notes
1	G3	(0.5 ac)	March 03- 1.5 days July 03 - 1 day	Annual grasses	Top of hill includes R2 (photo point only) and R3 outcrop (not seeded)
2	G1, G2	(1.5 ac)	March-03 - 2 days July 03 - 2 days	Annual grasses, fennel, oxalis	Closest to Hillside Blvd. Includes R1 outcrop seeded with Nassella pulchra and California brome
3 GSCRUB	no transect	(0.7 ac)	March 03 - 2 days July 03 - 2 days	Bacch. pilularis, CA sage-brush	Mixture of scrub and grassland. Vegetation was not heavily grazed after two days of grazing. Seeded with Nassella pulchra, Bromus carinatus, and Elymus glaucus.
4 GOX	G6.1, G6.2	(0.2 ac)	March 03 - 1 day July 03 - 0.5 days	Oxalis	West facing slope with dense oxalis infestation. Area was small, and heavily grazed. Control site on opposite slope. Seeded with Nassella pulchra and Bromus carinatus.
5 GRAV	G5	0.25 ac)	March 03 - 2.25 days July 03 - 0.75 days	Italian thistle, Oxalis, Mustard, radish	Ravine at base of slope, w/ dense exotics. Area received intensive grazing. Opposite side of ravine left ungrazed as control. Seeded with Elymus glaucus and Bromus carinatus.

Grazing Area, paddocks	**Transect**	**Size**	**Dates and Duration**	**Primary target**	**Notes**
M1 (single mow plot)	M1	(0.25 ac)	Mowed-weed-wack	Annual grasses	Mowed by WCW crews during same week as grazing. Some natives avoided (lupines, checkerbloom, etc.). No seeding, (seed collection).

M2 (double mow plot)	M2	(0.20 ac)	Mowed-weed-wack	Annual grasses	Mowed by WCW crews during same week as grazing. Includes R4 rocky outcrop, lupine counts for R4 extended partially beyond mowed area (to the west). Partial damage by OHV's, January 2004. No grass seeding.
Control	C5, C6		no treatment	Annual grasses	Control transects upslope within grassland outside of proposed burn area.
Control	C7		no treatment	Italian thistle, Oxalis, Mustard, radish	Control transect for ravine (transect G5).
Control	C8.1, C8.2		no treatment	Oxalis	Control transects on east facing slope with dense oxalis infestation. Control sites for transects G6.1 and G6.2.

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Personal Communications

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