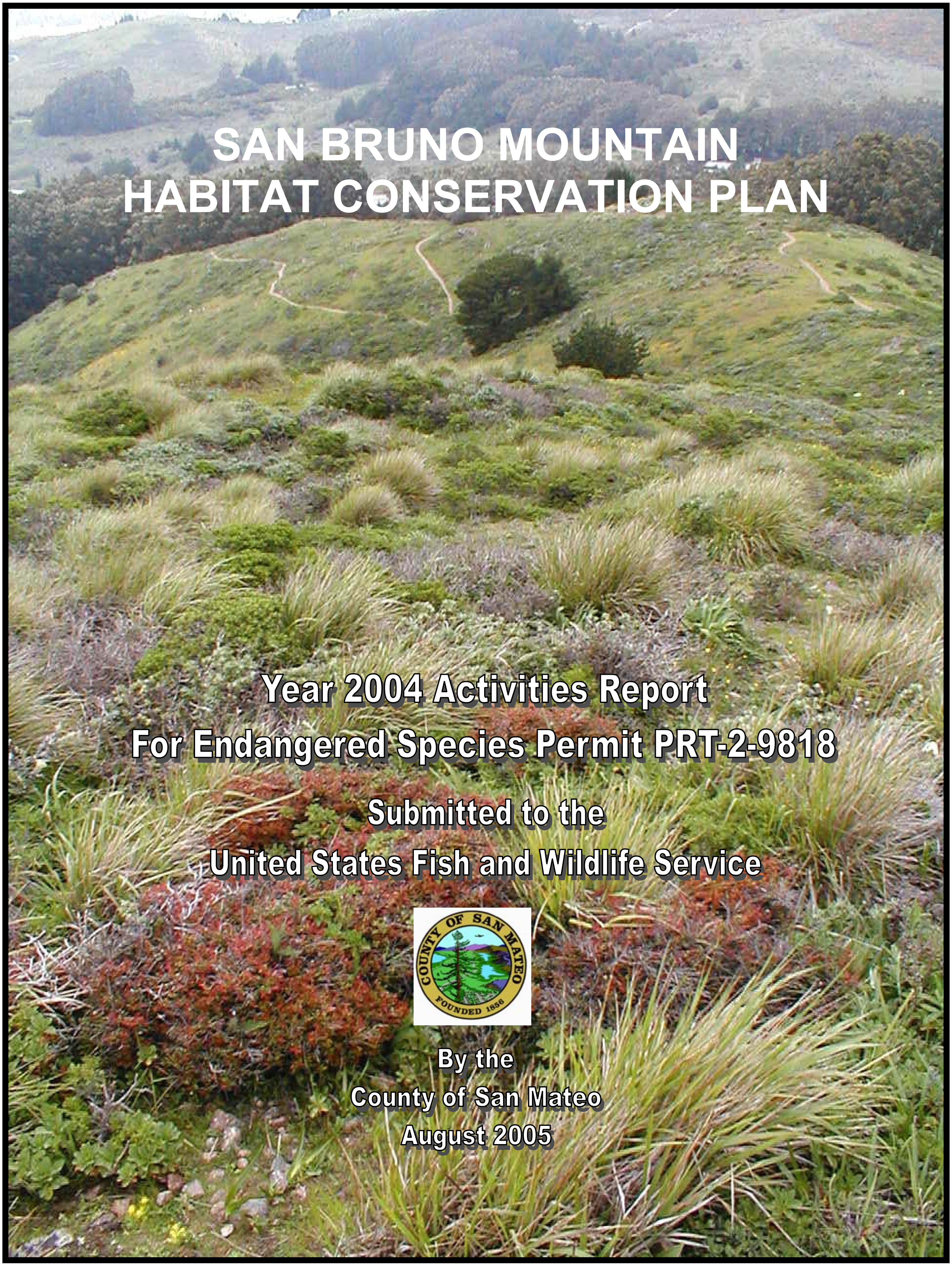

SAN BRUNO MOUNTAIN HABITAT CONSERVATION PLAN

Year 2004 Activities Report

For Endangered Species Permit PRT-2-9818

Submitted to the

United States Fish and Wildlife Service

By the

County of San Mateo

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF 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 <u>Insecta</u> 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 - the San Bruno Mountain Area Habitat Conservation Plan as adopted by the County Board of Supervisors on September 14, 1982 (Resolution No. 43770). Synonym: HCP.

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).

Wandering transects or surveys - Routes that cover large areas (up to a mile) of the mountain and are monitored typically 1-2 times during the flight season. The wandering transects are not standardized routes, but rather the surveyor walks and records butterflies as they are encountered. The wandering transects provide distribution data and allow monitors to check the status of butterfly habitat in remote areas of the park. Since 1982 over 20,000 butterfly observations have been recorded on wandering transects (San Bruno Mountain Ecological Database).

SUMMARY

In 2004, a variety of habitat management work was conducted on San Bruno Mountain to satisfy the requirements of the USFWS Incidental Take Permit (PRT 2-9818). This work included monitoring covered species, conducting invasive species control work and habitat restoration, monitoring development activities and coordinating with volunteer groups and oversight agencies (USFWS, California Department of Fish and Game).

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 status of the populations of the endangered butterflies occurring on the Mountain. Fixed transect data for the Mission blue (MB) and Callippe silverspot (CS) butterflies, and fixed point data for the San Bruno elfin (SBE) butterfly was analyzed using Analysis of Variance (ANOVA).

For Mission blue, butterfly numbers per transect were up in 2004 compared to previous years (Figure 1 *in* Appendix A). Of the seven years that Mission blue transect data has been collected and analyzed (1998-2004), 2000 had the greatest number of MB observations and was found to be nearly significant ($p<.10$) from the lowest year, 1998. All other years were not found to be significantly different from one another, and no significant trend across years was found using correlation or regression analysis (Charley and Wendy Knight, Appendix A).

For Callippe silverspot butterfly, sightings per hour were approximately the same as last year (Figure 1 *in* Appendix B). Of the five years that Callippe silverspot transect data has been collected and analyzed, 2001 was found to be significantly higher than all other years ($p.<.05$). No significant difference was found between all other years (2000, 2002, 2003, and 2004).

Variability in year and transect are the most influential variables in effecting butterfly abundance. Specific weather on survey days impacts the ability to observe the butterflies, however data that is collected during less than optimum weather conditions is not included in the analysis.

Analysis of the fixed transect data thus far has indicated that:

1) Mission blue data collected on the 50-meter long transects is highly variable. The 50-meter transects were established to approximate the relatively small patches of lupine habitat typically utilized by Mission blue and to provide comparable data to the Mission blue transects used by the National Park Service at Milagra Ridge, who also use 50-meter transects. After seven years of data collection, the low numbers of MB's encountered on the 50-meter transects may not provide enough statistical power to reveal trends within a time frame suitable for management. As a result the transects should be lengthened (See page 15 for a summary of a review of MB monitoring methods conducted by Stuart B. Weiss).

2) Callippe silverspot data is collected along transects that vary from 300 to 2000 meters in length. Much greater numbers of Callippes are encountered on the transects as a result,

and this data has greater statistical power and is more promising in providing data that can illustrate trends.

It should be noted that though the transect data collected and analyzed thus far does not indicate an upward or downward trend in butterfly abundance, this does not necessarily mean that the monitoring does not provide useful information. Since approximately 90% of the butterfly habitat has been protected on San Bruno Mountain, and habitat management has successfully maintained most habitat areas from being overtaken by weeds, it is possible that trends, either negative or positive, may not be occurring, and therefore would not be detected (See Appendix C: results of 1982-2000 butterfly data analysis). The monitoring therefore would need to provide enough statistical power to sufficiently detect trends, if they are occurring. At this point in time, the methodology for monitoring the Callippe appears to provide this function, while the MB monitoring methodology would likely need to be modified to intercept more MB observations in more habitat areas.

Prior to the establishment of fixed transects for butterfly monitoring, a random walk or 'wandering' method was used to monitor the Mission blue and Callippe silverspot butterflies. This data, collected on the Mountain from 1982- 2000, was analyzed in 2004 by Travis Longcore, Conservation Biologist with the University of Southern California. Longcore's analysis found that the overall distribution of the butterflies was stable, however specific areas of concern were identified where butterfly abundance had declined. Results are provided in Appendix C of this report. Although the wandering survey method is no longer being used on San Bruno Mountain since changing to the fixed transect methodology, past wandering data has been useful for identifying changes in distribution of MB and CS over time.

Invasive Plant Control and Habitat Restoration

In 2004, 585 acres of invasive plants were treated with herbicides and hand control (Figure 6). Appendix E shows the breakdown of acreage treated by quarter. In 2004, the greatest efforts went into spraying fennel on the South Slope and Northeast Ridge, treating gorse in the Saddle, treating various invasive species in Wax Myrtle Ravine and Dairy Ravine, and treating Bermuda buttercup (*Oxalis pes-caprae*) in upper Tank Ravine. Currently there are 51 invasive plant species that receive treatment on San Bruno Mountain. Approximately 15 of these are considered to be high priority species and receive consistent treatment. When invasive species control work first began under the HCP in 1982, only three species were considered high priority and were targeted for removal (gorse, French broom and Eucalyptus).

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 (Appendix F). They also controlled weeds in the April Brook and Colma Creek areas and along Guadalupe Canyon Parkway.

Volunteers continued their respective invasive species control and/or restoration work in 2004. Active groups include the Friends of San Bruno Mountain, Bay Area Mountain Watch (Appendix H) and the California Native Plant Society (Appendix I). In addition, a large-scale gorse control project was initiated in the Saddle in 2004. This work is being funded through a California State Parks grant. Over 22 acres of high density gorse has been removed through this project (Appendix G).

Grazing

Funding for a pilot grazing project was approved by the HCP Trustees in January 2003. The grazing experiment tested both goat grazing and mowing as a tool for reducing invasive weed infestations in 2003 and 2004 within a 3-acre area on the South Slope of San Bruno Mountain. Preliminary results of the experiment indicate that both mowing and grazing are useful tools, with mowing being the preferred tool for smaller areas (less than 20 acres). Funding was not available to continue this project in 2005.

Goat grazing can be applied to larger areas but a number of precautions need to be followed to ensure that:
A) the health of the goats is protected;
B) a suitable area for goats is chosen based on their diet and behavior;
C) the right amount of grazing pressure (livestock density and duration) is used, and;
D) the goats do not inadvertently spread weeds when moved into new areas.

Goats are effective at controlling weeds in dense stands and at reducing brush and thatch, however, they were also observed to impact native species. The goats significantly reduced the amount of thatch within the grasslands, as measured in residual dry matter (RDM) over the course of one year. The goats reduced thatch levels by approximately 25% (approximately 2300 lbs per acre on average), while control (untreated) areas showed an increase in RDM by approximately 500 lbs per acre.

Results of the experiment suggest that goats be used in brushy or weedy areas where there will be less risk of negative impact to native habitats, such as in the initial stages of restoration. For smaller areas with a significant native plant species component, mowing should be used. For areas with greater than 50% cover of grasses, other livestock (sheep, cattle) should be considered instead of goats.

Burning

No burns were conducted in 2004 on San Bruno Mountain. The prescribed burn for Juncus Ravine, planned since 2002, was not implemented in 2004. CDF is supporting a policy of conducting pile burns on San Bruno Mountain due to the difficulty of conducting open burning on San Bruno Mountain.

Grazing is likely to be the only viable alternative to the use of prescribed burning on the Mountain. Goat grazing can be used to remove ‘ladder fuels’ in the form of brush, dense weeds, and thatch. For management of extensive grassland habitat on San Bruno Mountain, sheep and/or cattle grazing should be considered as a method for removing thatch and controlling invasive grasses.

Development Activities

As of 2004, 300 acres of San Bruno Mountain have been developed. This is approximately 75% of the total development originally allowed under the HCP. Grading has yet to begin on an additional 105 acres. Approximately 25 acres have been graded to reduce the risk of landslides and these slopes are subject to restoration activities.

With the implementation of the HCP, take of MB butterfly 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 was allowed to be taken by development. As of 2004, 9% of this take has already occurred. Although take of 8% of Callippe habitat is allowable under the HCP, no take of CS occurred or was authorized in 2004. Since the listing of the CS in 1997, take of the CS or it's habitat (*Viola pedunculata*) either through development, routine maintenance, and/or restoration work is currently not authorized.

Funding

Substantial gains have been made on San Bruno Mountain over the course of the 23 year history of the HCP, including the containment and reduction of gorse and eucalyptus on the Mountain; the protection and continued presence of the endangered butterflies within their habitat areas, and successful restoration of habitat within former weed infested areas.

The success in reducing gorse and eucalyptus on San Bruno Mountain has been partially due to having a budget surplus that allowed spending an additional $30 – $80,000 per year between 1994 and 2003, and the recent infusion of approximately $600,000 in grant funds from California State Parks and the California Coastal Conservancy (2002-2005). In addition, during the early years of HCP implementation most of the funds were targeted at treating these two species.

Additional funding is needed to combat the relentless invasion of annual and bi-annual weeds such as fennel (*Foeniculum vulgare*), wild radish (*Raphanus sativa*), Bristly Ox-tongue (*Picris echioides*), poison hemlock (*Conium maculatum*) and Bermuda buttercup (*Oxalis pes-caprae*). These weeds are nearly impossible to control within the 3000+ acre HCP area with a base-level budget of approximately $130,000 per year (an average of $43.00 per acre). The conversion of grasslands to coastal scrub in the absence of any large-scale burning, grazing, and/or mowing is another problem this is difficult to address with such a limited budget.

We recommend that to manage the invasive weeds and coastal scrub succession problems on San Bruno Mountain effectively, a consistent level of funding of $420,000 per year (over 3 times the current level) is necessary. This total is based on an evaluation of the weed infestations on the entire Mountain that was done in 2004 for the 5-Year Plan. The recommended base-level funding would not address all of the weed problems on San Bruno Mountain, however it would provide the resources to contain and reduce the major weed infestations that threaten habitat areas (i.e. fennel, oxalis, poison hemlock, wild radish, gorse, French broom, Portuguese broom, eucalyptus, and others). Additional funds provided through grants would still be useful in providing funds for specific restoration and invasive species control projects. However, there are limits on the availability of the grant funds as well as County Park staff time to apply for and to manage grant funds.

A draft San Bruno Mountain Community Wildfire Protection and Fire Use Plan was prepared by the California Department of Forestry and Fire Protection (CDF, San Mateo and Santa Cruz Unit) and TRA. The Plan will be incorporated in the HCP through the amendment process. The Fire Plan recognizes 15 of 21 active management areas on the Mountain that are in need of some amount of fuel reduction or fuel type conversion, and recognizes the use of State fire crews for cutting and piling shrub vegetation and for burning the piles under the direction of CDF. The use of the State fire crews can reduce the costs of carrying out some aspects of the Fire Plan.

INTRODUCTION

This report describes biological and development related activities which took place on San Bruno Mountain under Endangered Species Act Section 10(a)(1)(B) Permit PRT 2-9818 for the 2004 calendar year. It provides information on the status of the butterflies of concern, habitat restoration, work on invasive species control and development activities. Figures and appendices containing data collected in 2004 are located at the end of the report. Anyone interested in reviewing field data or other information collected by Thomas Reid Associates should contact Patrick Kobernus at (650) 327-0429 (ext. 89) 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

1. STATUS OF SPECIES OF CONCERN

Fixed transects were used in 2004 to assess the status of the endangered Mission blue and Callippe silverspot butterflies on San Bruno Mountain. The endangered San Bruno elfin was monitored during the adult flight season at fixed points that were established in 1998. Larval counts for San Bruno elfin were not conducted in 2004.

In 2004, wandering transects were not conducted for the endangered butterflies, except as checks at the beginning of each butterflies' flight season to detect emergence. In the past (from 1982 to 2000) wandering surveys were used to evaluate the butterflies' status on the Mountain. Wandering transects are routes that cover large areas (up to one mile) of the mountain and are monitored typically 1-2 times during the flight season. The wandering transects are not standardized routes, but rather the surveyor walks and records butterflies as they are encountered. The wandering surveys provide distribution data on the butterflies and allow monitors to check on the status of butterfly habitat in remote areas of the park. Since 1982 over 20,000 butterfly observations have been recorded on the wandering transects.

Because wandering surveys are not done along set routes year after year, analysis of the data using standard statistical methods is difficult. The wandering transect data is however useful in tracking changes in butterfly distribution over time, which may be correlated with changes in habitat quality. In 2004, nineteen years of wandering survey data was analyzed using spatial analysis techniques by Travis Longcore, Conservation Biologist with the University of Southern California. The analysis found that the overall distribution of the butterflies was stable, however specific areas of concern were identified where butterfly abundance had declined (See Appendix C of this report).

In contrast to wandering surveys, fixed transect surveys provide a means to compare butterfly 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 included a variety of slope exposures, host plant types, 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 Mission blues under good weather conditions.

<u>Flight Season and Monitoring Period</u>

Due to the large area of butterfly habitat (approximately 1200 acres) on San Bruno Mountain, the varying microclimate on different parts of the Mountain, and the varying emergence times of the butterflies in different subareas, it is difficult to determine the actual start and end of the flight season for each of the butterflies. 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 for each species during that period. It is not cost effective for crews to monitor the fixed transects prior to species emergence, or to continue monitoring the 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.

The monitoring period provides a generalized picture of the butterflies activity in a given year, however gaps in data collection are an inherent problem in monitoring. For example, summertime fog and high winds are often a consistent problem during the Callippe silverspot flight season, limiting the number of available survey days. There is also a logistical problem in monitoring the different butterfly species during the periods where their flight seasons overlap. 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.

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

MB butterflies use three larval host plants: Silver lupine (*Lupinus albifrons var. collinus),* Early flying MB butterflies (March--April) are associated with *L. albifrons*, and late flying MBs (May-- June) are associated with *L. formosus*. *Lupinus variicolor* is used less commonly. Typically, MB butterflies begin adult flight in March, are most abundant in April, and observations begin to drop off by late May or early June. The timing and duration of the flight season is also influenced by overall seasonal climate as well as microclimate. Late spring rains can delay the onset of the flight season throughout the Mountain while hot spring conditions can shorten it. MB colonies on the warmer, dryer south-facing slopes of the Mountain begin and end their flight season earlier than colonies on the cooler north-facing slopes.

<u>Methods</u>

The 18 fixed transects that were surveyed in 2004 are 50-meters long and permanently marked in the field (<u>Figure 1</u>). Each transect is surveyed for 2 ½ minutes. Efforts are made to monitor each transect every 7-10 days (the average adult life span for MB) during the flight season. All transects are surveyed during warm, calm weather. Efforts are made to complete an observation cycle (a survey of all 18 transects) within one to two days. After each transect is surveyed, average wind speed (1 minute average) and air temperature are recorded. Only transect visits that had temperatures greater than or equal to 18^0 C (64.4^0 F) and wind speeds less than or equal to 5.0 mph were used in the analysis. All butterflies observed outside of the transect or in the transect vicinity during travel between transects are recorded as incidental observations.

In order to compare data across years and transects, we calculated a statistic that is the mean number of MB observed per transect. For example, for annual comparisons, we divided the total number of MB observed on a fixed transect in one year by the total number of visits to that transect in that same year. This provides a mean number of MB observations for each transect. The transect means for an entire year are then averaged to calculate the mean number of MB observed in one year.

MB fixed transect data was analyzed using Analysis of Variance (ANOVA), (Appendix A). The procedure allows us to determine if our sampling efforts are sufficient to detect relative changes in MB abundance between years and between transects.

ANOVAs to determine the variation in MB abundance between years and transect are performed using the following criteria:

1. Incidentals butterflies observed off transect were omitted.
2. Transects that had temperatures less than 18^{o} C (64.4^{0} F), and average wind speeds greater than 5.0 mph were omitted.
3. For transects that were surveyed twice in one week (spaced less than 4 days apart), the survey with the least # of MB observations or worse weather conditions was omitted.
4. Transects that were visited in 4 or less years were omitted (Transects # 8,9,10,11,14,15,16,19,20).
5. Transects that recorded 0 butterflies in 4 or more years were omitted (#12).
6. *L. formosus* transect (1, 1.1, 3, 4, 5, 12, 21, 22) visits prior to their first MB observation were omitted.

Results

In 2004, there were a total of 81 MB observed on the fixed transects. Observations that occurred outside of weather parameters or at transects that were surveyed twice in one week were excluded from analysis. For the seven years that we have fixed transect data (1998-2004), 2004 had the second highest mean number of MB observed per transect (Figure 1 *in* Appendix A).

MB Monitoring was conducted over an 8-week span (Table 1). The first MB butterflies of the year were observed on April 7 at several transects. The last MB of the season was observed on June 2 at transect 24. MB observed on Callippe transects were also observed within this period. In four of the past eight years (1998, 1999, 2001, 2002), the flight season has begun later than expected. This is likely due to higher rainfall and/or cooler conditions in the early spring delaying emergence of the adults.

Table 1. Mission blue flight season start and end dates: 1998-2004

Year	Date first MB observed	Date fixed transect surveys began	Date of last MB observation	Approximate length of flight season (Days)
1998	April 10	April 16	June 26	77
1999	April 16	April 16	June 23	68
2000	March 30	April 11	June 1	63
2001	April 12	April 18	June 8	57
2002	April 15	April 15	July 2	78
2003	March 21	March 21	June 16	87
2004	April 7	April 7	June 2	56

The highest numbers of MB in 2004 were observed on transect 17 on west peak, transect 5 at Owl Canyon, and transect 6 in Owl Canyon. All of these transects are well sheltered from the wind, and have abundant lupines – two habitat components that consistently yield higher butterfly observations.

The lowest numbers of MB in 2004 were observed on transect 13 on South Slope, transect 3 on the NE Ridge/San Francisco Water Department Road, and transect 23 on the NE Ridge/ water tank slope. Transect 3 is located on a SFWD road that was re-graveled 2 years ago, and MB observations have been very low since that event. Lupines have been replanted off of the roadway (*see section Habitat Islands Created within the Conserved Park Areas on page 9*). Transect 23 has had low observations of MB in most years since the transect system began and this appears to be due to the poor condition of the lupines at this transect. The site has not responded well after a *L. albifrons* die off occurred after the very wet El Nino year of 1998. It is not known why observations at transect 13 have declined. It may be due to a drop off in lupine density and vigor in the past few years.

Rainfall and MB Abundance

The winter of 2003-04 was moderately wet with approximately 20 inches of rainfall for the year (Table 2). December 2003, and February 2004 were the wettest months of the year, and almost all of the rainfall for the year occurred in December, January, and February.

Rainfall totals for monitoring years 1998-2004 is shown in Table 2. The Table shows a pattern of moderate to heavy rainfall during the months of December, January, February, and sometimes March. Years that deviated from this pattern are 1997-98 (El Nino year), which had almost three times the average annual rainfall; 2001-02 which had most of the rain occurring in November and December, and 2002-03 which had heavy rainfall in April. Observations of butterfly activity on the Mountain suggest that the El Nino rains of 1998 caused a dieback in *L. albifrons* in many locations on the Mountain, and this may have depressed butterfly numbers in 1999 as well. The *L. albifrons* had rebounded in 2000, which therefore may have caused the higher observations of MB in 2000. The lower observations of MB per transect in 2001 and 2002 are not well understood, since these years did not have unusual weather patterns. 2003 had a weather pattern similar to 2001 and 2002, however, the monitoring period was extended due to heavy rains in April, and this resulted in almost twice as many transect visits for that year (Table 3). The longer monitoring period likely included more of the beginning and end of the flight season than is usually intercepted and this may have resulted in lower numbers of MB per transect recorded. In 2004, an unusually warm late winter/early spring combined with average rainfall during the winter may have contributed to the higher observations of MB recorded.

Table 2. Weather data for San Bruno Mountain: 1997-98 — 2003-04. Average high daily temperature and rainfall shown by month. Data was recorded at the County park entrance, (except in 2002-03 and 2003-04).
T= Average temperature in Fahrenheit. R= Rainfall in inches. The two wettest months for each year are shown in **bold** type. Data shown is for the weather year which is recorded from July of one year, to June of the next year.

Temp	**97-98**	**98-99**	**99-00**	**00-01**	**01-02**	****02-03**	***03-04**	**Rain**	**97-98**	**98-99**	**99-00**	**00-01**	**01-02**	***02-03**	****03-04**
	T	T	T	T	T	T	T		R	R	R	R	R	R	R
July	66.6	66.5	64.9	62.7	70	72.1		**July**	0.29	0.31	0.05	0.23	0.26	0	0
Aug	69.1	68.5	65.5	65.7	65	72.4		**Aug**	0.86	0.18	0.47	1.80	0.44	0	0
Sep	72.4	67.6	66.3	73.7	70	74		**Sep**	0.12	0.35	0.50	0.46	0.51	0	0
Oct	64.9	65.9	68.4	61.0	68	69.7		**Oct**	1.08	0.51	0.61	3.21	0.56	0	0
Nov	59.8	56.2	59.1	54.7	60	64.8		**Nov**	6.94	4.29	2.57	1.40	**5.75**	2.95	2.12
Dec	53.2	50.7	55.6	56.0	52	57.9		**Dec**	4.06	1.61	0.68	1.16	**12.55**	**10.75**	**7.08**
Jan	54.5	52.2	53.8	52	51	57	55.1	**Jan**	**14.6**	**5.63**	**7.23**	**5.01**	2.44	2.09	3.32
Feb	52.3	52.0	54.7	53.3	57	56	58	**Feb**	**16.1**	**7.57**	**10.7**	**7.43**	3.14	3.16	**6.32**
Mar	56.4	53.4	57.9	59.2	57	59	**68.5**	**Mar**	3.03	3.42	2.92	2.04	2.97	2.37	0.95
Apr	58.6	57.9	60.7	56.5	58	57	**68**	**Apr**	3.23	2.77	2.21	2.34	0.72	**4.31**	.15
May	59.8	57.0	71.7	67.6	63	64	67.6	**May**	4.91	0.39	1.81	0.19	1.02	0.66	0
Jun	63.6	62.0	65.7	68.2	67	66	68.9	**Jun**	0.46	0.44	0.37	0.25	0.27	0.13	0
								Total	55.7	27.5	30.1	25.5	31	26.4	19.9

Data were not available from the County Park and rainfall data were taken from Lake Merced weather station (**) or SFO weather station (*) for 2003-04. Based on a comparison of years, temperature data from SFO tends to be 2-3° F warmer for the months January through May and 6-7°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.

Table 3. Mean number of Mission blue observations per transect for the years 1998-2004.		
Year	**Mean MB/ Transect**	**Total Number of Transect Surveys**
1998	0.75	39
1999	0.82	59
2000	1.67	76
2001	0.78	69
2002	0.84	46
2003	0.61	121
2004	1.23	67

MB Wandering Surveys

In 2004, essentially no wandering surveys were done for Mission blue butterfly. However Mission blues were recorded (a total of 84) on the fixed Callippe transects (Figure 2). Because the Callippe transects are much longer than the Mission blue transects, they intercept a substantial amount of Mission blue habitat as well. For this reason, approximately the same number of Mission blues were observed on the Callippe fixed transects (84) as the number of Mission blues observed on the MB transects (81). In the event that funding for monitoring is reduced, continuation of the recording of MB on the Callippe transects will provide important data for evaluating the status of MB on San Bruno Mountain.

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

CS use one larval host plant, *Viola pedunculata.* CS adults typically fly from mid-May to mid-July.

Methods

Twelve CS fixed transects were established on San Bruno Mountain in 2000. These vary in length from 470 to 2180 meters and are permanently marked in the field. Ideally, each transect is monitored every 7-10 days during warm, calm weather. However, in practice, transects are often surveyed less frequently due to poor weather conditions (fog) in June and July. Efforts are made to complete an observation cycle (a survey of all twelve transects) within one to two days. All butterflies observed outside of the transect or in the transect vicinity during travel between transects are recorded as incidental observations.

CS are stronger flyers than MB, and they are active during a wider range of weather conditions, however, they are most active during warm, calm weather. For this reason surveys are primarily conducted on days when weather conditions are favorable for butterfly observations.

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, as is done for MB.

CS transects are longer and of variable length in comparison to the MB transects, and for this reason a sightings per hour (S/H) statistic is used rather than the average number of butterflies observed per transect. To calculate S/H, we record the start and stop time for each transect. We then divide the number of CS observed for a particular transect by the number of minutes it took to survey the transect. For each year, the average of the CS S/H for all transects is taken and used to compare relative CS abundance between years.

Five years of CS fixed transect data was analyzed using ANOVA. See Appendix B for Analysis of CS Fixed Transect Surveys in 2004 performed by Charley and Wendy Knight. 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 5 years of monitoring).

Results

In 2004, a total of 270 CS were observed on all of the fixed transects. Figure 3 shows the locations on the Mountain where these observations were made. This corresponded to a sightings per hour of 9.25 S/H. This is similar to the S/H figure calculated for 2003 (9.36), (Figure 1 *in* Appendix B). For 2004, the highest CS S/H observations were recorded on transects 3 and 5 (both on Northeast Ridge). The transects with the lowest S/H observations included transect 1 (Dairy Ravine), transect 2 (Saddle), and transect 6 (NE Ridge Water Tank), (Figure 2 *in* Appendix B).

The monitoring period for CS in 2004 lasted between April 27 and June 15. The first CS observations were recorded on April 27 on several transects. The last CS observations were recorded on June 15 on several transects. The monitoring period in 2004 began earlier than in previous years (Table 4). An unusually warm late winter/early spring in 2004 is likely to have driven an early emergence of Callippe, which typically are not observed until May.

For Callippe, the timing of the flight season appears to occur fairly consistently across years between mid-May and early July. Although according to the fixed transect data, the 2000 flight season appears to have begun exceptionally late (June 1), CS were actually observed earlier on wandering transects on May 18, so using the start of fixed transect monitoring period as the beginning of the flight season would be misleading for some years (Table 4). This delay in the initiation of surveys is a problem during the CS flight season due to the onset of foggy weather which limits the number of monitoring windows. The limited number of good monitoring days also makes it difficult to monitor both Mission blues and Callippes when their flight seasons overlap (May).

Table 4. Callippe silverspot flight season start and end dates: 1998-2004.				
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

*Second CS sighting in 2001 occurred on May 8.

<u>Rainfall and CS abundance</u>

A cursory comparison of weather data for the CS flight season for the five years of monitoring showed that the year with the highest CS S/H (2001) was also the lowest rain year since 1998. A closer examination of weather factors including degree days, could provide some useful correlations. However more years of CS data may be necessary to complete such an analysis.

<u>CS Wandering Surveys</u>

In 2004 no Callippe silverspot wandering surveys were done. The Callippe fixed transects cover a large portion of the Mountain, and this data may be useful in monitoring distribution changes, since nearly every major hilltop utilized by the Callippes on San Bruno Mountain is intercepted by the transects.

i. Management Implications for Mission Blue and Callippe Silverspot

The San Bruno Mountain Habitat Conservation Plan, Biological Program (County of San Mateo, 1982, page III-20) states that (1) “the 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”. These statements suggest that a transect or other similar system should be used to monitor abundance trends, <u>*and*</u> a presence/absence system (butterflies and/or host plants) should be employed to monitor the distribution of the butterflies.

To determine trends in butterfly abundance on San Bruno Mountain, we ask the question “Are the butterfly populations increasing or decreasing?” To answer this we would need to establish a correlation or regression. For correlations, 8 years is the minimum number before correlations across years would become significant. As of 2004, seven years of MB and five years of CS fixed transect data has been collected and analyzed. So continued monitoring will be necessary to address this question (C. Knight pers. comm.).

For Mission blue butterfly, butterfly numbers per transect were up in 2004 compared to previous years (Figure 1 *in* Appendix A). 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 Callippe silverspot butterfly, sightings per hour were approximately the same as last year (Figure 1 *in* Appendix B). Of the five years that Callippe silverspot transect data has been collected and analyzed, 2001 was found to be significantly higher than all other years ($p.<.05$). No significant difference was found between all other years (2000, 2002, 2003, and 2004).

Variability in year and transect appear to be the most influential variables in effecting butterfly observations. This variability must be offset by recording high enough numbers of butterfly observations to make meaningful comparisons year to year. Though weather on survey days impacts the ability to observe the butterflies, this variability can be minimized by analyzing data that has been collected during optimum weather conditions.

Analysis of the fixed transect data thus far has indicated that:

1) Mission blue data collected on the 50-meter long transects is highly variable due to the short length of the transects. The 50-meter transects were established to approximate the relatively small patches of lupine habitat typically utilized by Mission blue, and to provide comparable data to Mission blue transects set up by the National Park Service at Milagra Ridge, who also use 50-meter transects. After seven years of data collection however, the low numbers of MB's encountered on average on the transects may not provide enough statistical power to reveal trends within a time frame suitable for management.

2) Callippe silverspot data is collected along transects that vary from 300 to 2000 meters in length. Much greater numbers of Callippes are encountered on the CS transects, and as a result this data has greater statistical power and is more promising in providing data that can illustrate trends.

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. Since approximately 90% of the butterfly habitat has been protected on San Bruno Mountain, and habitat management has successfully maintained most habitat areas from being overtaken by weeds, it is possible that trends, 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, while the MB monitoring methodology would likely need to be modified to intercept more MB observations in more habitat areas.

Prior to the establishment of fixed transects on the Mountain for butterfly monitoring, a random walk or 'wandering' method was used to monitor the Mission blue and Callippe silverspot butterflies. This data, collected on the Mountain from 1982- 2000, was analyzed in 2004 by Travis Longcore, Conservation Biologist with the University of Southern California. Longcore's analysis found that the overall distribution of the butterflies was stable, however, specific areas of concern were identified where butterfly abundance had declined. Results are provided in Appendix C of this report.

Although the wandering survey method is no longer being used on San Bruno Mountain since changing to the fixed transect methodology, past wandering data has been useful for identifying areas that have historically provided MB and/or CS habitat. A similar methodology such as the wandering method or a presence/absence system would be useful to at least periodically check on the butterflies' distribution on San Bruno Mountain.

The USC group headed by Travis Longcore proposed an alternative monitoring protocol to measure presence/absence on San Bruno Mountain. The new protocol was based on their analysis of the wandering data. Below is a brief description of the alternative protocol as well as two peer reviews of the methodology along with recommendations.

Longcore Protocol (Presence-Absence Surveys)

The Longcore protocol is based on presence-absence surveys on the same regular grid as the analysis of the wandering data. The 250m sampling grid used to analyze the wandering transects is used. Observers survey a 250 x 250 m cell for up to1 hour to establish presence. Only the presence, not the abundance of individuals is recorded. Once presence is established on a survey date, the observer moves on to the next cell. Cells are visited 3 times during the season, at nearly fixed dates, set by the composite curve of observations for each species over the entire 19 year monitoring record.

The cost of implementing abundance and presence surveys for the Mission blue and Callippe together would be $24,450–29,700, not including data analysis and report preparation. Thus, for approximately $30,000 per year a survey scheme could be implemented that would allow for comparison of population sizes across years and permit statistical inference about the status and trends of these two butterfly species. This estimate depends on the actual time required for each type of survey and the actual cost of hiring surveyors. It should provide, however, a framework for discussion.

The cost estimate does not include the cost of setting up the grid of cells on San Bruno Mountain. This initial effort will be costly, and require a substantial off-season effort with a Geographic Positioning System unit to identify the corners of each cell. This effort would identify cells that cannot or should not be surveyed for some reason, providing information to adjust the survey design.

Weiss Peer Review

Conducted by Stuart B. Weiss, Ph.D.

This existing transect system for the CSB samples the range of CSB habitats across SBM, covers important known local population centers and areas that are undergoing brush succession, and is easily supplemented with presence-absence surveys in more peripheral areas. The cost of the transect system in 2004 was about $7-8,000 (P. Kobernus 1/26/05). I would recommend continuing this system for CSB if costs remain the same.

The MB fixed transect system was started in 1998. These data are marginal for detecting abundance changes, since absolute numbers of butterflies on a transect walk range from 0-9 (Figure 2) and are even more subject to Poisson statistics, which give large confidence intervals. Abundance differences among years, sites, and a site x year interaction have been detected using 2-way ANOVA (but the same data transformation issues as CS need to be worked out). It is noted that numbers in 1998 were depressed because of lupine mortality, and abundance has been greater (statistically) in only one year since then (2000). The 50-meter transect length, 2.5-minute walking time, and relatively low abundance/ detectability of MB, are responsible for the low absolute numbers. Extending transects over greater distances, more similar to the CS system, would result in higher absolute numbers of observations over broader areas, and would allow for tracking relative abundance on various parts of SBM.

Fleishman Peer Review

Conducted by Erica Fleishman, Ph.D.

On the whole, Longcore's proposal is scientifically sound. However, I am concerned that implementation of many aspects of the proposal would not represent an optimal trade-off between information content and cost-efficiency. Resources for management of the San Bruno Mountain HCP area currently are limited. Monitoring of butterfly abundance and distribution must be balanced with adaptive management of threats to the butterflies and their habitat (such as natural succession or expansion of non-native plants), with efforts for other species of concern, and with vegetation management and restoration across the site. The conservation value of an extensive and detailed database on the mission blue butterfly and Callippe silverspot butterfly at San Bruno Mountain depends on whether potential threats to their viability can be addressed in a timely manner.

In January 2005, the USFWS directed San Mateo County to continue using the fixed transect method for monitoring CS butterflies. This was principally a result of the peer reviews and the fact that the existing method is cheaper to implement. Furthermore, due to budget constraints they agreed that surveys for both the Mission blue and the San Bruno elfin could be done every other year, rather then every year, and Elfin surveys could be restricted to the larval stage only.

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

SBE are closely associated with their host plant, Pacific stonecrop *(Sedum spathulifolium)*. SBE 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. SBE are the first of the three monitored butterfly species to emerge in the spring. Their flight season typically occurs between early March and mid-April.

Adult Survey Methods

In 1998, 21 fixed monitoring points for San Bruno elfin (SBE) were installed on San Bruno Mountain. Since that time, the number of points monitored has been reduced to 17, due to a lack of observations at four of the points. Each point is permanently marked in the field. Surveys are conducted at each point for 5 minutes. All points are surveyed during warm, calm weather. Points are surveyed on a weekly basis during the flight season of SBE as weather conditions permit. Efforts are made to complete an observation cycle (in 2004 a survey of all 17 points) within one to two days. Average wind speed (1 minute average) and air temperature are recorded. Only transect visits that had temperatures greater than or equal to 14°C (57.2°F) and wind speeds less than or equal to 7.0 mph were used in the analysis. All butterflies observed in the vicinity of the observation point during travel between points are recorded as incidental observations.

For the seven years of adult SBE fixed point data, ANOVAs to detect variation in SBE abundance between years and points were performed using the following criteria:

1. Incidentals (i.e. SBE observed off transect) were omitted.
2. For points that were surveyed twice in one week (spaced less than 4 days apart), the survey with the least # of SBE or worse weather conditions was omitted.
3. Only points that had temperatures greater than or equal to 14°C (57.2°F), and average wind speeds equal to or less than 7.0 mph were considered in the analysis.
4. Surveys done before the first SBE sighting were omitted.
5. Days on which only one point was surveyed, or that occurred late in the season, and have no SBE observations were omitted. (These surveys are intended to check if SBE are still flying late in the season).
6. Points that were surveyed in only 1 year were omitted (Points 1, 4, 21).

Results

SBE Fixed Points: Seven Year Data Analysis (1998-2004)

In 2004, a total of 31 adult SBE butterflies were observed at the points, and 12 incidentals were observed between points. Figure 4 shows the distribution of observations at the SBE points. ANOVA analysis results are shown in Appendix D: 2004 SBE Fixed Point Surveys Analysis, performed by Charley and Wendy Knight.
In 2004, the first adult SBE observations were recorded on March 11. The last recorded adult SBE observations were on April 9. SBE were likely flying a few days prior to and after the recorded observations. The length of the flight season was about average compared to previous years (1998-2004), (Table 5).

Across the seven years of data, the flight season generally begins in early to mid March. In 1999 the flight season was exceptionally late and began in late March. The length of the flight season varies and in most years SBE surveys overlap with the beginning of the MB flight season. Since survey effort tends to switch to MB surveys in early April, survey effort at the tail end of the SBE flight season is often less consistent. However, the date of the first SBE observation is generally accurate since point checks and surveys are often done prior to the first SBE sighting.

Table 5. San Bruno elfin flight season start and end dates: 1998-2004.				
Year	Date first SBE observed	Date fixed point surveys began	Date of last SBE observation	Approximate length of flight season (Days)
1998	February 20	February 20	March 30	39
1999*	March 28	early March	April 14	17
2000**	March 1	March 1	April 3	33
2001	March 13	February 15	March 27	14
2002	March 4	February 28	April 22	49
2003	March 4	February 18	April 7	34
2004	March 11	March 11	April 9	29

* In 1999, newly emerged SBE adults were observed on April 14. Therefore, the 1999 flight season was at least 24 days. **In 2000 crews began monitoring MB transects at the end of March, and missed the end of the SBE flight season.

Management Implications for San Bruno elfin

All of the existing San Bruno elfin 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 SBM 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.

Adult fixed point monitoring data for SBE collected over the last seven years has shown to have a high variability, and this data may prove difficult to determine trends in abundance. SBE larval data may be more reliable for statistical comparison and possibly more cost effective to collect and analyze.

Though abundance trends are not available, the combination of adult and larval data that has been collected over the 23 years of the HCP has demonstrated that this species continues to be consistently recorded in the same areas over time. It is likely that SBE will continue to survive as long as the abundance of their host plant, *Sedum spathulifolium*, and the surrounding habitat is protected from weed invasion and other threats.

Coastal scrub expansion in the absence of burning and grazing, and new weed threats such as *Oxalis pes-caprae* are currently the most serious threats to SBE habitat and the long-term survival of SBE on SBM. In the case that HCP funds cannot support monitoring efforts for SBE every year, some funding should be allocated in all years to manage SBE habitat for protection against these threats.

d. Monitoring Recommendations for 2005

1) Lengthen MB transects to intercept more MB observations. Consider using a system that utilizes previous MB data that has been collected on MB transects, CS transects, and wandering surveys.
2) Place new MB transects (or presence/absence monitoring points) in Colma Creek, Dairy Ravine, the Saddle and any new habitat restoration islands as they become established.

3) Maintain the number of transect visits per year for MB at approximately 70 visits so comparisons between years will be consistent.

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

5) 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.

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

7) Investigate the possible correlation between degree-days and butterfly abundance and length of flight season for MB, CS, and SBE.

8) Consider establishing a presence/absence butterfly (and/or host plant) monitoring. This may allow us to evaluate management impacts (i.e. succession, grazing, restoration) in areas that are not intercepted by the transects. A standardized method of conducting the wandering surveys could also be used for this purpose.

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 2004. In October 2000, the U.S. Fish and Wildlife Service 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 2004. There have been no confirmed observations of CRLF on San Bruno Mountain in the 23 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. Plants of Concern

Several rare and listed plant species are found on San Bruno Mountain. No rare plants were mapped in 2004 on San Bruno Mountain. In previous years, colonies of listed plants or rare plants of a status of CNPS List 1B or higher (i.e. *Arctostaphylos 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.

i. 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.

2. VEGETATION MANAGEMENT AND RESTORATION

a. San Bruno Mountain Five Year Plan

In 2004, the vegetation management program of the San Bruno Mountain HCP followed the objectives set forth in the 1996 San Bruno Mountain HCP Five Year Strategic Plan. This Plan was developed to specifically address a five year period of program implementation (from 1997-2001). The 1996 plan focused on invasive species control, and expanded the previous program to cover most of San Bruno Mountain. This was necessary as invasive species such as fennel, French broom *(Genista monspessulana*), and Portuguese broom (*Cytisus striatus*) were expanding into butterfly habitat areas on the South Slope, Brisbane Acres, and the slopes above the Crocker Industrial Park. Prior to 1996, control efforts were focused primarily on the Saddle, Radio Ridge, Northeast Ridge and in Owl and Buckeye Canyons.

A subsequent 5-year plan has been developed, however, formal approval of the 2004 Five-year Plan has been delayed. When approved, the 5-year plan will be expanded to address the following activities: 1) Invasive species Control, 2) Sensitive Species Population Monitoring, 3) Habitat Restoration, 4) Development Mitigation, and 5) Public Participation.

b. 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 terms "invasive species control" "habitat maintenance" and "habitat enhancement" are used to describe areas that receive invasive species control or brush control work, but not replanting.

Due to the large area of the Mountain that is subject to invasive species control work, (approximately 2800 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 back-pack 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® or Roundup®. 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 two 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 seedling and stump herbicide treatment.

<u>Summary of Large Scale Invasive species Control Work</u>

Invasive species control work has been done on dense stands of eucalyptus, gorse, French broom and other infestations with the intent of restoring these areas to native habitats. All of the areas that have received invasive species control work in the past now comprise a combination of native plants and ruderal weeds that have become established after the primary invasive target species was controlled. Small (½ acre or smaller) planting island areas have been established within some of these areas.

Though it has been difficult to eradicate weeds completely, significant control of specific 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), due to repeated control work over twenty years and the recent work conducted under a State Parks Grant by Shelterbelt Builders, May Associates, and Restoration Resources (Appendix G). In addition, the 2003 Wax Myrtle Ravine burn provided an opportunity to control 3 more acres of gorse that had been essentially unreachable due to the presence of dense eucalyptus slash and brush. 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.

2004 Invasive Plant Treatment Summary

Currently there are 51 invasive plant species that are received treatment on San Bruno Mountain. Approximately 15 of these are considered to be high risk species and receive consistent treatment. These include gorse, French broom, Portuguese broom, fennel, Eucalyptus, Pampas grass, Himalaya blackberry, Oxalis, Cotoneaster, Cape ivy, English ivy, and iceplant. When invasive species control work first began under the HCP in 1982, only three species were targeted for removal (gorse, French broom and Eucalyptus).
The following plant species currently receive invasive species control work on San Bruno Mountain.

Acacia sp. (Acacia)
Avena spp. (wild oat)
Briza maxima (rattlesnake grass)
Bromus hordeaceus (soft chess)
Carduus pycnocephalus (Italian thistle)
Carpobrotus edulis (hottentot fig, iceplant)
Centaurea calcitrapa (purple star thistle)
Centaurea melitensis (Napa thistle)
Centranthus ruber (red valerian)
Chenopodium album (lamb's quarter)
Cirsium vulgare (bull thistle)
Conium maculatum (poison hemlock)
Cortaderia jubata (pampas grass)
Cotoneaster sp. (Cotoneaster)
Cupressus macrocarpa (Monterey cypress)
Cytisus scoparius (Scotch Broom)
Cytisus striatus (Portuguese broom)
Delairea odorata (Cape ivy)
Digitalis sp. (fox-glove)
Erechtites arguta (New Zealand fireweed)
Ehrharta longiflora (Ehrharta)
Erodium cicutarium (filaree)
Eucalyptus globulus (blue gum tree)
Foeniculum vulgare (fennel)
Genista monspessulana (French broom)
Hedera helix (English ivy)
Helichrysum petiolare (licorice plant)
Hirschfeldia incana (mustard)
Holcus lanatus (velvet grass)
Hypochaeris radicata (hairy cat's ear)
Lactuca serriola (prickly lettuce)
Lactuca virosa (wild lettuce)
Leucanthemum vulgare (ox-eye daisy)
Lobularia maritima (Lobularia)
Lolium multiflorum (Italian wild rye)
Lythrum salicaria (purple loosestrife)
Myoporum laetum (Myoporum)
Oxalis pes caprae (Bermuda buttercup)
Phalaris stenoptera (Harding grass)
Picris echioides (bristly ox-tongue)
Pinus radiata (Monterey pine)
Plantago lanceolata (plantain)
Pyrocantha crenato-serrata (Pyrocantha)
Raphanus raphanistrum (wild radish)
Rubus crispus (curly dock)
Rubus discolor (Himalaya blackberry)
Rumex acetosella (sheep sorrel)
Scabiosa atropurpurea (pin-cushion plant)
Silybum marianum (milk thistle)
Solanum sp. (nightshade)
Ulex europaeus (gorse)

In 2004, 585 acres of invasive plants were treated by hand or with herbicides (Figure 6). West Coast Wildlands, subcontractor to TRA, maintains daily record sheets for all invasive species work conducted on the Mountain. Appendix E shows the breakdown of acreage treated by quarter, and includes general observations on several invasive species by Mike Forbert of West Coast Wildlands.

In 2004, the greatest efforts went into 1) spraying fennel on the Southslope and Northeast Ridge; 2) treating gorse in the Saddle; 3) treating various invasive species in Wax Myrtle Ravine and Dairy Ravine, and 4) treating Bermuda buttercup (*Oxalis pes-caprae*) in upper Tank Ravine.

Additional Invasive Species Control Work

Several supplemental invasive species control projects are currently being implemented on San Bruno Mountain in addition to the work funded through the HCP. Some of these projects are very large in scope, and have resulted in significant reduction in invasive weeds. Figure 7 shows the location of these projects on the Mountain.

1) Through a California State Parks Grant, 22 acres of dense gorse and 26 acres of scattered gorse have been removed and treated with herbicide. This work is being conducted by Shelterbelt Builders, May and Associates, and Restoration Resources. For a summary of this project, see Appendix G.

2) West Coast Wildlands has conducted invasive species control on six parcels of Myers Development Co. property within Phase II and III 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). WCW also controls gorse on the slopes above the Carter Street Quarry Development extending to the Saddle Ridge Development owned by Standard Pacific Homes.

3) The volunteer group San Bruno Mountain Watch focused its 2004 stewardship efforts on invasive species control of the lower reaches of Buckeye Canyon, including the ridge east of the Canyon and areas adjacent to Lippman School in Brisbane (Appendix H). The following invasive species were removed from these areas; black mustard (*Brassica nigra*), poison hemlock (*Conium maculatum*), bristly ox-tongue (*Carduus pycnocephalus*), broom (*Genista monspessulana*), cotoneaster (*Cotoneaster* sp.), pincushion plant (*Scabiosa purpurea*), Himalayan blackberry (*Rubus discolor*) and bull thistle (*Cirsium vulgare*). In addition, since the Wax Myrtle Ravine fire in July 2003, volunteers put in approximately 350 hours of invasive plant removal in this area, focusing on gorse (*Ulex europaeus*) and some of the above species. Total volunteer time for 2004 was roughly 500 hours.

4) Under a State Parks Grant, the California Native Plant Society's group "Heart of the Mountain" directed by Joe Canon, is working to restore the headwaters of Colma Creek. This project is described in detail in Appendix I.

5) The Friends of San Bruno Mountain, under the direction of Doug Allshouse are moving their native plant nursery to a new site in Brisbane. The Friends continue to conduct weed control within the Botanic Garden and in the Saddle bog area.

c. 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.

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 the Mission blue's host plants (lupines) are often patchy in their distribution, and will often colonize disturbed roadcuts, landslides, and trails. MB 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, Callippes utilize much larger areas of habitat due to their larger size and stronger flying ability. Callippes can move several hundreds of feet within a few minutes when traveling across terrain searching for Viola and appropriate hilltopping habitat (personal observations). The Callippes 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 contain 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 Mission blues, because this is similar to the lupine patch size that can support Mission blues on the Mountain. However, if one creates a habitat island with 50 Viola plants, it is unlikely Callippe silverspots would utilize this habitat area, because 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 Callippe habitat on the Mountain from weeds or coastal scrub expansion, rather than focus significant effort in creating Callippe 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 the Mission blue and Callippe silverspot on San Bruno Mountain (Biological Program, HCP Volume I).

In spring, 2004 and spring 2005 Viola was mapped within approximately 95% of the grassland areas on the Mountain (Figure 5). This work revealed extensive patches of Viola on the Mountain on the Northeast Ridge, Owl and Buckeye Canyons, Brisbane Acres, Southeast Ridge and on Southslope.

Status of Restoration on Development Slopes

The San Bruno Mountain HCP allowed a total of approximately 14% of MB habitat and 8% of CS habitat on the Mountain to be taken by development. At complete build out of the

HCP developments, the total habitat taken will be slightly less than the original 1982 estimate, because developments such as Terrabay Phase III were required to reduce their building footprint.

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 (totally approximately 10-20 acres) that were disturbed for slope stabilization have not been restored to grassland butterfly habitat. These areas are often rocky with very thin soils and it has been difficult to establish native plant cover. In some areas, restoration of MB habitat has been successful (i.e. Linda Vista development slopes, Northeast Ridge development slopes), however CS habitat has not been successfully restored due to a lack of understanding in how to successfully propagate and maintain Viola plantings, as well as an inability to develop enough soil to support Viola plantings. Viola is more typically found in established grassland habitat, whereas lupines can colonize very rocky, barren slopes. In 2001 and 2002, restoration work conducted by PG&E was very successful in establishing *Viola* at transmission tower sites on the Northeast Ridge and Army Road. Their methods are now being shared with other restoration contractors on the Mountain. In 2004, a habitat island using Viola plantings was created on the Northeast Ridge by Shelterbelt builders, through funding from Brookfield Homes.

Though developer-funded restoration work has resulted in extensive weed control on the Mountain and established a few habitat islands, this work has fallen short on restoring grassland butterfly habitat on disturbed slopes. Weed problems have not been addressed, and developer and/or HOA follow up management of the slopes has not occurred or was terminated after only a few years. 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, the 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 within the conserved habitat areas of the park, 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, expanded funding is needed.

<u>Restoration guidelines for MB and CS</u>

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: 1) to provide corridors and restored grassland habitat for the three endangered butterflies on the Mountain (MB, CS, and SBE), and 2) to restore native habitats for other native wildlife species.

Since the initial Eucalyptus cutting, eucalyptus regrowth control has been done 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 done 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 2004, 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.

Habitat Islands Created within the Conserved Park Areas

Since 1995, seven habitat restoration islands have been created within former Eucalyptus and gorse sites. These sites are located in the Botanic Garden (2 islands), Colma Creek (2 islands), and Dairy Ravine (2 islands), and the Saddle (1 island). In 2003, one new planting island was added in Dairy Ravine and one was added in the Botanic Garden. No new islands were established in 2004. To date, two habitat islands have had confirmed presence of Mission blue butterflies (Colma Creek #1 and Colma Creek #2).

In 2004, Shelterbelt Builders, subcontractor to TRA, conducted annual weed control work to prepare and maintain planting island sites in the Saddle, Colma Creek, and Dairy Ravine. They are also mowing in April Brook to control the spread of poison hemlock. See

Appendix F for a summary report on the habitat restoration activities conducted by Shelterbelt on San Bruno Mountain in 2004.

Shelterbelt has also created a habitat island along the 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 (*L. formosus* primarily) and Mission blue nectar plants being successfully installed and monitored.

d. Grazing

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 the native species composition and predispose grasslands to become more weedy over time.

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. This goat grazing study was initiated to study how best to apply grazing for controlling invasive plant species. Mowing may also be a useful tool in areas where slopes are accessible, and Myers development provided funds for additional mowing treatment areas to be added to the experiment.

The grazing was done within five separate areas on the southslope near Hillside School was done in March 2003, July 2003 and April 2004 (Figure 7). Mowing was conducted within separate plots on the same schedule as the grazing by West Coast Wildlands and the Friends of San Bruno Mountain. The grazing project was implemented for two years, and was not approved for year 3 due to funding limitations in the HCP budget.

During the two year period, extensive data was taken in spring 2003 and spring 2004. Over 100 quadrats were evaluated for plant percent cover, and residual dry matter samples were taken from each treatment group. Due to the cessation of funding, this data has only been partially analyzed.

Results of the experiment revealed that goats can be used effectively to control coastal scrub and various invasive species on San Bruno Mountain. However a number of considerations need to be understood when using goats, both to protect the health of the goats and the native plant communities on San Bruno Mountain.

Goat Grazing on San Bruno Mountain: Observations and Preliminary Conclusions

From the San Bruno Mountain goat grazing and mowing experiment the following conclusions were made.
1) Goat grazing was not observed to substantially reduce invasive species within the grassland areas where it was applied. This was especially true for invasive grasses. The goats tended to focus on broadleaf plants (weeds and natives alike). Furthermore, it

appeared that goat grazing resulted in a decrease in native species cover (*Vicia, Acaena sp., Lupinus sp, Achillea sp.*). This appeared to be due to the goats preference for rocky areas, which often were sites where natives were more dominant. The goats would congregate on these rocky areas, and as a result these areas had more intensive grazing and trampling pressure.

2) Where goat grazing appeared to be effective was where invasive species were thoroughly dominant and there was no risk of impacting native plant species. In one area, at the base of a slope (corral GRAV) where soil moisture was relatively high, the goats appeared to significantly reduce Italian thistle. At this site, reseeding of native grasses (*Bromus carinatus*) both while the goats were grazing and immediately afterwards, was done and this appeared to work well in establishing native grass cover to replace the Italian thistle. These grasses likely benefited by the increased soil moisture at this location. Grass seeding that was done in other, dryer treatment areas did not appear successful.
3) Goat grazing is not an effective tool for controlling *Oxalis pes caprae*, at least in the time frame it was used during this experiment. Though the goats took the Oxalis down to bare ground, the Oxalis recovered each year. Oxalis is mildly toxic to goats and could cause health problems to these animals. As a result due to the health concern for goats when eating Oxalis, the animals had to be moved to an adjacent corral to feed on brush. This resulted in the spread of the Oxalis to the brushy area (probably though corms or other plant material stinking to their hooves). This area has been sprayed with herbicide as part of follow up control work after the experiment.

4) Mowing was more effective in controlling weeds while still maintaining natives. This is because mowing can target the invasive species while avoiding native plants. (Mowing has been used effectively to maintain Mission blue habitat restoration islands that are up to ½ acre in size on San Bruno Mountain). All of the test sites were relatively small, approximately one acre or less. As a result, mowing was determined to be the most cost effective treatment method for small areas. For larger area, 20 acres or more, grazing is likely to be the most cost effective option.

5) The goats were effective at dramatically reducing thatch, as measured by residual dry matter (RDM) within the grasslands. Healthy grasslands are generally believed to have a range of residual dry matter of 600 – 2000 lbs per acre. On the coast side, where summer fog prolongs the growth season of grasses and other plants, this number is likely higher. Residual dry matter samples taken from the grassland areas on San Bruno Mountain prior to the grazing experiment had ranges between 5500 to 9000 lbs per acre. After one year of grazing, RDM values were lowered by approximately 2300 lbs per acre on average. During the same time period, control (untreated) areas showed an increase of RDM by approximately 500 lbs per acre on average. Due to their ability to break down excess plant biomass through feeding and trampling, the goats can provide a good initial treatment to open up thatch covered, weedy grasslands that have not burned or have been grazed for decades. For smaller areas where mowing is applied, raking should be done to remove the biomass from the grasslands.

6) The goats, at $750 per acre, are cost competitive with other invasive species control methods such as mowing and herbicide.

7) Mowing costs are approximately $650 per acre. This can be effectively done on areas up to 10 acres but larger areas areas would be difficult to mow due to the intensive labor required, as well as the need to rake out the thatch.

8) Extreme care should be taken when grazing goats for controlling invasive species, and moving them to new areas, since they can introduce invasive species into new areas if they are not properly cleaned first. Cleaning entails quarantining the goats for at least four days before moving them to a new treatment area.

9) Goats can be used effectively on San Bruno Mountain to control dense weeds, coastal scrub, 'ladder fuels' for fire hazard reduction, and thatch within grassland. They should be used in areas where there is not a significant native species component, except areas of coastal scrub that are to be converted to grassland. In densely vegetated areas, such as northfacing slopes or the sides of ravines where slopes are steep, goats would provide an effective way to control weeds and open up areas for reseeding with native grasses. There are several areas along the periphery of San Bruno Mountain that are dominated by coastal scrub and/or weeds such as broom, Himalaya blackberry, and gorse (e.g. Brisbane Industrial Park, Southwest slopes above Colma, northfacing slope of the Saddle). Goats could be used as one component in a program to restore these areas to a more native plant community.

Goat Workshop Summary

A one day "Goat Summit" workshop was held at Fort Mason, San Francisco on January 25, 2005, sponsored by the San Francisco Department of the Environment and the National Park Service. A number of important issues applicable to San Bruno Mountain were discussed at the workshop. The following information was taken from the lectures of An Peiscel of the Tennessee State University Cooperative Extension Program, Nashville TN and Goats Unlimited; and Roger Ingram of the UC Cooperative Extension Service.

Livestock selection

The general rule to follow when selecting the appropriate livestock for a specific site is:

Site	Livestock
<50% grass	goats
>50% grass	sheep
>75% grass	cattle

Feeding and Water

Goats need to be well fed, but not overfed. They may need diet supplements depending upon the quality of the vegetation. They need fresh, clean water.

Grasses

Goats only eat 10% grass and 90% brush and herbaceous plants. Goats will eat the seed heads of grasses after they've dried.

Coastal Scrub

1) Toyon: goats will eat older plants.
2) Manzanita: goats will eat young manzanita, 1-3 year old plants.
3) Coffeeberry: the berries are poisonous to goats; they will eat the foliage before or after the plant has fruited.
4) Ferns are toxic to goats in the fiddleneck stage; goats will eat the leaves when the plant has leafed out.
5) Buckeye trees when green are toxic to goats; goats will eat the woody material when the tree is dormant.
6) Poison oak: goats will eat second year shoots.
7) Periwinkle (Vinca) is toxic to goats.
8) Sagebrush has turpins that are difficult to digest, and the goats need energy. supplements when grazing in sagebrush.
9) Baby goats will eat moss.

Invasive species

1) Broom species effect estrogen levels in goats, and are toxic to pregnant females.
2) Pine: goats will not eat pine seedlings in winter dormant phase.
3) Yellow start thistle has high protein and is edible when plants are young.
4) Gorse: goats will eat gorse, it has good protein value.
5) Cape ivy and English ivy: goats will eat ivies.
6) Fennel: goats will eat fennel
7) Oxalis: goats will eat oxalis, but a build up of oxalic acid can cause health problems.

Goat Behavior

1) Goats are less selective in what they eat in the morning, because they are hungry. (They also become less selective as plants become scarce within the corrals (personal observation).
2) Goats need to be taken to brushy areas to build up their physical condition, in-between feeding in “nutritionally stressful” areas. (This can result in spreading invasive species to new areas, and therefore these movements need to be planned beforehand).
3) When confronted with a new type of vegetation, goats need time to learn which plants are OK to eat and which are not.
4) Goats do not physically handle stress well. Their stress levels need to be minimized in all aspects of their activities.

3. DEVELOPMENT ACTIVITIES

As of 2004, 300 acres of San Bruno Mountain have been developed. This is approximately 75% of the total development originally allowed under the HCP. Grading has yet to begin on an additional 105 acres. Approximately 25 acres have been graded to reduce the risk of landslides and these slopes are subject to restoration activities.

With the implementation of the HCP, take of MB butterfly 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

2004, 9% of this take has already occurred. Although take of 8% of Callippe habitat is allowable under the HCP, no take of CS occurred or was authorized in 2004. Since the listing of the CS in 1997, take of the CS or it's habitat (*Viola pedunculata*) either through development, routine maintenance, and/or restoration work is currently not authorized.

Funding

Substantial gains have been made on San Bruno Mountain over the course of the 23-year history of the HCP, including the containment and reduction of gorse and eucalyptus on the Mountain; the protection and continued presence of the endangered butterflies within their habitat areas, and successful restoration of habitat within former weed infested areas. The success in reducing gorse and eucalyptus on San Bruno Mountain has been partially due to having a budget surplus that allowed spending an additional \$30 – \$80,000 per year between 1994 and 2003, and the recent infusion of grant moneys from California State Parks and the California Coastal Conservancy (2002-2005). In addition, during the early years of HCP implementation most of the funds were targeted at treating these two species.

Additional funding is needed to combat the relentless invasion of annual and bi-annual weeds such as fennel (*Foeniculum vulgare*), wild radish (*Raphanus sativa*), Bristly Ox-tongue (*Picris echioides*), poison hemlock (*Conium maculatum*) and Bermuda buttercup (*Oxalis pes-caprae*). These weeds are nearly impossible to control within a 3000-acre park with a base-level budget of approximately \$130,000 per year (an average of \$43.00 per acre). The conversion of grasslands to coastal scrub in the absence of any large-scale burning, grazing, and/or mowing is another problem this is difficult to address with such a limited budget.

We recommend that to manage the invasive weeds and coastal scrub succession problems on San Bruno Mountain effectively, a consistent level of funding of \$420,000 per year (over 3 times the current level) is necessary. This total is based on an evaluation of the weed infestations that was done on the entire Mountain in 2004 for the 5-Year Plan. The recommended base-level funding would not address all of the weed problems on San Bruno Mountain, however it would provide the resources to contain and reduce the major weed infestations that threaten habitat areas (i.e. fennel, oxalis, poison hemlock, wild radish, gorse, French broom, Portuguese broom, eucalyptus, and others). Additional funds provided through grants would still be useful in providing funds for specific restoration and invasive species control projects.

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

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

Travis Longcore, Urban Wildlands Group. Communications re: CS monitoring

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Patrick McNamera

FIGURE 1

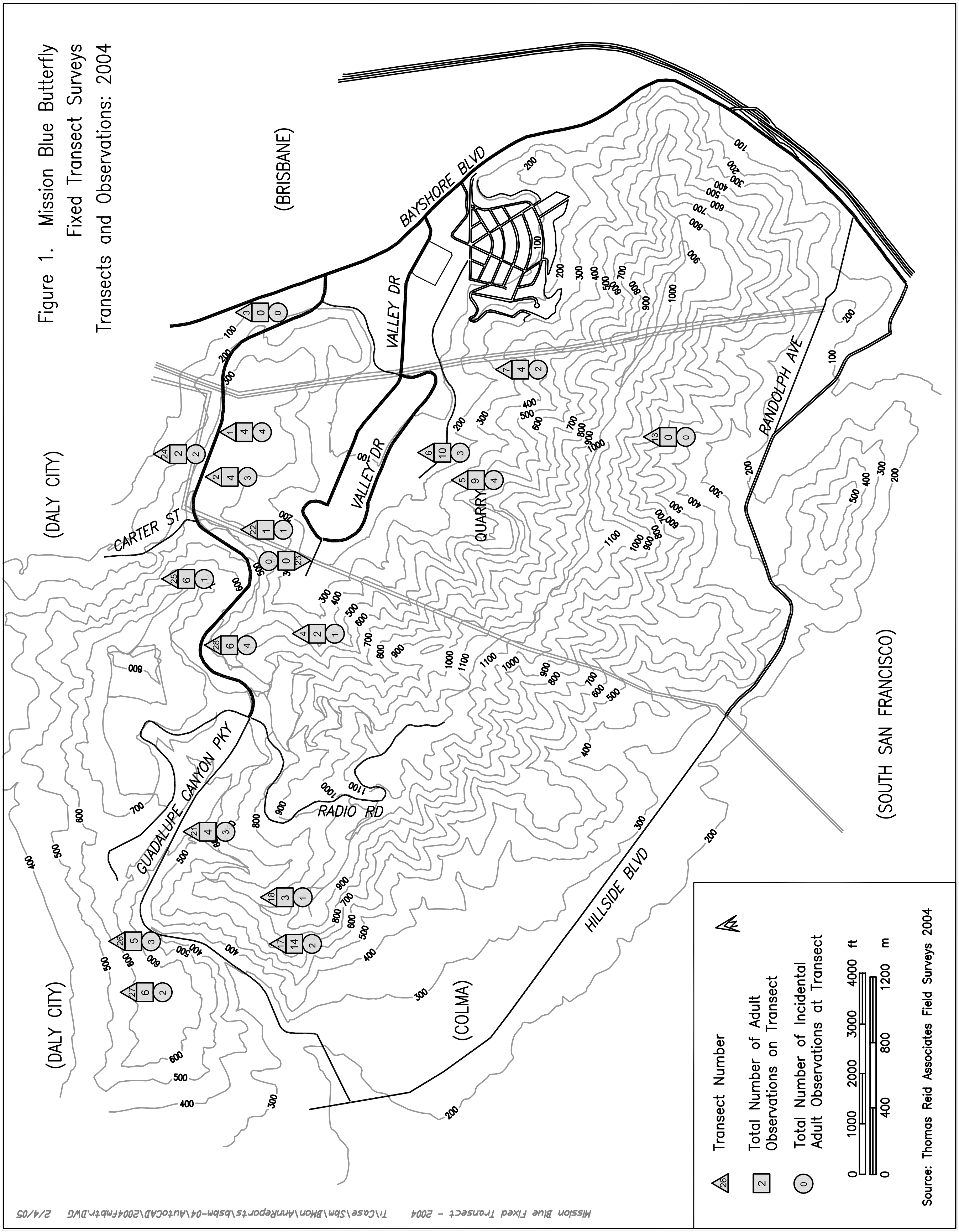


Figure 1. Mission Blue Butterfly
Fixed Transect Surveys
Transects and Observations: 2004
(BRISBANE)
(DALY CITY)
(DALY CITY)
(COLMA)
(SOUTH SAN FRANCISCO)
BAYSHORE BLVD
VALLEY DR
VALLEY DR
CARTER ST
QUARRY
RADIO RD
GUADALUPE CANYON PKY
RANDOLPH AVE
HILLSIDE BLVD
Transect Number
Total Number of Adult Observations on Transect
Total Number of Incidental Adult Observations at Transect
0 1000 2000 3000 4000 ft
0 400 800 1200 m
Source: Thomas Reid Associates Field Surveys 2004
Mission Blue Fixed Transect - 2004 T:\Case\Sbm\BMon\AnnReports\bsbm-04\AutoCAD\2004fmbtr.DWG 2/4/05

FIGURE 2

Figure 2. Mission Blue Observed On Callippe Silverspot Fixed Transects : 2004

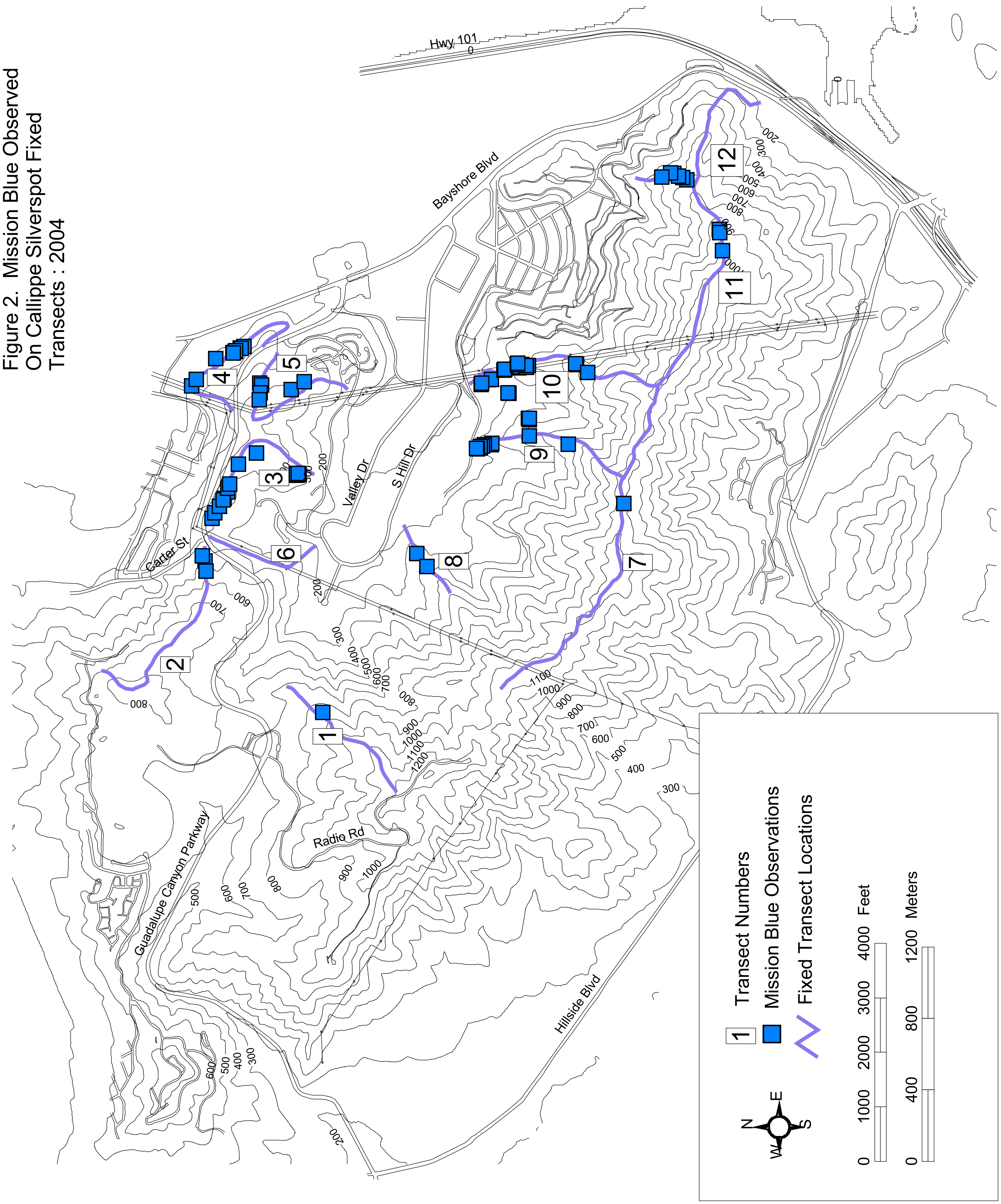


FIGURE 3

Figure 3. Callippe Silverspot Fixed Transects and Observations: 2004

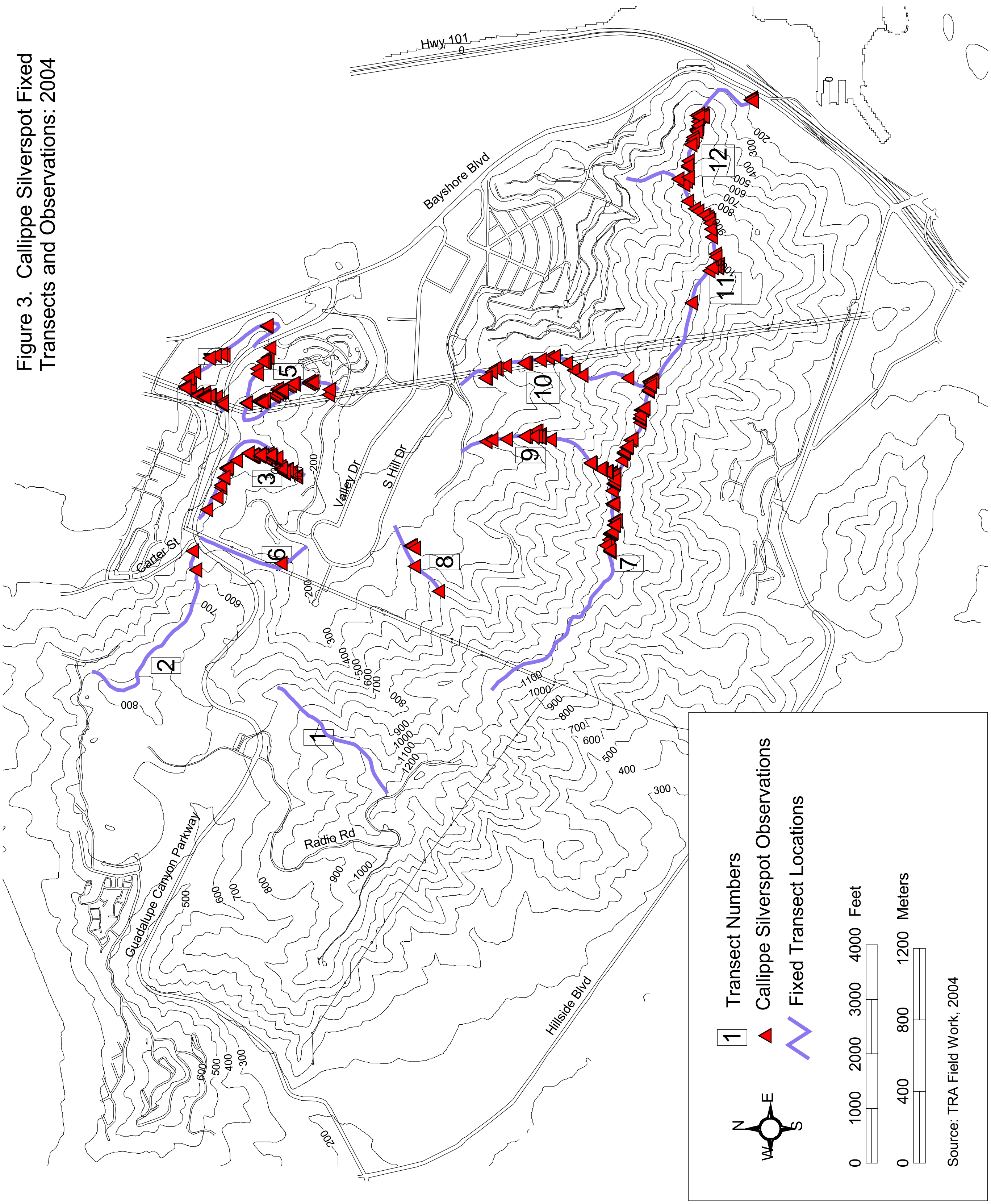


FIGURE 4

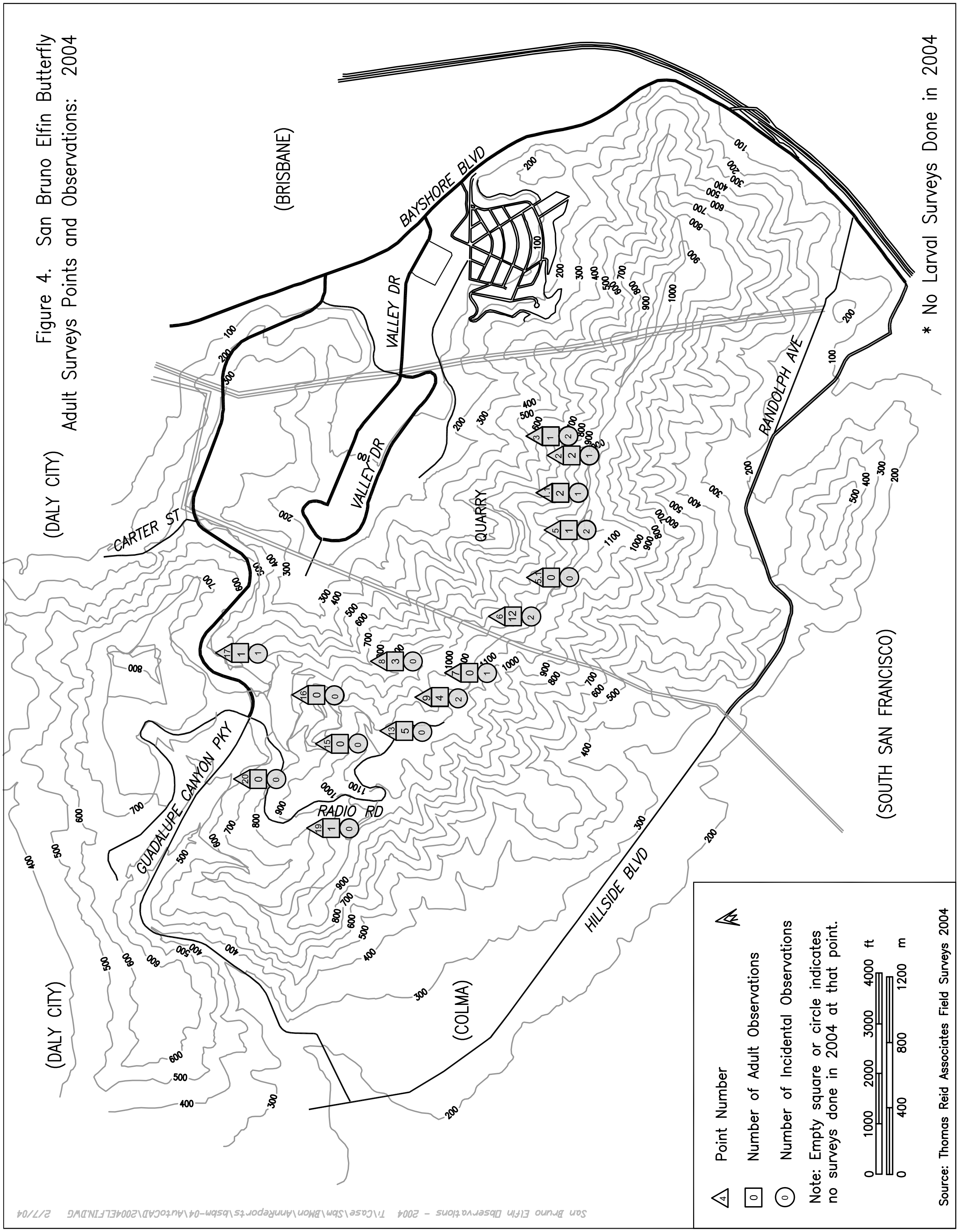


Figure 4. San Bruno Elfin Butterfly
Adult Surveys Points and Observations: 2004
(BRISBANE)
(DALY CITY)
(DALY CITY)
(COLMA)
(SOUTH SAN FRANCISCO)
BAYSHORE BLVD
VALLEY DR
CARTER ST
QUARRY
RANDOLPH AVE
GUADALUPE CANYON PKY
RADIO RD
HILLSIDE BLVD
* No Larval Surveys Done in 2004
Point Number
Number of Adult Observations
Number of Incidental Observations
Note: Empty square or circle indicates no surveys done in 2004 at that point.
0 1000 2000 3000 4000 ft
0 400 800 1200 m
Source: Thomas Reid Associates Field Surveys 2004

FIGURE 5

Figure 5. 2005 Viola Map For San Bruno Mountain, Mapped in 2002, 2004, & 2005.

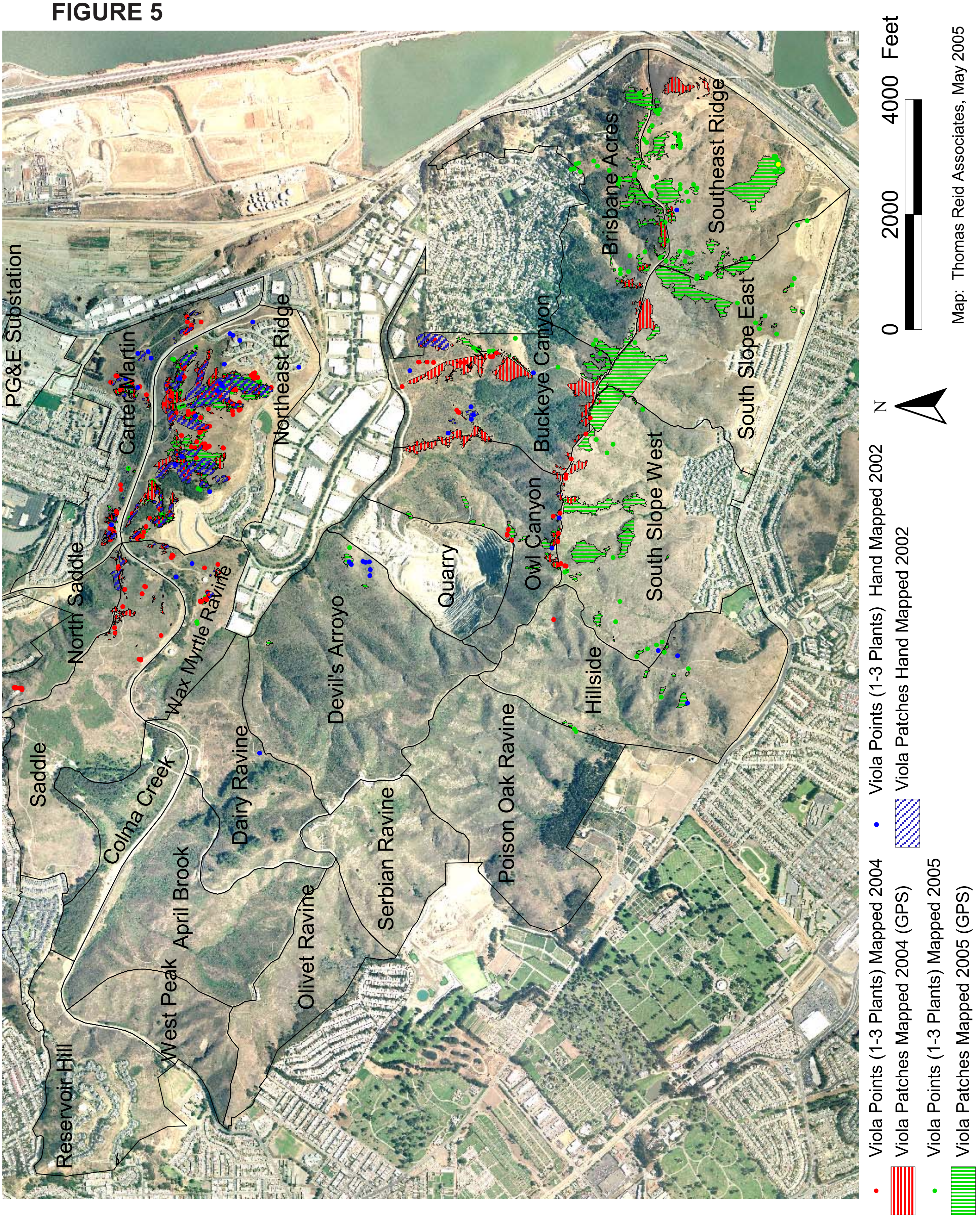


FIGURE 6

Figure 6. HCP Hand and Herbicide Exotics Control Work on San Bruno Mountain in 2004 (West Coast Wildlands) (Additional Invasive Species Control Areas Managed Through Special Projects Not Shown)

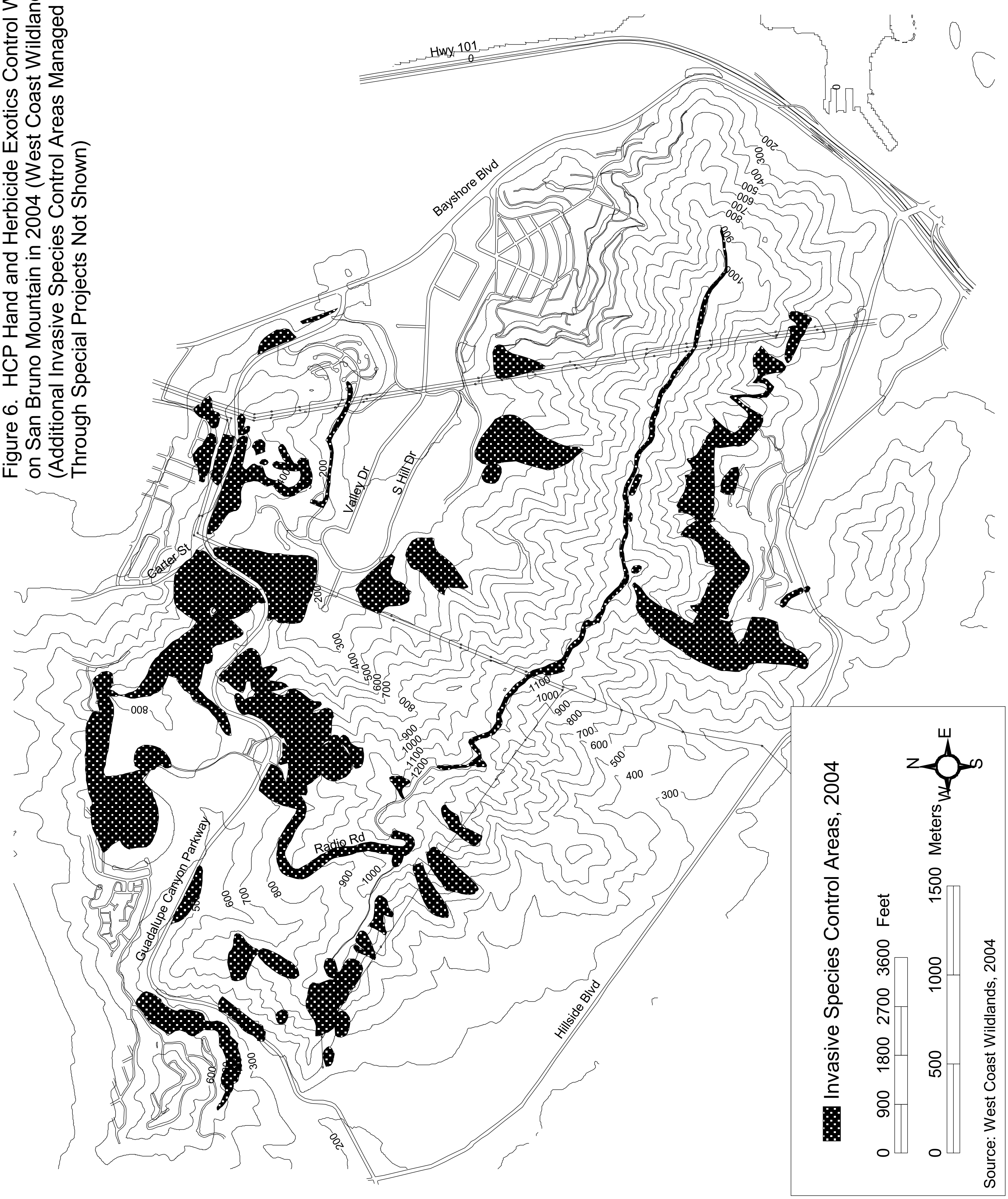
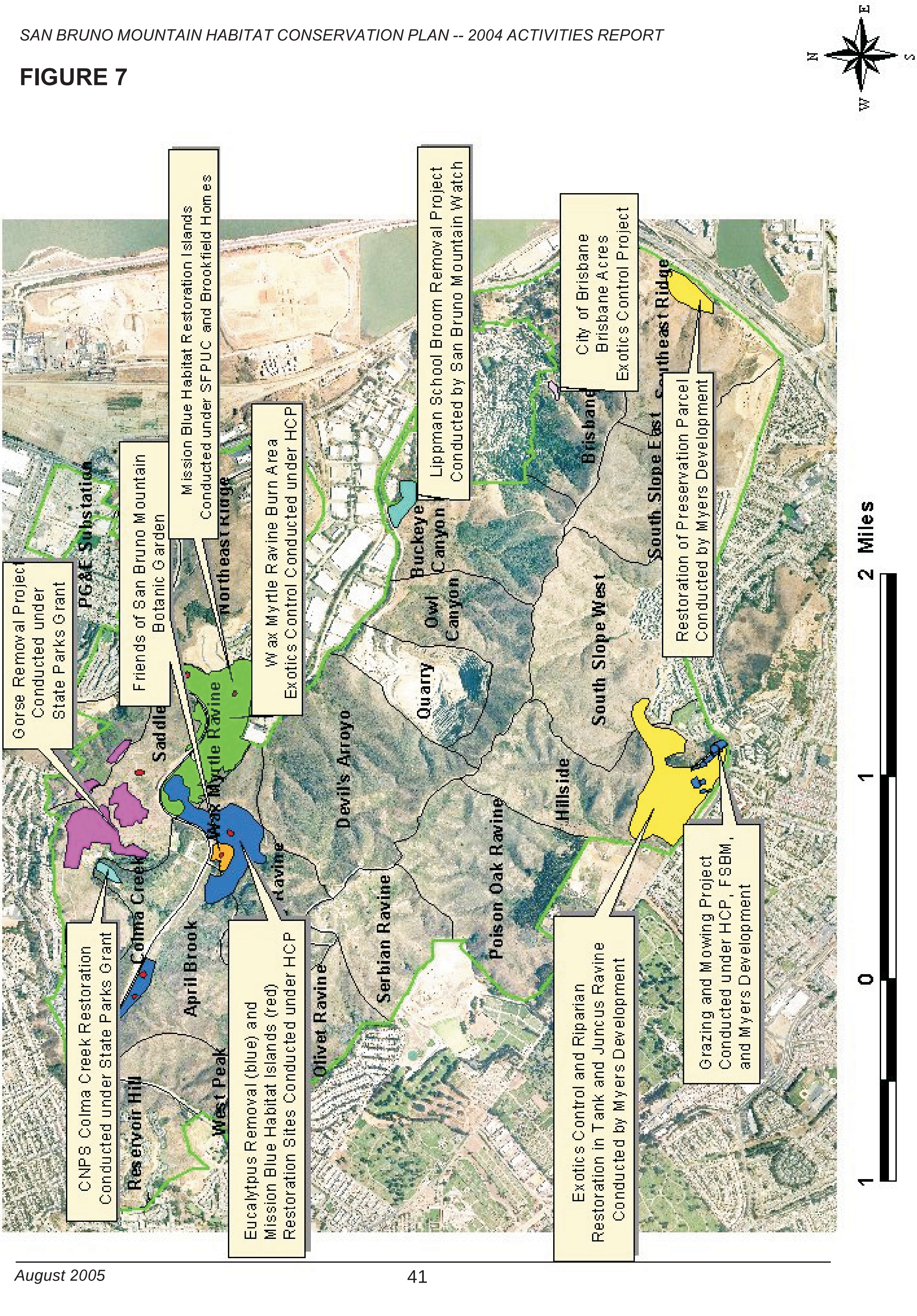


FIGURE 7

Habitat Restoration Projects on San Bruno Mountain 2005. Mountain-wide HCP exotics control program area and San Bruno Mountain Watch CCC grant area not shown. Map prepared by Thomas Reid Associates, May 2005.



Appendix A: 2004 Mission Blue Fixed Transect Surveys Analysis

We used a two factor ANOVA with Scheffe post-hoc tests to test whether there was a significant difference between years and transects for the number of mission blue butterflies (MB) that we observed per transect.

Difference between years.

We found that there was a significant difference between years ($F=2.45$, $p<0.025$; Fig. 1). Scheffe post-hoc tests show that this difference was primarily due to the relative abundance of MB in 2000. Data from the year 2000 were nearly significantly different from 1998 ($p<0.1$) but none of the other years were significantly different. If presence/absence data (1 or 0) is used instead of the number of mission blue per transect, there was not a significant difference between years. There is no significant trend across years for MB by either correlation or regression analysis.

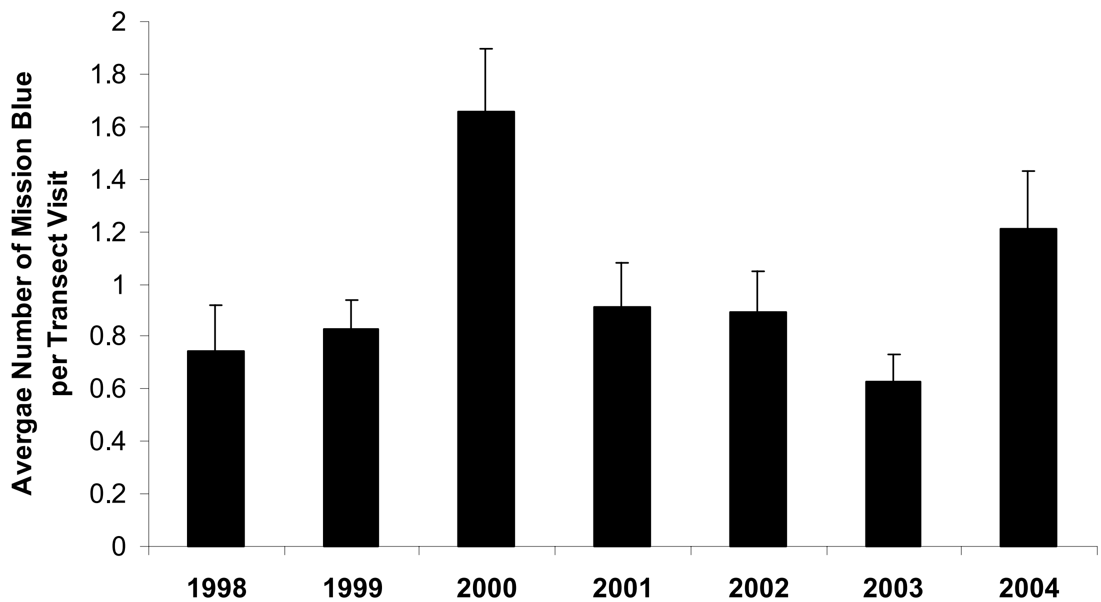


Figure 1. Average number of Mission Blue butterflies observed per transect per year. Error bars represent the standard error of the mean.

Difference between transects.

There was a significant difference between transects for the average number of MB observed per hour ($F=4.09$, $p<0.0001$; Fig. 2). There was also a significant interaction between year and transect ($F=1.91$, $p<0.0001$; Fig. 3), which means that the two are related. This interaction suggests that the relative ranking of transects is different from year to year. The significant interaction also suggests that what was a good year on one transect does not necessarily mean that it was a good year for the rest of the transects that same year (i.e. what was the highest ranking year for one transect may not be the highest ranking year for all other transects).

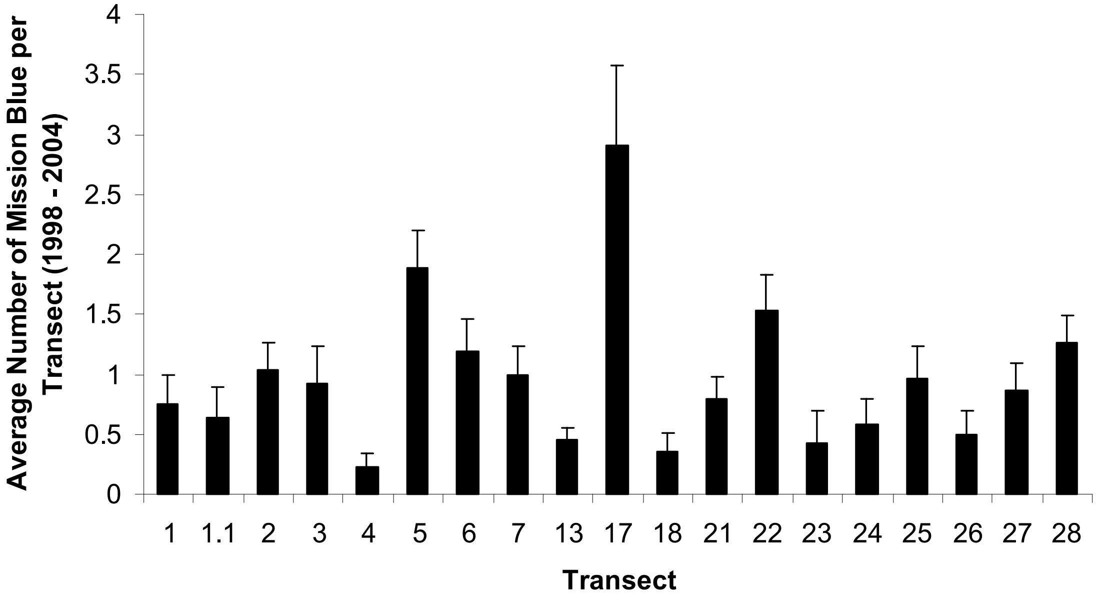


Figure 2. The difference between transects for the average number of mission blue butterflies observed per transect. These are averages for the period 1998 to 2004. Error bars are the standard error of the mean.

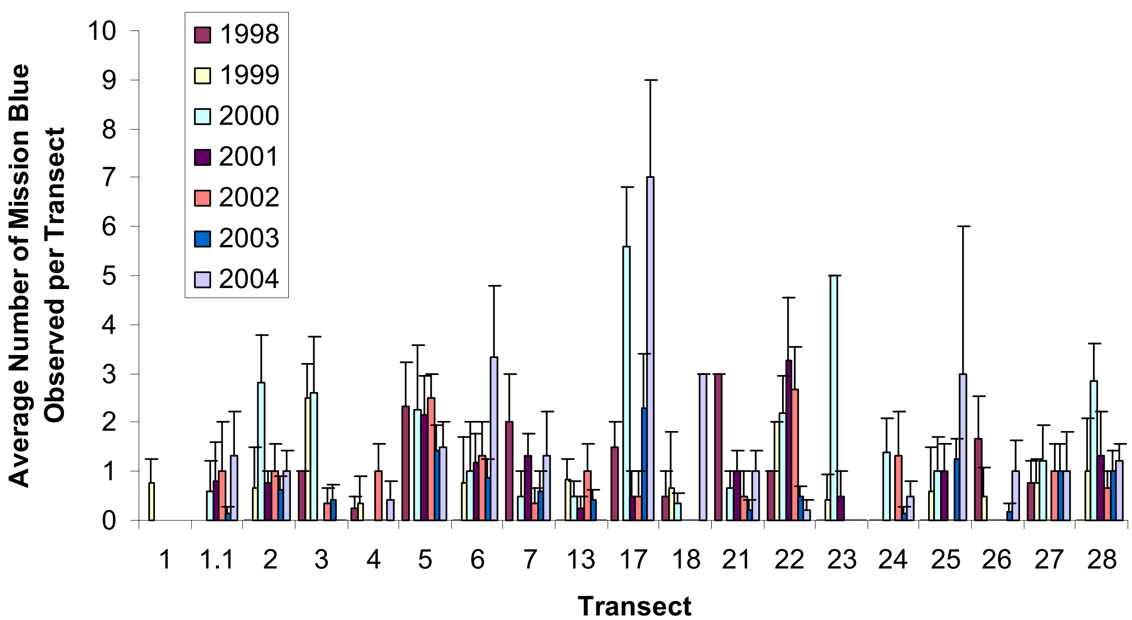


Figure 3. The difference between transects for the average number of mission blue butterflies observed per transect. The average of each transect for every year is shown. Error bars are the standard error of the mean.

SUMMARY

The analyses show that both year and transect are significant predictors for the number of MB observed (2-factor ANOVA). Transect number was the strongest predictor of MB abundance (F-Statistic = 4.09, $p<0.0001$). Year was also a significant factor (F-Statistic = 2.45, $p<0.0247$). Therefore the relative quality of transects for MB changed from year to year. However the interaction between year and transect was also significant (F-Statistic = 1.91, $p<0.0001$), and the significant interaction term is more important than looking at Year and Transect individually. The significant interaction term means that it is the combination of year and transect that predicts MB abundance on any given transect in any given year. Not just year alone and not just transect alone. For example Transect 17 was the highest in 2004, but in other years it ranked differently. Therefore, transect by itself couldn't predict MB abundance and year also couldn't predict the ranking of transect 17.

It's interesting to note that this year (2004) in comparison to last year's annual report, year had less predictive power and transect gained more importance (although the interaction was significant in both years). This could be encouraging from a management perspective because it suggests that the conditions of individual transects predict MB abundance better than stochastic weather forces. Therefore MB abundance is somewhat controllable from a management perspective. This highlights the importance of quantifying habitat characteristics on each transect and further effort should be expended towards this goal in light of these results.

This result makes sense in comparison with the callippe data. MB are more localized and therefore we would predict that transect condition is important, whereas for CS, a far-flyer that can travel between transects, year is the most important factor for predicting abundance.

DESIGN

Dependent variables

Name	**Code**
# MB	#M

Type of analysis: OLS ANOVA

Factors

Name	**Code**	**Nested in**	**F/R**	**Kind**
Year	Yr	()	Fix	Disc
Transect #	T#	()	Fix	Disc

Partial (Type 3) Sums of Squares

Interactions up to 2 - way

No Modifications

RESULTS

General Results

477 total cases

ANOVA

Analysis of Variance For **# MB**
No Selector

Source	**df**	**Sums of Squares**	**Mean Square**	**F-ratio**	**Prob**
Const	1	453.302	453.302	306.72	≤ 0.0001
Yr	6	21.719	3.61984	2.4493	0.0247
T#	18	108.905	6.05027	4.0938	≤ 0.0001
Yr*T#	96	271.538	2.82852	1.9139	≤ 0.0001
Error	356	526.135	1.47791		
Total	476	1027.7			

Results for factor Yr

Coefficients

Expected Cell Means

Scheffe Post Hoc Tests

	Difference	**std. err.**	**Prob**
1999 - 1998	1	0.823	0.960714
2000 - 1998	2.83333	0.8596	0.0960461
2000 - 1999	1.83333	0.6565	0.256499
2001 - 1998	1.33333	0.9926	0.936327
2001 - 1999	0.333333	0.823	0.999912
2001 - 2000	-1.5	0.8596	0.802686
2002 - 1998	0.666667	0.9926	0.998361
2002 - 1999	-0.333333	0.823	0.999912
2002 - 2000	-2.16667	0.8596	0.387037
2002 - 2001	-0.666667	0.9926	0.998361
2003 - 1998	1	0.8389	0.964255
2003 - 1999	26.6731e-15	0.6292	1
2003 - 2000	-1.83333	0.6763	0.292829
2003 - 2001	-0.333333	0.8389	0.999921
2003 - 2002	0.333333	0.8389	0.999921
2004 - 1998	1.2	0.8878	0.934445
2004 - 1999	0.2	0.6931	0.999988
2004 - 2000	-1.63333	0.7361	0.554544
2004 - 2001	-0.133333	0.8878	1
2004 - 2002	0.533333	0.8878	0.999132
2004 - 2003	0.2	0.7118	0.99999

Culled data for ANOVA

1. Transects that were surveyed twice in one week (spaced less than 4 days apart) were culled.
The survey with the least # of MB observations was deleted.
2. Transects that were visited in 4 or less years were discarded (Transects # 8,9,10,11,14,15,16,19,20)
3. Transects that recorded 0 butterflies in 4,5,or 6 of the years were discarded (#12).
4. Formosus transects (1, 1.1, 3, 4, 5, 12, 21, 22) visited before first MB observation (on L.formosus) were discarded.

Sp. Observed	Year	Week	Date	Transect #	# MB	Presence/Absence	Wind <5mph	Temp > 18C
MB	1998	1	16-Apr	6	0	0	1.9	21.2
MB	1998	1	16-Apr	7	1	1	0.7*	21.2*
MB	1998	1	16-Apr	17	2	1	1.2	21.6
MB	1998	1	16-Apr	18	0	0	2.3	20.7
MB	1998	1	16-Apr	23	0	0	3.5	22.2
MB	1998	1	16-Apr	26	2	1	3	19.7
MB	1998	1	16-Apr	27	1	1	3.8	22
MB	1998	1	19-Apr	2	0	0	4.5	22.1
MB	1998	1	19-Apr	13	0	0	3.4	20.2
MB	1998	1	19-Apr	24	0	0	5	18.2
MB	1998	2	26-Apr	2	0	0	1.6	27.6
MB	1998	2	26-Apr	24	0	0	2.9	26.3
MB	1998	2	26-Apr	25	0	0	0.8	22.4
MB	1998	2	27-Apr	4	0	0	0.5	26.6
MB	1998	2	27-Apr	5	1	1	0.4	25.4
MB	1998	2	27-Apr	6	0	0	0.4	24.4
MB	1998	2	27-Apr	7	3	1	0.9	24.9
MB	1998	2	27-Apr	13	0	0	2.6	18
MB	1998	2	27-Apr	17	1	1	0.8	23.4
MB	1998	2	27-Apr	18	1	1	1.5	20
MB	1998	2	27-Apr	21	3	1	4.2	24.9
MB	1998	2	27-Apr	26	3	1	2.1	24.1
MB	1998	2	27-Apr	27	2	1	0.7	21.2
MB	1998	2	27-Apr	28	0	0	1.5	21.8
MB	1998	4	10-May	4	0	0	1.6	18.1
MB	1998	4	10-May	25	0	0	3.5	19
MB	1998	5	18-May	4	1	1	2.8	19.7

MB	1998	5	18-May	27	0	0	4.7	21.9
MB	1998	5	20-May	5	2	1	2.2	20.4
MB	1998	5	20-May	28	0	0	1.8	20.2
MB	1998	7	1-Jun	25	0	0	*	~21-27
MB	1998	7	5-Jun	3	1	1	4	21.2
MB	1998	7	5-Jun	4	0	0	1.4	19.7
MB	1998	7	5-Jun	5	4	1	1.9	20.7
MB	1998	7	5-Jun	13	0	0	3.3	21.8
MB	1998	7	5-Jun	22	1	1	3.5	19.5
MB	1998	7	5-Jun	26	0	0	4.9	20
MB	1998	7	5-Jun	27	0	0	4.6	20.4
MB	1998	7	5-Jun	28	0	0	1.5	22.7
MB	1999	1	16-Apr	13	1	1	y	y
MB	1999	1	16-Apr	23	0	0	y	y
MB	1999	1	16-Apr	24	0	0	y	y
MB	1999	1	16-Apr	25	0	0	y	y
MB	1999	1	16-Apr	28	1	1	y	y
MB	1999	2	23-Apr	2	2	1	y	y
MB	1999	2	23-Apr	13	1	1	y	y
MB	1999	2	23-Apr	18	2	1	y	y
MB	1999	2	23-Apr	23	0	0	y	y
MB	1999	2	23-Apr	28	1	1	y	y
MB	1999	2	24-Apr	6	0	0	y	y
MB	1999	2	24-Apr	25	2	1	4.4	y
MB	1999	2	24-Apr	26	0	0	y	y
MB	1999	2	24-Apr	27	0	0	y	y
MB	1999	4	4-May	28	0	0	y	y
MB	1999	4	7-May	2	0	0	y	y
MB	1999	4	7-May	4	1	1	y	y
MB	1999	4	7-May	26	1	1	y	y
MB	1999	4	7-May	27	1	1	y	y
MB	1999	4	7-May	28	2	1	4.1	y
MB	1999	4	8-May	1	1	1	y	y
MB	1999	4	8-May	22	2	1	y	y
MB	1999	4	8-May	23	1	1	y	y
MB	1999	4	8-May	25	1	1	y	y
MB	1999	5	16-May	28	3	1	y	y

MB	1999	5	17-May	22	2	1	y	y
MB	1999	5	18-May	1	1	1	y	y
MB	1999	5	18-May	2	1	1	y	y
MB	1999	5	18-May	23	1	1	y	y
MB	1999	5	16-May	4	0	0	y	y
MB	1999	5	16-May	6	1	1	y	17.7
MB	1999	5	16-May	13	1	1	y	y
MB	1999	5	16-May	26	1	1	y	y
MB	1999	5	16-May	27	1	1	y	y
MB	1999	6	25-May	1	0	0	y	y
MB	1999	6	25-May	2	1	1	y	y
MB	1999	6	25-May	3	3	1	y	y
MB	1999	6	25-May	4	0	0	y	y
MB	1999	6	25-May	6	2	1	y	y
MB	1999	6	25-May	22	2	1	y	y
MB	1999	6	25-May	23	0	0	y	y
MB	1999	6	25-May	25	0	0	y	y
MB	1999	6	25-May	28	1	1	y	y
MB	1999	6	26-May	13	1	1	y	y
MB	1999	6	26-May	18	0	0	y	y
MB	1999	8	7-Jun	13	1	1	y	y
MB	1999	8	8-Jun	1	1	1	y	y
MB	1999	8	8-Jun	2	0	0	4.6	y
MB	1999	8	8-Jun	25	0	0	y	y
MB	1999	8	8-Jun	28	0	0	y	y
MB	1999	10	18-Jun	3	2	1	4.2	y
MB	1999	10	20-Jun	2	0	0	4.5	y
MB	1999	10	20-Jun	22	2	1	y	y
MB	1999	10	20-Jun	26	0	0	y	y
MB	1999	10	20-Jun	27	1	1	4.8	y
MB	1999	10	20-Jun	28	0	0	y	y
MB	1999	10	22-Jun	6	0	0	y	y
MB	1999	10	22-Jun	13	0	0	y	y
MB	1999	10	22-Jun	18	0	0	y	y
MB	2000	1	3-Apr	18	0	0	y	y
MB	2000	2	11-Apr	2	5	1	y	y
MB	2000	2	11-Apr	7	0	0	4.1	y

MB	2000	2	11-Apr	13	0	0	y	y
MB	2000	2	11-Apr	17	6	1	y	y
MB	2000	2	11-Apr	18	0	0	y	y
MB	2000	2	11-Apr	24	0	0	y	y
MB	2000	2	11-Apr	28	0	0	y	y
MB	2000	3	18-Apr	1.1	0	0	y	y
MB	2000	3	18-Apr	2	4	1	4.5	y
MB	2000	3	18-Apr	4	0	0	y	y
MB	2000	3	18-Apr	5	0	0	y	y
MB	2000	3	18-Apr	22	1	1	y	y
MB	2000	3	18-Apr	24	1	1	4.8	y
MB	2000	3	18-Apr	25	0	0	y	y
MB	2000	3	19-Apr	3	0	0	y	y
MB	2000	3	19-Apr	13	1	1	4.2	y
MB	2000	3	19-Apr	17	9	1	y	y
MB	2000	3	19-Apr	18	1	1	y	y
MB	2000	3	19-Apr	21	1	1	y	y
MB	2000	3	19-Apr	26	0	0	y	y
MB	2000	3	19-Apr	27	0	0	5	y
MB	2000	3	19-Apr	28	5	1	4.6	y
MB	2000	4	26-Apr	1.1	0	0	y	y
MB	2000	4	26-Apr	2	4	1	y	y
MB	2000	4	26-Apr	3	0	0	y	y
MB	2000	4	26-Apr	17	4	1	y	y
MB	2000	4	26-Apr	18	0	0	y	y
MB	2000	4	26-Apr	22	5	1	y	y
MB	2000	4	26-Apr	23	5	1	y	y
MB	2000	4	26-Apr	25	3	1	y	y
MB	2000	4	26-Apr	28	4	1	y	y
MB	2000	4	28-Apr	4	0	0	4.2	y
MB	2000	4	28-Apr	5	0	0	y	y
MB	2000	4	28-Apr	13	1	1	y	y
MB	2000	4	28-Apr	26	0	0	y	y
MB	2000	4	28-Apr	27	3	1	y	y
MB	2000	5	3-May	1.1	0	0	y	y
MB	2000	5	3-May	3	3	1	y	y
MB	2000	5	3-May	22	1	1	y	y

MB	2000	5	3-May	24	0	0	y	y
MB	2000	5	3-May	25	1	1	y	y
MB	2000	5	3-May	26	0	0	4.6	y
MB	2000	5	3-May	27	3	1	5	y
MB	2000	5	3-May	28	3	1	y	y
MB	2000	6	12-May	1.1	0	0	y	y
MB	2000	6	12-May	17	7	1	y	y
MB	2000	6	12-May	18	0	0	y	y
MB	2000	6	12-May	21	0	0	5	y
MB	2000	6	12-May	22	2	1	y	y
MB	2000	6	12-May	26	0	0	y	y
MB	2000	6	12-May	27	0	0	y	y
MB	2000	6	12-May	28	4	1	y	y
MB	2000	7	17-May	2	1	1	4.2	y
MB	2000	7	17-May	4	0	0	y	y
MB	2000	7	17-May	5	4	1	y	y
MB	2000	7	17-May	6	2	1	y	y
MB	2000	7	17-May	13	0	0	y	y
MB	2000	7	17-May	24	3	1	y	y
MB	2000	7	17-May	25	0	0	y	y
MB	2000	7	18-May	3	6	1	y	y?
MB	2000	8	23-May	1.1	3	1	y	y
MB	2000	8	23-May	2	0	0	y	y
MB	2000	8	23-May	3	4	1	y	y
MB	2000	8	23-May	4	0	0	y	y
MB	2000	8	23-May	5	5	1	y	y
MB	2000	8	23-May	6	0	0	y	y
MB	2000	8	23-May	7	1	1	y	y
MB	2000	8	23-May	17	2	1	y	y
MB	2000	8	23-May	18	1	1	y	y
MB	2000	8	23-May	21	1	1	y	y
MB	2000	8	23-May	22	2	1	y	y
MB	2000	8	23-May	24	3	1	y	y
MB	2000	8	23-May	26	0	0	y	y
MB	2000	8	23-May	27	0	0	y	y
MB	2000	8	23-May	28	1	1	y	y
MB	2001	1	18-Apr	21	1	1	y	y

MB	2001	2	23-Apr	1.1	0	0	y	y
MB	2001	2	23-Apr	2	1	1	5	y
MB	2001	2	23-Apr	3	0	0	y	y
MB	2001	2	23-Apr	4	0	0	y	y
MB	2001	2	23-Apr	5	1	1	y	y
MB	2001	2	23-Apr	6	3	1	y	y
MB	2001	2	23-Apr	7	3	1	y	y
MB	2001	2	23-Apr	13	0	0	y	y
MB	2001	2	23-Apr	24	0	0	y	y
MB	2001	2	25-Apr	22	6	1	y	y
MB	2001	2	25-Apr	25	2	1	y	y
MB	2001	3	30-Apr	1.1	0	0	Y	55-67
MB	2001	3	30-Apr	5	0	0	y	y
MB	2001	3	30-Apr	7	1	1	4.4	64-69F
MB	2001	3	30-Apr	28	3	1	Y	Y
MB	2001	3	1-May	3	0	0	4.4	y
MB	2001	3	1-May	17	2	1	?	?
MB	2001	3	1-May	27	0	0	y	y
MB	2001	3	2-May	2	1	1	y	y
MB	2001	3	2-May	4	0	0	y	y
MB	2001	3	2-May	6	0	0	5	y
MB	2001	3	2-May	22	5	1	4.7	y
MB	2001	4	7-May	1.1	0	0	y	y
MB	2001	4	7-May	2	0	0	y	y
MB	2001	4	7-May	3	0	0	y	y
MB	2001	4	7-May	4	0	0	y	y
MB	2001	4	7-May	5	1	1	y	y
MB	2001	4	7-May	6	3	1	y	y
MB	2001	4	7-May	7	1	1	y	y
MB	2001	4	7-May	13	1	1	y	y
MB	2001	4	7-May	17	0	0	y	y
MB	2001	4	7-May	18	0	0	y	y
MB	2001	4	7-May	21	2	1	y	y
MB	2001	4	7-May	22	1	1	y	y
MB	2001	4	7-May	23	0	0	y	y
MB	2001	4	7-May	24	0	0	y	y
MB	2001	4	7-May	25	1	1	y	y

MB	2001	4	7-May	26	0	0	y	y
MB	2001	4	7-May	27	0	0	y	y
MB	2001	4	7-May	28	1	1	y	y
MB	2001	6	18-May	1.1	0	0	y	y
MB	2001	6	18-May	3	0	0	y	y
MB	2001	6	18-May	4	0	0	y	y
MB	2001	6	18-May	6	1	1	y	y
MB	2001	6	18-May	7	1	1	y	y
MB	2001	6	18-May	13	0	0	4.5	y
MB	2001	6	18-May	22	1	1	y	y
MB	2001	6	18-May	23	1	1	y	y
MB	2001	6	18-May	25	0	0	y	y
MB	2001	6	21-May	2	1	1	y	y
MB	2001	6	21-May	5	5	1	y	y
MB	2001	6	21-May	17	0	0	y	y
MB	2001	6	21-May	18	0	0	y	y
MB	2001	6	21-May	21	1	1	y	y
MB	2001	6	21-May	26	0	0	y	y
MB	2001	6	21-May	27	0	0	y	y
MB	2001	8	31-May	1.1	4	1	y	y
MB	2001	8	31-May	3	0	0	y	y
MB	2001	8	31-May	5	4	1	y	y
MB	2001	8	31-May	6	0	0	y	y
MB	2001	8	31-May	7	2	1	y	y
MB	2001	8	31-May	13	0	0	y	y
MB	2001	8	31-May	21	0	0	y	y
MB	2001	8	4-Jun	17	0	0	4.1	y
MB	2001	8	4-Jun	28	0	0	y	y
MB	2001	10	8-Jun	5	2	1	y	y
MB	2001	10	8-Jun	6	0	0	y	y
MB	2001	10	8-Jun	7	0	0	y	y
MB	2002	1	15-Apr	22	4	1	y	y
MB	2002	1	15-Apr	27	2	1	y	y
MB	2002	1	19-Apr	1.1	0	0	y	y
MB	2002	1	19-Apr	2	2	1	y	y
MB	2002	1	19-Apr	3	0	0	y	y
MB	2002	1	19-Apr	4	1	1	y	y

MB	2002	1	19-Apr	5	2	1	y	y
MB	2002	1	19-Apr	6	0	0	y	y
MB	2002	1	19-Apr	7	0	0	y	y
MB	2002	1	19-Apr	13	0	0	y	y
MB	2002	1	19-Apr	17	1	1	4.6	y
MB	2002	1	19-Apr	18	0	0	y	y
MB	2002	1	19-Apr	24	0	0	y	y
MB	2002	1	19-Apr	25	0	0	4.9	y
MB	2002	1	19-Apr	28	0	0	4.7	y
MB	2002	5	8-May	2	0	0	y	y
MB	2002	5	8-May	3	0	0	y	y
MB	2002	5	8-May	4	0	0	y	y
MB	2002	5	8-May	6	2	1	y	y
MB	2002	5	8-May	7	1	1	y	y
MB	2002	5	8-May	13	1	1	y	y
MB	2002	5	8-May	18	0	0	y	y
MB	2002	5	8-May	21	1	1	y	y
MB	2002	5	8-May	22	3	1	y	y
MB	2002	5	8-May	24	1	1	y	y
MB	2002	5	8-May	26	0	0	4.4	y
MB	2002	5	8-May	27	0	0	y	y
MB	2002	5	8-May	28	1	1	y	y
MB	2002	7	23-May	1.1	2	1	y	y
MB	2002	7	23-May	2	1	1	y	y
MB	2002	7	23-May	3	1	1	y	y
MB	2002	7	23-May	4	2	1	y	y
MB	2002	7	23-May	5	3	1	y	y
MB	2002	7	23-May	6	2	1	y	y
MB	2002	7	23-May	7	0	0	y	y
MB	2002	7	23-May	17	0	0	y	y
MB	2002	7	23-May	18	0	0	y	y
MB	2002	7	23-May	21	0	0	y	y
MB	2002	7	23-May	22	1	1	5	y
MB	2002	7	23-May	24	3	1	y	y
MB	2002	7	23-May	26	0	0	4.4	y
MB	2002	7	23-May	27	1	1	y	y
MB	2002	7	23-May	28	1	1	y	y

MB	2002	7	24-May	13	2	1	y	y
MB	2002	7	24-May	23	0	0	y	y
MB	2002	7	24-May	25	0	0	y	y
MB	2003	1	21-Mar	17	6	1	2.8	21.6
MB	2003	1	21-Mar	18	0	0	3.7	20.6
MB	2003	1	25-Mar	1.1	0	0	1.8	22.1
MB	2003	1	25-Mar	3	0	0	1.8	18.5
MB	2003	1	25-Mar	4	0	0	1.5	22.1
MB	2003	1	25-Mar	5	0	0	2.2	22.8
MB	2003	1	25-Mar	6	1	1	0.5	22
MB	2003	1	25-Mar	7	0	0	1.1	19.7
MB	2003	1	25-Mar	13	1	1	1.7	24.5
MB	2003	1	25-Mar	26	1	1	2.3	20
MB	2003	1	25-Mar	27	1	1	2	20
MB	2003	1	25-Mar	28	0	0	1.7	20.2
MB	2003	1	27-Mar	2	2	1	2.4	21.8
MB	2003	1	27-Mar	22	1	1	4.6	25.6
MB	2003	1	27-Mar	23	0	0	3.1	25.6
MB	2003	1	27-Mar	25	0	0	4.9	18.5
MB	2003	4	9-Apr	1.1	1	1	4.1	22.1
MB	2003	4	9-Apr	2	0	0	0.8	23.2
MB	2003	4	9-Apr	4	0	0	2.2	25
MB	2003	4	9-Apr	17	7	1	1.3	23.3
MB	2003	4	9-Apr	18	0	0	1	21.4
MB	2003	4	9-Apr	21	0	0	3.4	19.1
MB	2003	4	9-Apr	22	0	0	1.7	21.8
MB	2003	4	9-Apr	23	0	0	2	21.2
MB	2003	4	9-Apr	24	0	0	1.3	23.9
MB	2003	4	9-Apr	25	1	1	2.1	23
MB	2003	4	9-Apr	28	2	1	1	24.3
MB	2003	4	10-Apr	3	0	0	4.2	19.4
MB	2003	4	10-Apr	5	0	0	1.8	19.2
MB	2003	4	10-Apr	6	0	0	1.4	27.2
MB	2003	4	10-Apr	7	0	0	2	22.1
MB	2003	4	10-Apr	13	1	1	3.2	19.2
MB	2003	5	15-Apr	13	0	0	2.2	21.3
MB	2003	5	18-Apr	1.1	0	0	3.6	20.6

MB	2003	5	18-Apr	2	1	1	3	21.3
MB	2003	5	18-Apr	3	0	0	3.3	22.8
MB	2003	5	18-Apr	4	0	0	1.7	25
MB	2003	5	18-Apr	5	0	0	0.5	23.2
MB	2003	5	18-Apr	6	3	1	4.5	19.2
MB	2003	5	18-Apr	18	0	0	5	20.2
MB	2003	5	18-Apr	22	0	0	2.2	21
MB	2003	5	18-Apr	24	0	0	4.3	22.2
MB	2003	5	18-Apr	25	3	1	3.7	20.9
MB	2003	5	18-Apr	26	0	0	3.5	22
MB	2003	5	18-Apr	27	3	1	2	22
MB	2003	5	18-Apr	28	1	1	0.5	18.2
MB	2003	5	19-Apr	17	2	1	5	21.2
MB	2003	7	30-Apr	1.1	0	0	1.5	21.1
MB	2003	7	30-Apr	2	1	1	2.9	18.6
MB	2003	7	30-Apr	3	0	0	2.4	25
MB	2003	7	30-Apr	4	0	0	1.5	24.2
MB	2003	7	30-Apr	5	2	1	1.5	22.8
MB	2003	7	30-Apr	6	1	1	0.8	23.3
MB	2003	7	30-Apr	7	2	1	2.2	18.4
MB	2003	7	30-Apr	13	0	0	1.6	18.9
MB	2003	7	30-Apr	21	0	0	3.2	19
MB	2003	7	30-Apr	22	1	1	0.7	19.3
MB	2003	7	30-Apr	23	0	0	4.5	18.3
MB	2003	7	30-Apr	24	0	0	2.7	22.4
MB	2003	7	30-Apr	25	1	1	2.5	18.9
MB	2003	7	30-Apr	26	0	0	2.4	18
MB	2003	8	9-May	1.1	0	0	1.3	26.2
MB	2003	8	9-May	2	0	0	2.2	22.3
MB	2003	8	9-May	3	1	1	2.5	22.2
MB	2003	8	9-May	4	0	0	2.1	21.5
MB	2003	8	9-May	5	2	1	0.8	23.3
MB	2003	8	9-May	6	0	0	1.9	22.8
MB	2003	8	9-May	13	1	1	3	21.2
MB	2003	8	9-May	17	1	1	4.5	20.5
MB	2003	8	9-May	21	0	0	3.5	21.5
MB	2003	8	9-May	22	0	0	3.1	23.6

MB	2003	8	9-May	23	0	0	4.1	19.3
MB	2003	8	9-May	24	0	0	2.8	20.3
MB	2003	8	9-May	25	1	1	3	18.1
MB	2003	8	9-May	26	0	0	4.8	22.8
MB	2003	8	9-May	27	1	1	4.2	22.8
MB	2003	8	9-May	28	0	0	2.7	19.8
MB	2003	9	16-May	1.1	0	0	0.8	24.8
MB	2003	9	16-May	2	1	1	3.9	23.3
MB	2003	9	16-May	3	0	0	1.5	29.9
MB	2003	9	16-May	4	0	0	1.8	26.1
MB	2003	9	16-May	5	3	1	3	26.7
MB	2003	9	16-May	6	1	1	1.3	22.6
MB	2003	9	16-May	7	0	0	1.2	22.4
MB	2003	9	16-May	13	0	0	4.2	26.2
MB	2003	9	16-May	17	0	0	2.2	26.3
MB	2003	9	16-May	18	0	0	1.6	24.3
MB	2003	9	16-May	21	1	1	4.5	21.2
MB	2003	9	16-May	22	1	1	2.5	22.8
MB	2003	9	16-May	23	0	0	3.6	22
MB	2003	9	16-May	24	1	1	1.1	24.4
MB	2003	9	16-May	25	0	0	3.6	21.7
MB	2003	9	16-May	28	0	0	1.7	23.2
MB	2003	9	17-May	26	0	0	2.1	22.5
MB	2003	9	17-May	27	0	0	3	19
MB	2003	10	21-May	6	0	0	1.5	28
MB	2003	10	21-May	7	1	1	1.5	28
MB	2003	10	22-May	1.1	0	0	2.3	19.6
MB	2003	10	22-May	3	2	1	3.9	24.3
MB	2003	10	22-May	4	0	0	1.4	21.6
MB	2003	10	22-May	5	3	1	3	24
MB	2003	10	23-May	13	0	0	4.4	24.4
MB	2003	10	23-May	18	0	0	4.1	20.2
MB	2003	10	23-May	21	0	0	3.9	20
MB	2003	10	23-May	22	1	1	4.2	24.9
MB	2003	10	23-May	23	0	0	4.3	23
MB	2003	10	23-May	24	0	0	2.4	25.5
MB	2003	10	23-May	28	3	1	1.7	20.7

MB	2003	11	27-May	2	0		0	2.4		31.4	
MB	2003	11	27-May	26	0		0	4.5		26.9	
MB	2003	11	27-May	27	0		0	4.5		26.9	
MB	2003	11	28-May	17	0		0	1.7		21.8	
MB	2003	11	28-May	25	1		1	1.1		28.2	
MB	2003	12	3-Jun	2	0		0	1.4		30.2	
MB	2003	12	3-Jun	17	0		0	3.1		25.2	
MB	2003	12	3-Jun	18	0		0	3.6		27.4	
MB	2003	12	3-Jun	22	0		0	2.1		28.3	
MB	2003	12	3-Jun	23	0		0	2.4		27.3	
MB	2003	12	3-Jun	24	0		0	4.5		29.3	
MB	2003	12	3-Jun	25	3		1	2.6		27	
MB	2003	12	3-Jun	28	1		1	2		28.3	
MB	2004	1	7-Apr	1.1		1	1		1.5		25.9
MB	2004	1	7-Apr	2		2	1		1.5		25.9
MB	2004	1	7-Apr	3		0	0		0.7		21.5
MB	2004	1	7-Apr	4		0	0		3.7		22.3
MB	2004	1	7-Apr	5		0	0		2.7		19.6
MB	2004	1	7-Apr	22		1	1		2.4		25.7
MB	2004	1	7-Apr	23		0	0		2.1		25.7
MB	2004	1	7-Apr	25		6	1		3.3		25.5
MB	2004	1	8-Apr	13		0	0		4.6		23.5
MB	2004	1	8-Apr	17		9	1		1.5		25
MB	2004	1	8-Apr	21		0	0		3.8		18.1
MB	2004	1	8-Apr	24		0	0		1.7		20.5
MB	2004	1	8-Apr	26		1	1		2.9		18.5
MB	2004	2	15-Apr	17		5	1		5		19.7
MB	2004	2	15-Apr	20		1	1		3.6		21.6
MB	2004	2	15-Apr	26		4	1		2.5		19
MB	2004	2	15-Apr	27		5	1		2.1		19
MB	2004	3	22-Apr	2		1	1		2.7		20.5
MB	2004	3	22-Apr	21		1	1		1.4		22
MB	2004	3	22-Apr	24		0	0		3.1		23
MB	2004	3	22-Apr	26		1	1		5		24.9
MB	2004	3	22-Apr	27		1	1		5		25
MB	2004	3	23-Apr	4		2	1		1.2		26.4
MB	2004	3	23-Apr	5		2	1		0.3		22.7

MB	2004	3	23-Apr	6	6	1	1.8	19.6
MB	2004	3	23-Apr	7	1	1	1.5	22.7
MB	2004	3	23-Apr	13	0	0	2.4	26.5
MB	2004	3	23-Apr	18	3	1	3.3	27.1
MB	2004	3	23-Apr	22	0	0	3.6	32
MB	2004	3	23-Apr	28	1	1	3.3	29
MB	2004	4	30-Apr	5	3	1	0.7	19.6
MB	2004	4	30-Apr	28	1	1	4.1	22.2
MB	2004	5	5-May	13	0	0	3	25.7
MB	2004	5	5-May	26	0	0	4	20.8
MB	2004	5	5-May	27	0	0	4.4	19.9
MB	2004	6	11-May	2	1	1	4	20.5
MB	2004	6	11-May	4	0	0	1.7	24.8
MB	2004	6	11-May	26	0	0	4.1	24.2
MB	2004	6	11-May	27	0	0	2.7	22.5
MB	2004	6	12-May	5	2	1	1.7	30.3
MB	2004	6	12-May	6	3	1	1.8	28.4
MB	2004	6	12-May	7	3	1	2.4	25.6
MB	2004	6	12-May	13	0	0	2.9	25.1
MB	2004	6	12-May	21	2	1	3.9	23
MB	2004	6	12-May	22	0	0	3.1	25
MB	2004	6	12-May	28	2	1	1.8	23.4
MB	2004	6	13-May	22	0	0	4.2	22
MB	2004	6	13-May	25	0	0	3.3	22
MB	2004	7	19-May	1.1	3	1	3.4	21.3
MB	2004	7	19-May	2	0	0	4.7	19
MB	2004	7	19-May	4	0	0	1.5	22.3
MB	2004	7	19-May	5	2	1	2.8	24.4
MB	2004	7	19-May	6	1	1	2.9	23.2
MB	2004	7	19-May	22	0	0	3.4	18.4
MB	2004	7	19-May	24	1	1	3.1	20
MB	2004	7	19-May	26	0	0	2.9	22
MB	2004	7	19-May	27	0	0	3.3	21.4
MB	2004	7	19-May	28	2	1	2.1	20.2
MB	2004	9	2-Jun	1.1	0	0	3.3	22.8
MB	2004	9	2-Jun	4	0	0	0.9	26.5
MB	2004	9	2-Jun	5	0	0	2.7	22.5

MB	2004	9	2-Jun	23	0	0	3.7	21.6
MB	2004	9	2-Jun	24	1	1	2.5	21.4
MB	2004	9	2-Jun	27	0	0	4.5	20.8
MB	2004	9	2-Jun	28	0	0	2.5	21.6
MB	2004	9	3-Jun	3	0	0	2.8	23.3
MB	2004	9	4-Jun	7	0	0	4.8	21.1

Appendix B: 2004 Callippe Silverspot Fixed Transect Surveys Analysis:

We used a two factor ANOVA with Scheffe post-hoc tests to test whether there was a significant difference between years and transects for the number of Callippe Silverspot butterflies (CS) that we observed per hour.

Difference between years.

We found that there was a significant difference between years ($F= 7.71$, $p <0.0001$; Fig. 1). Scheffe post-hoc tests show that this difference was primarily due to the relative abundance of CS in 2001. Data from the year 2001 were significantly different from 2000, 2003 and 2004 ($p <0.05$) and nearly significantly different from 2002 ($p<0.1$). None of the other year by year comparisons were significantly different. If the year 2001 is removed from the analysis, there is no significant difference between years. There is not enough data to do trend analyses by correlation or regression statistics.

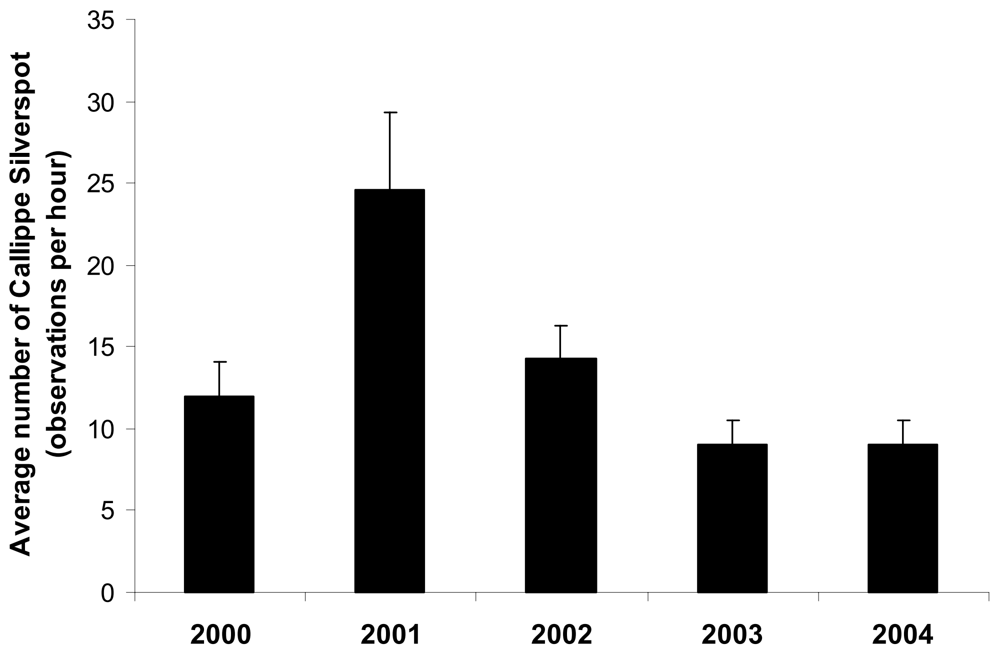


Figure 1. The difference between years for the average number of callippe silverspot butterflies observed per hour across all transects. Error bars represent the standard error of the mean.

Difference between transects.

There was a significant difference between transects for the average number of CS observed per hour ($F=5.44$, $p<0.0001$; Fig. 2). There was also a significant interaction between year and transect ($F=1.58$, $p=0.019$; Fig. 3). This suggests that the relative ranking of transects changed from year to year. The significant interaction also suggests that what was a good year on one transect does not necessarily mean that it was a good year on another transect that same year.

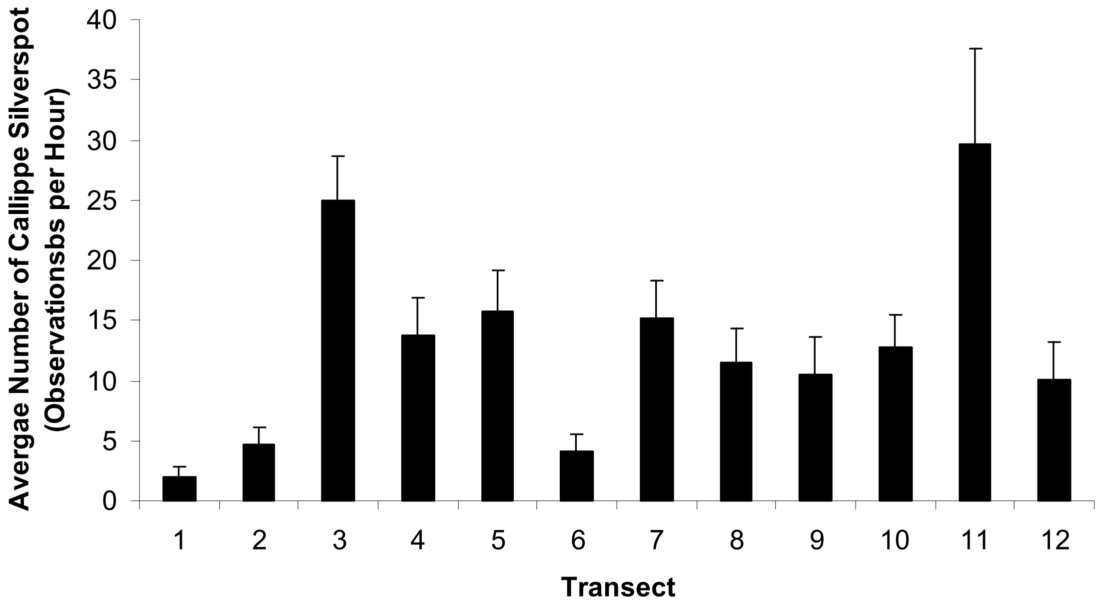


Figure 2. The difference between transects for the average number of callippe silverspot butterflies observed per hour. These are averages for the period 2000 to 2004. Error bars are the standard error of the mean.

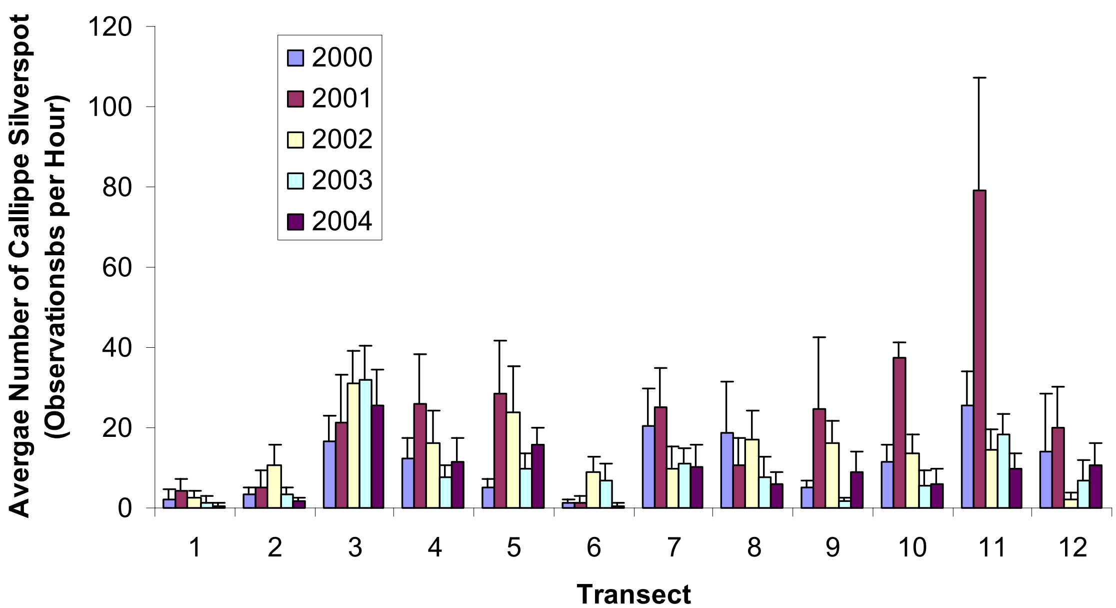


Figure 3. The difference between transects for the average number of callippe silverspot butterflies observed per hour. The average of each transect for every year is show. Error bars are the standard error of the mean.

SUMMARY

The analyses show that both year and transect are significant predictors for the number of CS observed (2-factor ANOVA). Year was the strongest predictor of CS abundance (F-Statistic = 7.71, $p<0.0001$). Transect was also a significant factor (F-Statistic = 5.95, $p<0.0001$). However the interaction between year and transect was also significant (F-Statistic = 1.58, $p<0.0194$), and the significant interaction term is more important than looking at year and transect individually. The significant interaction term means that it is the combination of year and transect that predicts CS abundance on any given transect in any given year. Not just year alone and not just transect alone. For example transect 3 was the greatest in 2004, but in no other years did transect 3 rank the highest. Therefore, transect by itself cannot predict CS abundance, and likewise, a good year on one transect is not necessarily a good year on other transects (comparatively).

It's interesting to note that both 2003 and 2004 year had more predictive power than transect number (although the interaction was significant in both years). CS are far-flyers and interact with more of the available habitat on San Bruno Mountain in any given year than MB do. Therefore, small-scale perturbations of CS habitat on San Bruno Mountain may not affect CS as much as year to year climate forced variation at a whole mountain scale. These results suggest that metrics for assessing whole mountain CS used vegetation is important for gaining a better understanding of what aspects of CS habitat (vegetation type, density, health, or phenology) directly affect CS abundance.

This result makes sense in comparison with the Mission blue data. MB are more localized and therefore we would predict that transect condition is important, whereas for CS, a far-flyer that can travel between transects, year is the most important factor for predicting abundance.

DESIGN

Dependent variables

Name	Code
CS/Hour	C/H

Type of analysis: OLS ANOVA

Factors

Name	Code	Nested in	F/R	Kind
Transect	Trt	()	Fix	Disc
Year	Yr	()	Fix	Disc

Partial (Type 3) Sums of Squares

Interactions up to 2 - way

Source	F/R	max df	EMS	F-Denom
Const	-	1	Const	Error
Trt	F	11	Trt	Error
Yr	F	4	Yr	Error
Trt*Yr	F	44	Trt*Yr	Error
Error	R	275		
Total		334		

No Modifications

RESULTS

General Results

335 total cases of which 92 are missing

ANOVA

Analysis of Variance For **CS/Hour**
No Selector
335 total cases of which 92 are missing

Source	df	Sums of Squares	Mean Square	F-ratio	Prob
Const	1	42322.9	42322.9	202.88	≤ 0.0001
Trt	11	13644.2	1240.38	5.9459	≤ 0.0001
Yr	4	6433.23	1608.31	7.7096	≤ 0.0001
Trt*Yr	44	14530.2	330.231	1.583	0.0194
Error	183	38175.8	208.611		
Total	242	74203.7			

Results for factor Yr

Coefficients

Expected Cell Means

Scheffe Post Hoc Tests

	Difference	std. err.	Prob
2001 - 2000	12.321	3.248	0.00753866
2002 - 2000	2.56512	3.211	0.95845
2002 - 2001	-9.75583	3.146	0.0513921
2003 - 2000	-1.95138	3.006	0.980522
2003 - 2001	-14.2723	2.937	171.691e-6
2003 - 2002	-4.51651	2.895	0.657057
2004 - 2000	-2.34786	3.069	0.964425
2004 - 2001	-14.6688	3.001	153.77e-6
2004 - 2002	-4.91299	2.96	0.600782
2004 - 2003	-0.396476	2.736	0.999945

CS DATA

Year	Week	Date	Transect	#CS	minutes	CS/Hour	A.wind	temp
2000	1	6/1	7	14	58	14.48	7.5	29.3
2000	1	6/1	8	16	22	43.64	0.6	30.6
2000	1	6/1	9	3	32	5.63	17.3	24.8
2000	1	6/1	10	23	60	23.00	1.6	24.9
2000	1	6/1	11	37	63	35.24	0.6	30.6
2000	1	6/2	2	3	49	3.67	2.8	22.4
2000	1	6/2	3	16	32	30.00	3.6	17.8
2000	2	6/9	3	24	42	34.29	6.7	22
2000	2	6/9	4	15	44	20.45	15.4	19.7
2000	2	6/9	5	4	39	6.15	14.1	19.9
2000	2	6/9	6	2	36	3.33	3.1	18.7
2000	3	6/14	2	4	40	6.00	0.3	30
2000	3	6/14	7	15	51	17.65	3.2	36.6
2000	3	6/14	9	2	29	4.14	windy	hot
2000	3	6/14	10	10	50	12.00	1.6	33.2
2000	3	6/14	11	16	25	38.40	3.2	36.6
2000	3	6/14	12	17	36	28.33	1.6	33.2
2000	3	6/15	1	2	26	4.62	breezy	hot
2000	3	6/15	3	3	24	7.50	breezy	warm
2000	3	6/16	4	7	32	13.13	4.1	27
2000	3	6/16	5	6	35	10.29	3.8	26.3
2000	3	6/16	6	0	17	0.00	4	29
2000	3	6/16	8	4	20	12.00	2.1	27
2000	5	6/28	7	33	42	47.14	0.8	26.4
2000	5	6/28	9	9	56	9.64	3.5	19.3
2000	5	6/28	10	5	38	7.89	7.8	27.7
2000	5	6/28	11	13	28	27.86	0.8	26.4
2000	5	6/29	3	4	29	8.28	4.8	18.1
2000	5	6/29	5	2	27	4.44	4	24.6
2000	7	7/10	1	0	28	0.00	5.3	31.5
2000	7	7/10	2	0	31	0.00	2.4	21.5
2000	7	7/10	6	0	23	0.00	3.9	20.8
2000	7	7/10	8	0	12	0.00	7.6	25.6
2000	7	7/10	10	2	37	3.24	4.5	20.9
2000	7	7/10	11	0	20	0.00	14.9	28.4
2000	7	7/10	12	0	31	0.00	4.7	25.4
2000	7	7/12	3	1	26	2.31	3.6	19.5
2000	7	7/12	4	2	38	3.16	7.2	24.1
2000	7	7/13	5	0	28	0.00	4.2	25.5
2000	7	7/14	7	1	27	2.22	3.8	25.8
2000	7	7/14	9	1	49	1.22	1.7	22.3
2001	1	5/21	3	6	34	10.59	5	17.1
2001	1	5/21	4	5	51	5.88	8.25	29.8
2001	1	5/21	5	2	51	2.35	9.3	25
2001	1	5/21	6	0	23	0.00	4.6	16.2

2001	1	5/22	7	22	46	28.70	8.2	19.3
2001	1	5/22	9	13	58	13.45	5.9	22.3
2001	1	5/22	10	23	39	35.38	2.3	28.2
2001	1	5/22	11	100	50	120.00	1.8	30.8
2001	1	5/22	12	36	65	33.23	1.6	27.6
2001	1	5/23	1	0	24	0.00	7.7	25.5
2001	1	5/23	8	7	52	8.08	2.6	27.5
2001	2	5/30	1	0	25	0.00	4	30
2001	2	5/30	2	1	42	1.43	2	33.6
2001	2	5/30	3	19	21	54.29	3.1 ?	
2001	2	5/30	4	5	39	7.69	5.4	36.2
2001	2	5/30	6	3	43	4.19	1.7 warm	
2001	2	5/31	5	25	28	53.57	1.5	31.5
2001	3	6/5	7	3	32	5.63	8.1	17.9
2001	3	6/5	9	54	54	60.00	2.8	21.5
2001	3	6/5	10	19	35	32.57	7.5	24.2
2001	3	6/5	11	41	46	53.48	12.5	29
2001	3	6/5	12	43	95	27.16	4.1	25.9
2001	3	6/7	1	7	34	12.35	1.7	28.9
2001	3	6/7	2	9	40	13.50	2.6	34.8
2001	3	6/7	8	11	28	23.57	3.6	33.4
2001	4	6/13	3	11	32	20.63	7.8	22
2001	4	6/13	4	21	39	32.31	12.2	32.4
2001	4	6/13	5	5	30	10.00	12.4	27.4
2001	4	6/14	7	53	62	51.29	2	23.8
2001	4	6/14	11	83	38	131.05	2.2	26.7
2001	7	7/3	1	1	14	4.29	6.5	35.3
2001	7	7/3	2	0	24	0.00	7.2	35.5
2001	7	7/3	3	0	15	0.00	2.4	34.9
2001	7	7/3	6	0	25	0.00	4.2	33.8
2001	7	7/3	7	11	45	14.67	2	37.6
2001	7	7/3	8	0	12	0.00	0.7	31.8
2001	7	7/3	9	0	27	0.00	4.5	29.5
2001	7	7/3	10	3	4	45.00	0.8	26
2001	7	7/3	11	5	26	11.54	3.9	34.9
2001	7	7/3	12	0	29	0.00	1.3	33.7
2001	7	7/4	4	40	41	58.54	4.1	25.1
2001	7	7/4	5	26	32	48.75	4.8	29.1
2002	1	5/17	3	4	28	8.57		
2002	1	5/17	4	3	33	5.45		
2002	1	5/17	5	12	35	20.57		
2002	1	5/17	6	4	32	7.50		
2002	2	5/22	1	0	20	0.00		
2002	2	5/22	9	1	50	1.20		
2002	2	5/22	10	6	45	8.00		
2002	2	5/22	12	0	29	0.00		
2002	2	5/23	8	1	13	4.62		

2002	3	5/29	1	0	23	0.00		
2002	3	5/29	2	11	34	19.41		
2002	3	5/29	3	21	26	48.46		
2002	3	5/29	4	20	31	38.71		
2002	3	5/29	5	32	34	56.47		
2002	3	5/29	6	4	20	12.00		
2002	3	5/29	7	1	30	2.00		
2002	3	5/29	8	6	12	30.00		
2002	3	5/29	9	9	35	15.43		
2002	3	5/29	10	11	39	16.92		
2002	3	5/29	11	2	29	4.14		
2002	3	5/29	12	5	50	6.00		
2002	4	6/7	8	7	15	28.00		
2002	4	6/7	11	8	24	20.00		
2002	4	6/10	1	3	25	7.20		
2002	4	6/10	7	5	43	6.98		
2002	4	6/10	9	16	42	22.86		
2002	4	6/10	10	15	35	25.71		
2002	4	6/10	12	0	36	0.00		
2002	4	6/11	2	6	36	10.00		
2002	4	6/11	3	14	25	33.60		
2002	4	6/11	4	8	27	17.78		
2002	4	6/11	5	10	36	16.67		
2002	4	6/11	6	7	25	16.80		
2002	7	7/1	3	14	25	33.60		
2002	7	7/1	4	1	26	2.31		
2002	7	7/1	5	1	30	2.00		
2002	7	7/2	8	2	19	6.32		
2002	7	7/2	9	13	31	25.16		
2002	7	7/2	10	3	45	4.00		
2002	8	7/9	1	1	23	2.61		
2002	8	7/9	2	1	22	2.73		
2002	8	7/9	6	0	10	0.00		
2002	8	7/9	7	15	44	20.45		
2002	8	7/9	11	6	19	18.95		
2003	1	5/12	1	0	14	0.00	5.2	28.3
2003	1	5/12	3	6	23	15.65	2.5	22.3
2003	1	5/12	4	0	24	0.00	3.8	23.3
2003	1	5/12	7	3	42	4.29	1.5	27
2003	1	5/12	9	1	33	1.82	0.9	23.1
2003	1	5/12	10	0	20	0.00	1.5	25.2
2003	1	5/12	11	8	30	16.00	1.9	24
2003	1	5/12	12	0	34	0.00	2	23.5
2003	1	5/13	5	8	49	9.80	5.8	23.6
2003	1	5/13	8	0	10	0.00	4.6	24.8
2003	2	5/20	1	0	36	0.00	1	27
2003	2	5/20	3	31	37	50.27	1.8	27.5

2003	2	5/20	6	4	22	10.91	0.9	28
2003	2	5/20	7	10	49	12.24	2.6	29.2
2003	2	5/20	9	0	37	0.00	2.6	30
2003	2	5/20	10	0	29	0.00	2	29
2003	2	5/21	2	5	53	5.66	3.1	24.2
2003	2	5/21	4	1	41	1.46	4.4	22.6
2003	2	5/21	5	14	41	20.49	5.2	28
2003	2	5/21	8	0	14	0.00	1.5	28
2003	2	5/21	11	11	36	18.33	1.1	26
2003	2	5/21	12	0	39	0.00	2	23
2003	3	5/27	4	4	23	10.43	7.8	29.2
2003	3	5/28	5	9	50	10.80	2.9	30.3
2003	4	6/2	1	0	18	0.00	5.7	29
2003	4	6/2	6	10	36	16.67	1.2	30.9
2003	4	6/2	7	17	49	20.82	2.3	33
2003	4	6/2	8	3	14	12.86	1.5	28.3
2003	4	6/2	10	9	31	17.42	0.4	31.9
2003	4	6/2	11	16	28	34.29	0.4	31.9
2003	4	6/2	12	16	35	27.43	3.3	27.2
2003	4	6/3	2	6	50	7.20	2.9	23.8
2003	4	6/3	3	14	41	20.49	2.3	28.7
2003	4	6/3	4	8	24	20.00	2.3	28.9
2003	4	6/3	5	10	25	24.00	3.2	27.2
2003	5	6/9	1	4	28	8.57	3.2	25.6
2003	6	6/16	4	3	35	5.14	6.3	26.5
2003	6	6/16	5	0	32	0.00	6.9	28.8
2003	7	6/23	2	0	35	0.00	7.7	29
2003	7	6/23	8	5	12	25.00	8.1	29.7
2003	7	6/24	1	0	18	0.00	8.8	24.9
2003	7	6/24	3	21	30	42.00	1.9	26.4
2003	7	6/24	4	10	36	16.67	2.2	27
2003	7	6/24	5	2	25	4.80	2.3	26.5
2003	7	6/24	6	0	31	0.00	1.2	29.6
2003	7	6/24	7	11	38	17.37	3.6	28.1
2003	7	6/24	9	3	38	4.74	4.3	31
2003	7	6/24	10	6	32	11.25	2.1	31.7
2003	7	6/24	11	11	31	21.29	3.4	31.2
2003	7	6/24	12	3	40	4.50	4.3	30.6
2003	9	7/8	1	0	15	0.00	6	warm
2003	9	7/8	2	0	38	0.00	5.25	23.6
2003	9	7/9	4	0	23	0.00	4.8	20.3
2003	9	7/9	5	0	15	0.00	3.7	24
2003	9	7/9	6	0	25	0.00	1.6	26.6
2003	9	7/9	7	0	29	0.00	11.1	27.6
2003	9	7/9	8	0	19	0.00	1.5	30.7
2003	9	7/9	9	0	38	0.00	4	29.8
2003	9	7/9	10	0	20	0.00	6.9	32.7

2003	9	7/9	11	1	30	2.00	3 very warm
2003	9	7/9	12	1	33	1.82	1 very warm
2004	1	4/27	6	0	16	0.00	4	24
2004	1	4/28	7	1	41	1.46	7.6	21.3
2004	1	4/28	10	0	29	0.00	5.4	21.5
2004	1	4/28	9	1	108	0.56	8.5	27.2
2004	1	4/28	12	2	46	2.61	5.8	21.2
2004	1	4/28	11	6	39	9.23	5.1	20.7
2004	1	4/29	4	0	37	0.00	5.2	27
2004	1	4/29	5	7	33	12.73	5.7	25.4
2004	1	4/29	3	15	23	39.13	6	26.2
2004	1	4/29	8	1	13	4.62	6.3	26.7
2004	1	4/29	1	1	21	2.86	5	23.5
2004	2	5/4	3	7	28	15.00	10.6	27.3
2004	2	5/4	10	0	42	0.00	4.8	21.1
2004	2	5/4	9	0	43	0.00	11.1	18.4
2004	2	5/6	2	1	28	2.14	2.3	24.7
2004	2	5/6	4	4	30	8.00	6.1	22.8
2004	2	5/6	6	1	27	2.22	1.7	24.6
2004	2	5/7	7	1	39	1.54	5.1	20.8
2004	2	5/7	9	4	59	4.07	3.7	23.3
2004	2	5/7	8	1	16	3.75	6.4	28.5
2004	2	5/7	10	1	37	1.62	7.8	23.2
2004	2	5/7	5	8	30	16.00	5.8	24.6
2004	2	5/7	12	15	43	20.93	2.3	27
2004	2	5/7	11	6	19	18.95	5.1	25.6
2004	2	5/7	1	0	18	0.00	2.9	20.4
2004	3	5/14	2	1	20	3.00	16.6	20.2
2004	3	5/14	4	15	46	19.57	4.1	25.1
2004	3	5/14	5	19	36	31.67	7	22.1
2004	3	5/14	3	19	27	42.22	7.7	22.1
2004	3	5/14	6	0	20	0.00	1.7	27
2004	3	5/14	9	6	34	10.59	4.3	19.5
2004	3	5/14	7	11	37	17.84	5.5	22
2004	3	5/14	10	4	31	7.74	2.4	27.4
2004	3	5/14	8	3	12	15.00	3.5	27.4
2004	3	5/18	1	0	17	0.00	10.5	19.8
2004	3	5/18	12	14	43	19.53	9	20
2004	3	5/18	11	5	27	11.11	11.2	18.1
2004	4	5/26	1	0	37	0.00	9.9	22.2
2004	4	5/26	10	15	37	24.32	5	23
2004	4	5/26	7	31	66	28.18	2.9	24.2
2004	4	5/26	9	14	25	33.60	5	23
2004	4	5/27	4	13	26	30.00	3.8	25
2004	4	5/27	5	3	18	10.00	11.4	25
2004	5	6/4	6	0	15	0.00	2.4	36.7
2004	6	6/11	4	0	28	0.00	6.1	24.7

2004	6	6/11	5	4	30	8.00	6.5	21.1
2004	6	6/11	3	4	37	6.49	8.3	20.4
2004	6	6/15	10	2	37	3.24	5.5	29.3
2004	6	6/15	11	0	40	0.00	8.5	28
2004	6	6/15	12	0	31	0.00	4	28
2004	6	6/15	8	0	10	0.00	2	33
2004	6	6/15	9	3	37	4.86	4	29.8
2004	6	6/15	7	1	25	2.40	2.7	32.2
2004	6	6/15	1	0	15	0.00	1	33.9
2004	6	6/15	2	0	23	0.00	1.5	37.1

Analysis of Butterfly Survey Data and Methodology from San Bruno Mountain Habitat Conservation Plan (1982–2000)

1. Status and Trends

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Lupines at San Bruno Mountain, March 2003 (T. Longcore)

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Summary

Managers surveyed for sensitive butterfly species with the San Bruno Mountain Habitat Conservation Plan area between 1982 and 2000 using a haphazard "wandering transect." To extract as much valuable information as possible from the data collected by this suboptimal methodology we analyzed patterns of surveys and butterfly presence and absence within 250 m square cells gridded across the area within a Geographic Information System. While estimates of butterfly abundance were not possible, the data could be tested for trends in butterfly occupancy. For those cells surveyed during at least 10 years, no trends in the total number of occupied cells was evident for either Callippe silverspot butterfly or mission blue butterfly. There were cells, however, that showed positive or negative trends ($p<0.2$) in occupancy for each species (Callippe silverspot butterfly: 14 positive, 15 negative, 6 cells occupied all years; mission blue butterfly: 40 positive; 40 negative, 2 cells occupied all years). The analysis concludes that for the period 1982–2000 the population of each species was stable in overall total distribution, but indicates geographic areas of concern for each, specifically the edges of the northeast ridge for Callippe silverspot butterfly and the northwest of the study area for mission blue butterfly.

Introduction

The Habitat Conservation Plan at San Bruno Mountain was the first of its kind, opening a pathway for this new type of conservation mechanism (Beatley 1994). As part of the management of the reserve established at San Bruno Mountain, yearly surveys were conducted to count listed butterfly species, and butterfly species of regulatory concern (Thomas Reid Associates 2000). These surveys were initiated in the early 1980s and continue today. Recently, the surveys have been digitized and complied in a Geographic Information System, which facilitates in-depth analysis of the status and trends of populations of these sensitive species. This report presents the results of an analysis of these data and an assessment of the survey methodology.

The surveys at San Bruno Mountain record incidence of two species, mission blue butterfly (*Icaricia icarioides missionensis*) and Callippe silverspot butterfly (*Speyeria callippe callippe*). A third species, San Bruno elfin (*Incisalia mossii bayensis*), was surveyed but is not addressed here. The surveys, called "Wandering Surveys" by Thomas Reid Associates ("TRA"), followed no fixed route and were conducted throughout the flight seasons of both species from 1982–2000. Such a methodology presents immediate difficulties for drawing statistical inference or even detecting qualitative trends. The goal of our analysis is to extract the maximum amount of information from the dataset, while acknowledging the flaws inherent in the methodology.

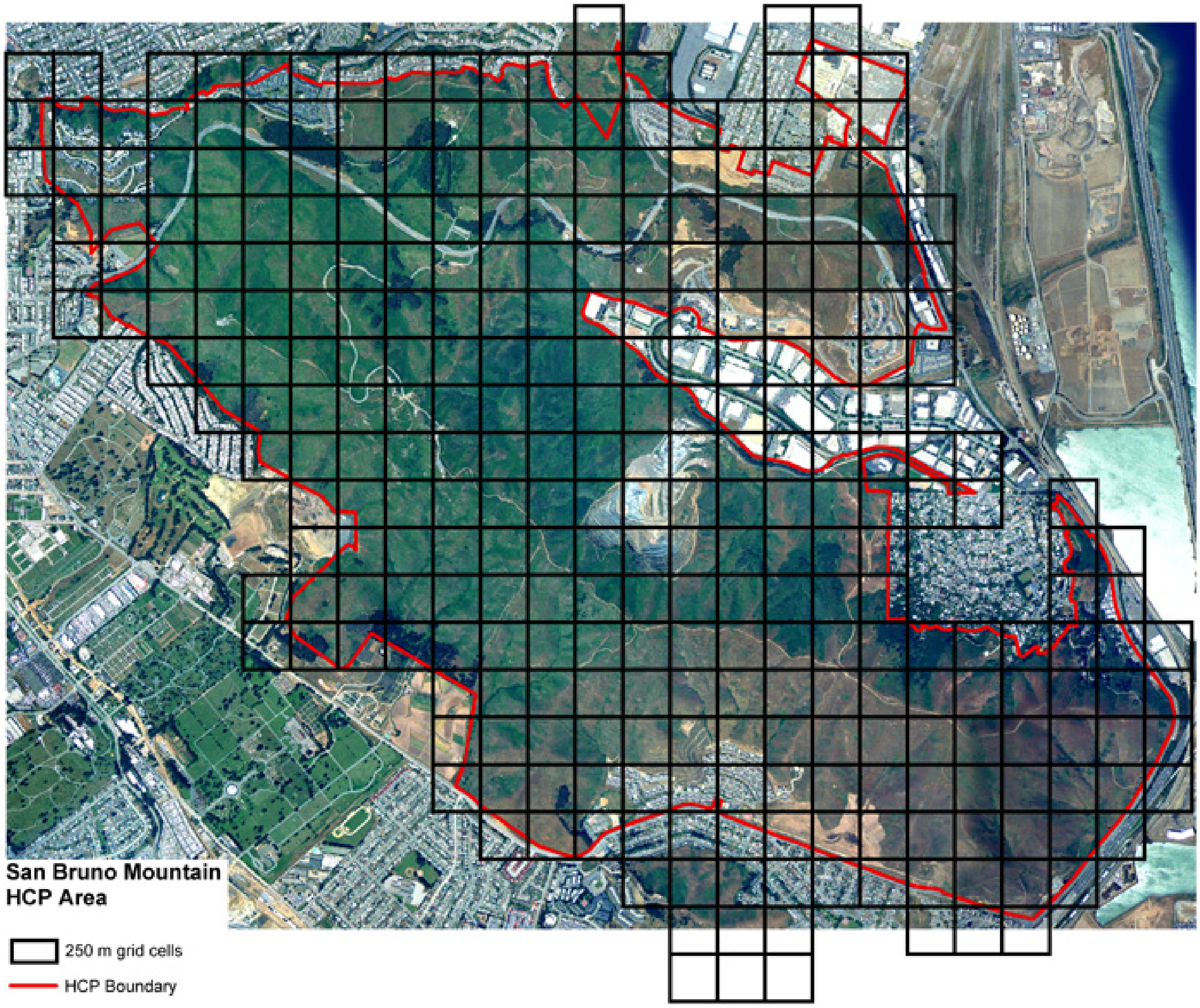


Figure 1. Aerial photograph of San Bruno Mountain HCP area with 250 m grid.

Research Questions

Several challenges are posed by the analysis of the San Bruno Mountain butterfly data. Some can be solved, some are likely intractable. The first problem posed by the dataset is that surveys were not completed in the same geographic locations each year. Most butterfly monitoring schemes involved repeated, fixed transects (Pollard et al. 1975, Pollard and Yates 1993). In this manner, the number of individuals each year can be compared with some degree of confidence. The second problem is that the data provide no obvious way to estimate what proportion of butterflies is being observed each year. The detection probability is a central part of monitoring schemes; for butterflies it can be calculated either from mark-recapture data (Gall 1985) or distance sampling (Buckland et al. 1993). In this *post hoc* analysis, neither option is available. Detection probability is affected by the use of different survey locations each year that may have different habitat features that increase or decrease detection. Because of these two difficulties with estimating butterfly abundance, we chose rather to investigate trends in the distribution of the species.

Knowledge of trends in the geographic distribution of the butterflies on San Bruno Mountain is in some ways superior to knowledge of trends in abundance. Butterflies are notoriously variable in abundance from year to year and wide fluctuations may obscure secular trends (Pollard 1988). Occupancy (or at least observation) and abundance are related: butterflies will be detected in more locations in years when butterflies are abundant if only because the chances of encountering a butterfly are increased. Aside from this statistical result of greater population size, some patches may indeed be colonized during years with many adult butterflies. In either instance, if butterflies are observed in more areas it is a good sign for the species. Indeed, mathematical models of metapopulation persistence often record only the number and occupancy rate of habitat patches, not the number of butterflies at each patch (Hanski 1999).

The research questions therefore involve the distribution patterns of mission blue butterfly and Callippe silverspot butterfly 1982-2000.

- Has each species exhibited secular trends in total area occupied?
- What areas have exhibited secular trends in occupancy?
- What areas have exhibited large and small variability in occupancy?

A second set of research questions address the survey methodology.

- What areas exhibited secular trends in survey coverage?
- What areas were surveyed frequently and infrequently?
- What was the relationship between survey frequency and occupancy?

Methodology

Thomas Reid Associates conducted butterfly surveys in the San Bruno Mountain HCP area (Figure 1) every year since 1982. The surveys were characterized as “wandering” transects, in which the observer did not follow any set route but rather conducted surveys across the mountain and recorded his survey route and location of any butterflies observed. Timing of surveys and weather conditions were also recorded. Surveys were conducted through the adult flight season of both butterfly species. Results from these surveys were digitized by TRA and are managed in a Geographic Information System.

We overlaid a 250 m square grid over the HCP area (Figure 2). The grid size provides a sufficient number of cells to identify differences across the study area but not so many that analysis is intractable. Furthermore, each cell is sufficiently large to incorporate the elements necessary for butterfly reproduction, including foodplants, nectar sources, and potentially ridgelines for hilltopping.

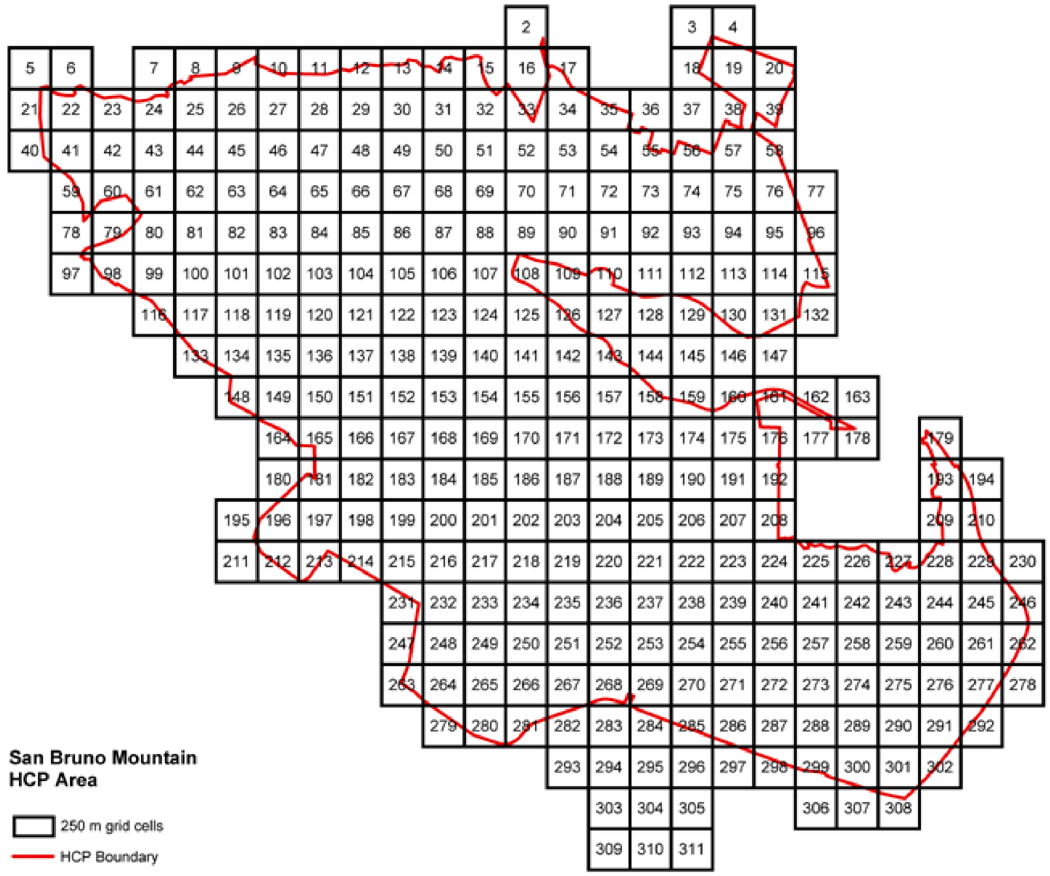


Figure 2. Numbered grid for analysis of butterfly survey data, San Bruno Mountain HCP.

For each 250 m square cell and for each year for each species, the number of visits, total length of surveys, and presence of the butterfly was recorded. For this analysis, we considered that a cell was "surveyed" if a total of 250 m of surveys were conducted within the cell during a particular year. This constitutes a substantial assumption, because detection of butterflies depends on the number, length, and timing of surveys (Zonneveld et al. 2003). The risk of choosing 250 m as a cut-off is that some cells where the butterfly was actually present will be recorded as absences because 1) too few surveys were conducted to detect a small population, 2) surveys were timed improperly to detect adults, or 3) the butterfly was too cryptic to detect because of behavioral or weather conditions. While such false negatives are possible, false positives are not, except for the instance of the misidentification of an adult butterfly. This results, therefore, in a conservative analysis – the situation will not be worse than described based on this assumption, and it may be slightly better. Summary statistics such as the number of years each cell was surveyed, the proportion of years butterflies were observed were also recorded.

For each cell and each butterfly, we completed a logistic regression of occupancy with year as the independent variable. Trends with $p < 0.20$ were recorded. This relatively low confidence threshold serves to provide a conservative analysis that can identify potential areas of change in the distribution of each species. If a requirement to meet a higher significance level is required, then greater confidence can be achieved but the opportunity for remediation would be delayed.

Data collected with each butterfly observation could also be incorporated into the analysis to investigate geographic patterns. These variables include date observed, time, wind speed, temperature, observer, butterfly sex, and butterfly behavior. For example, because of the hilltopping behavior of Callippe silverspot butterflies, one would expect that males are more frequently observed on ridgetops (Shields 1967, Thomas Reid Associates 1982). We analyzed the use of ridgelines by both species to test this hypothesis. Ridgelines were identified by querying the DEM to assign a rank to each cell relative to all other cells within a 30 m radius, using the ElevResidGrid algorthim (written by John Gallant, CSIRO Land and Water). The ranking ranges from 0 (lowest cell within 30 m) to 1 (highest grid cell). The DEM was clipped at the HCP boundary to avoid interference from the urban topography surrounding it. Ridgelines were identified as those cells with a ranking of 0.66 and higher. A higher value (e.g., 0.75) would present few sparse grid cells across the study area to identify contiguous ridgelines. A lower value (e.g., 0.60) would classify an excessive number of cells as ridgelines, including cells that were predominantly hillslopes. We then mapped a 25 m buffer around ridgeline cells and recorded the number of butterflies of each sex found within the buffer area.

Results

During the 19 years of surveys, 295 of 310 cells were surveyed at least one time. Some cells were surveyed significantly less frequently over time. The number of cells surveyed that did not support either endangered butterfly decreased significantly over time, as did the total length of survey routes per year. This change in survey distribution indicates that surveyors directed efforts in locations where butterflies had been found before, and avoided areas that had yielded negative results for a number of years. While some cells were surveyed for many years (>15) with no butterflies of either species found, they were located along routes to sites that support the target species.

Survey distribution for mission blue butterfly (Figure 3) and Callippe silverspot butterfly (Figure 4) both show a concentration in the northeast ridge and along other ridgetops where access is less difficult. The western side of the HCP area has been surveyed somewhat less than the eastern regions, reflecting, among other things, the climatic preferences of the butterflies (Weiss and Murphy 1990). The distribution of surveys included both ridgelines and hillslopes across the HCP study area (Figures 5, 6).

The tendency over time was for the surveyors to stop searching for the butterflies in areas that had been surveyed with negative results several times. Consequently, the number of "empty" cells surveyed decreases significantly during the study period, as seen for Callippe silverspot butterfly (Figure 7). This was accompanied a significant overall decrease in the total length of surveys each year (Figure 8).

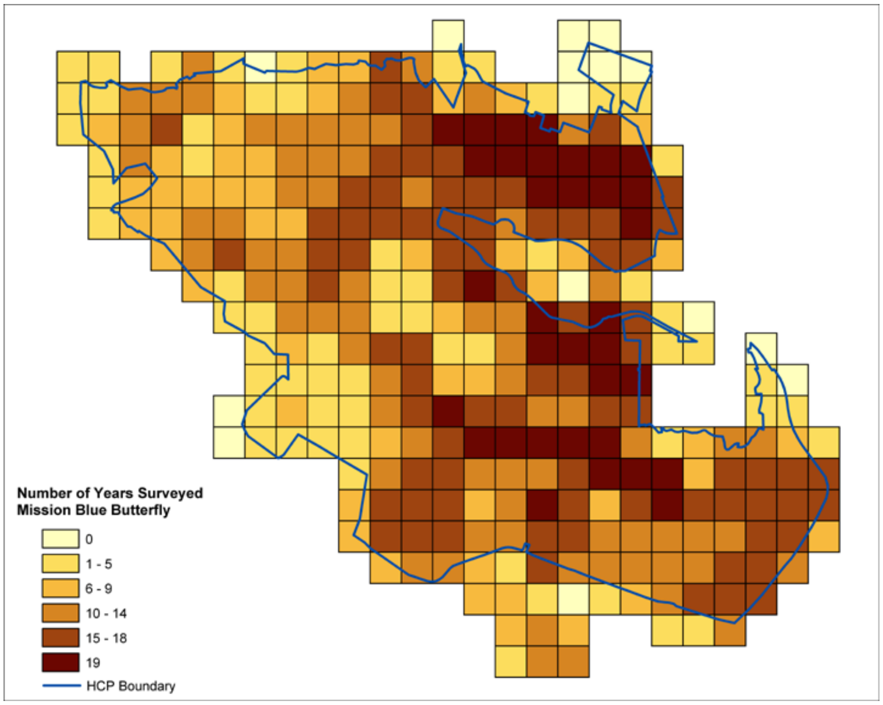


Figure 3. Distribution and frequency of surveys for mission blue butterfly at San Bruno Mountain, 1982–2000.

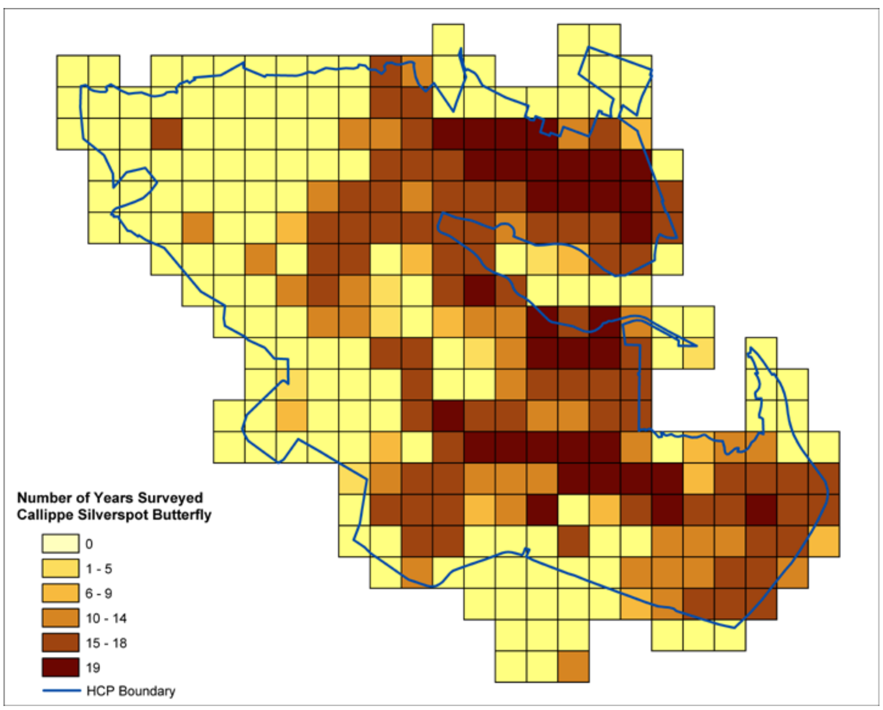


Figure 4. Distribution and frequency of surveys for Callippe silverspot butterfly at San Bruno Mountain, 1982–2000.

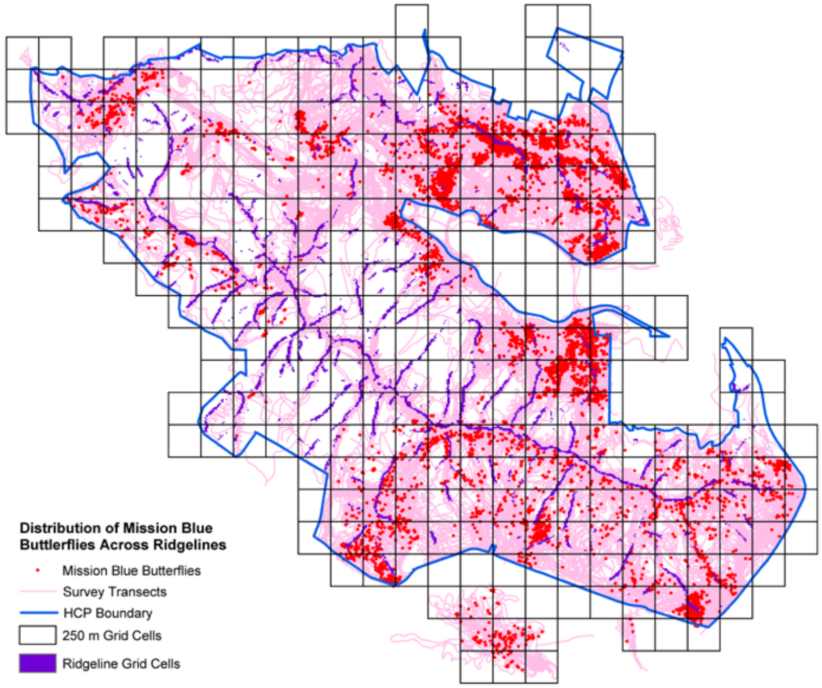


Figure 5. Distribution of surveys and observations of mission blue butterfly relative to ridgelines, 1982–2000.

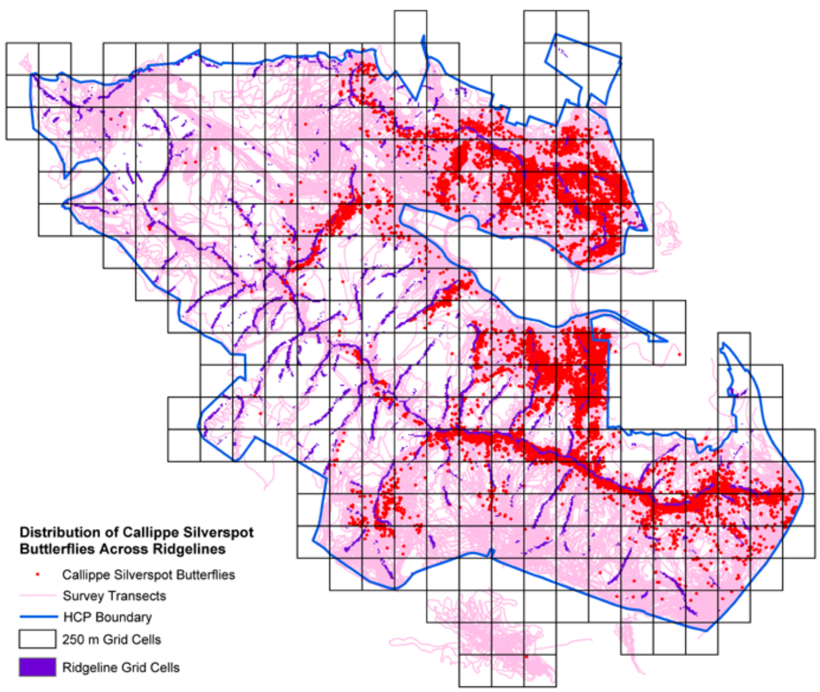
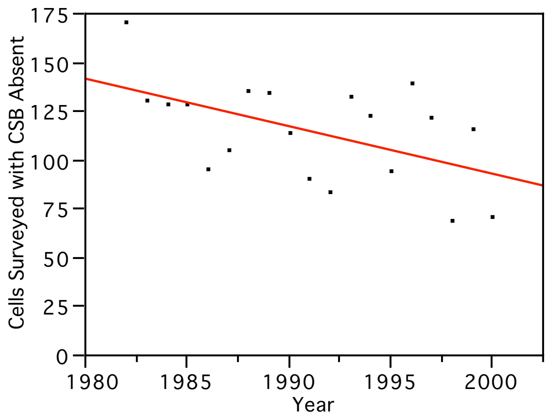


Figure 6. Distribution of surveys and observations of Callippe silverspot butterfly relative to ridgelines, 1982–2000.



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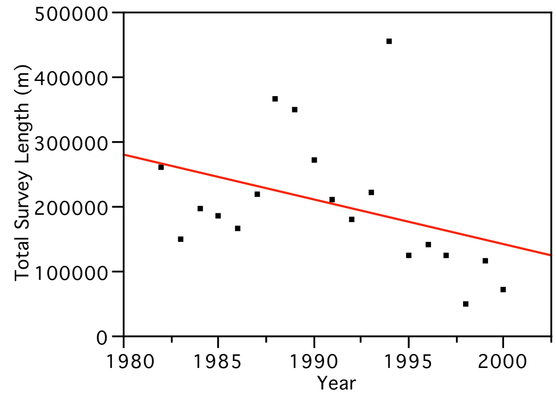

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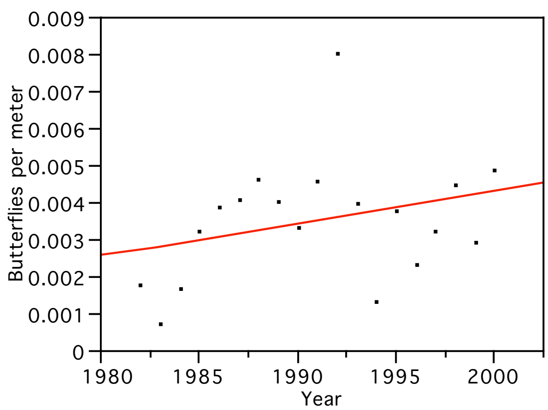

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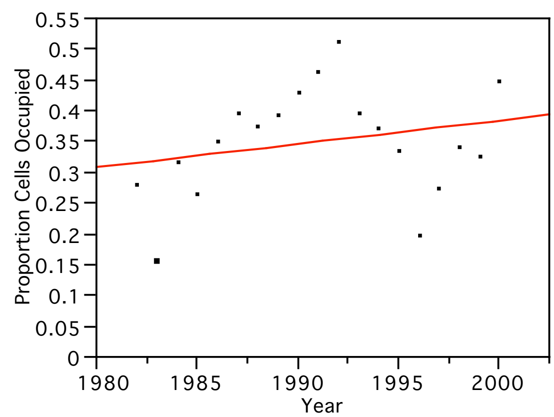

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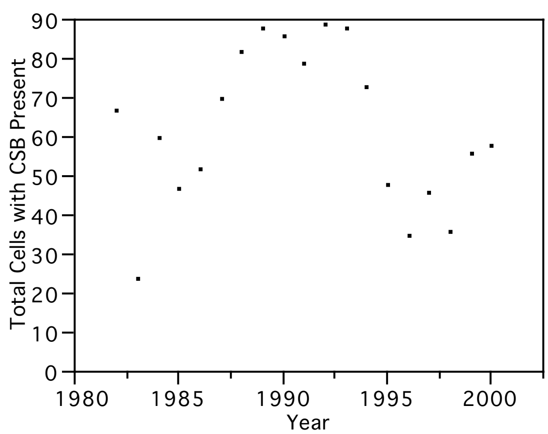

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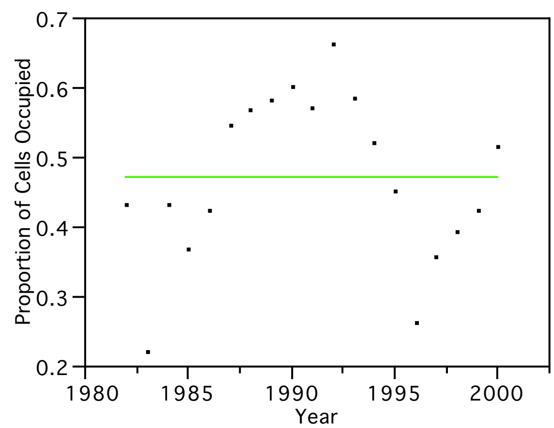

12)

Figure 7. Number of cells surveyed per year where Callippe silverspot butterfly was not detected, with linear regression ($r^2 = 0.27$, $p < 0.02$). Figure 8. Total survey length per year with linear regression. Figure 9. Number of Callippe silverspot butterflies observed per meter of transect – a spurious measure of population status because transect location and effort were not fixed. Figure 10. Proportion of cells occupied by Callippe silverspot butterfly each year – also a spurious metric because of the changing number of "empty" cells surveyed each year. Figure 11. Total number of cells with Callippe silverspot butterfly present per year. Figure 12. Proportion of cells occupied by Callippe silverspot butterfly of those cells where butterfly was located at least once. The horizontal line indicates the mean (47%).

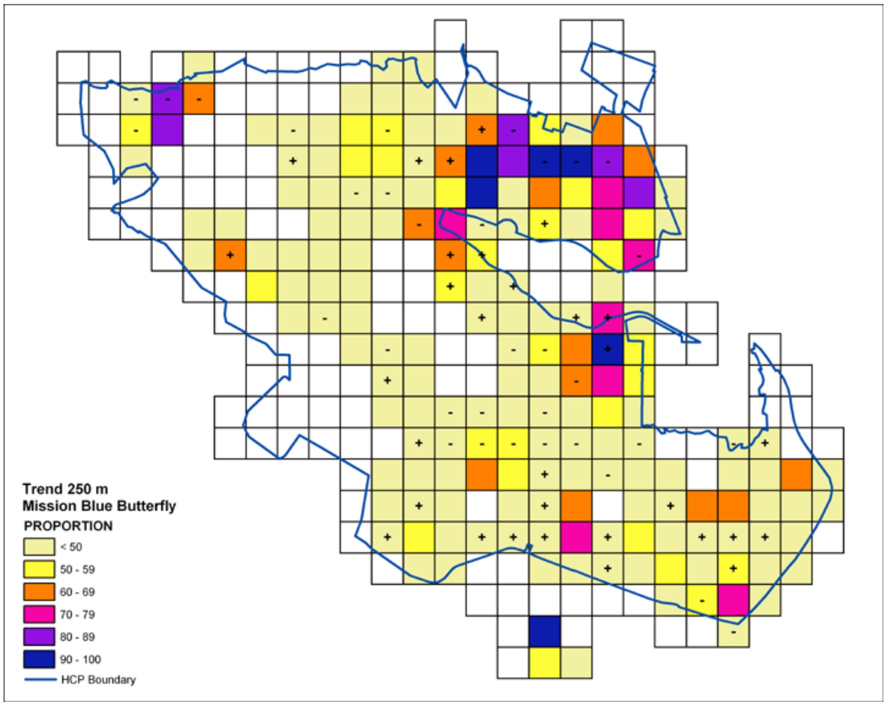

Figure 13. Status and trends of mission blue butterfly at San Bruno Mountain. Proportion of years occupied is depicted for all cells surveyed during 10 or more years 1982–2000. Trends in occupancy (p<0.20) determined by a logistic regression are indicated in each cell.

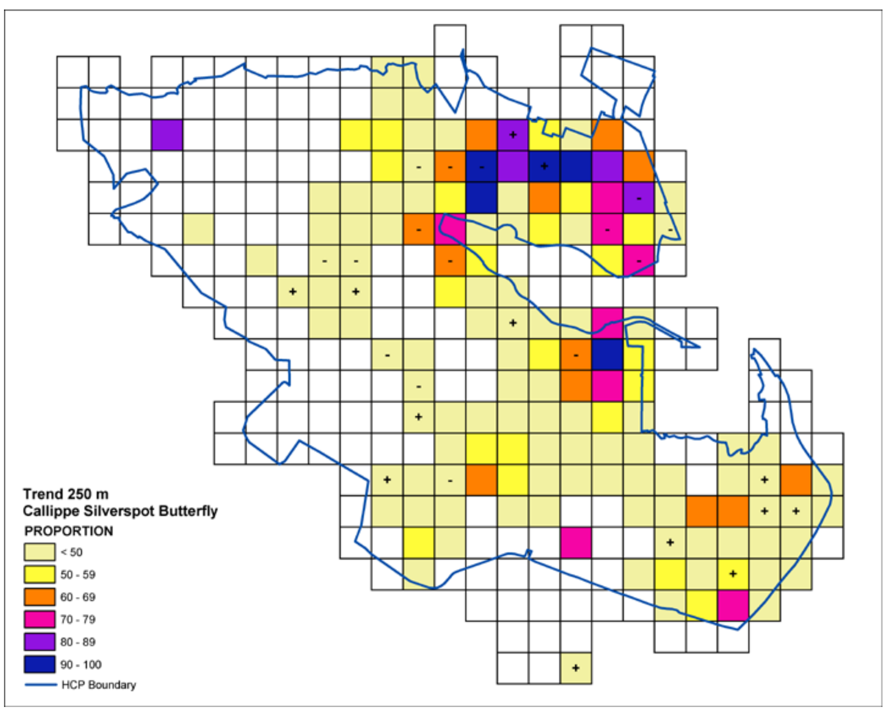

Figure 14. Status and trends of Callippe silverspot butterfly at San Bruno Mountain. Proportion of years occupied is depicted for all cells surveyed during 10 or more years 1982–2000. Trends in occupancy (p<0.20) determined by a logistic regression are indicated in each cell.

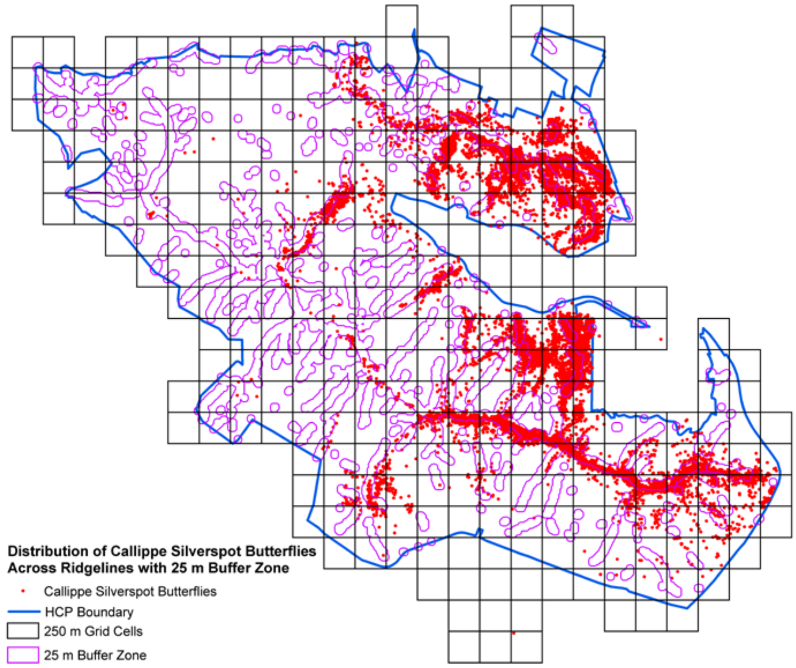

Figure 15. Distribution of Callippe silverspot butterflies relative to ridgeline buffers, 1982–2000.

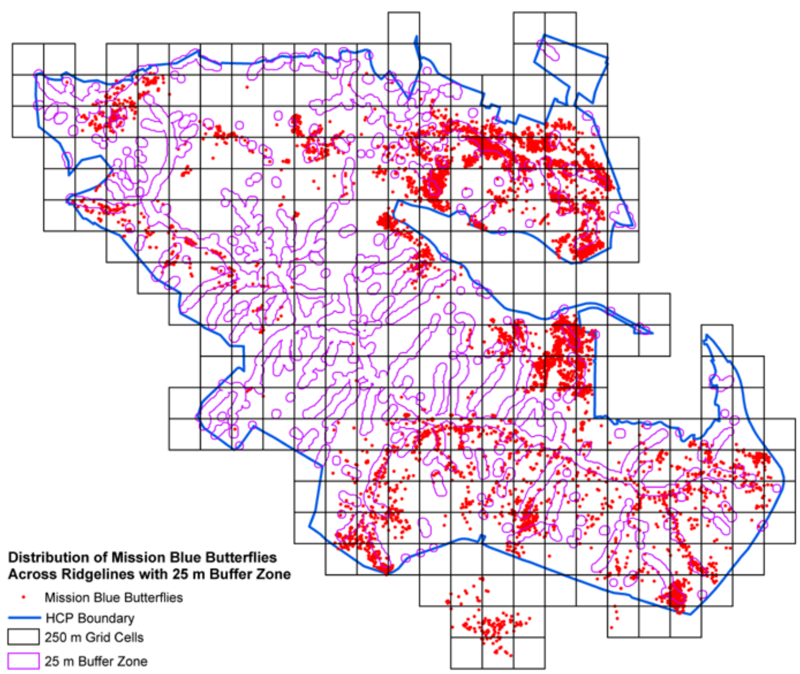

Figure 16. Distribution of mission blue butterflies relative to ridgeline buffers, 1982–2000.

The changing effort and location of surveys each year violates the assumptions of random sampling and uniform methodology. Several of the metrics that might be used to track population status therefore reveal instead artifacts of the methodology. For example, the average number of Callippe silverspot butterflies observed per meter of transect appears to show a positive trend over time (Figure 9). This trend is spurious, because surveys over time concentrated increasingly on cells where butterflies were present. Without surveying marginal habitats with butterflies absent, the apparent density of butterflies increases. All such butterflies per meter estimates derived from these data are similarly useless in evaluating population status because they are not comparable year to year. Similarly, the raw proportion of cells occupied by either mission blue butterfly or Callippe silverspot butterfly is a spurious measure because of the decreasing number of "absent" cells surveyed over time. Therefore, while the proportion of cells with Callippe silversot butterfly present each year increased significantly (Figure 10), the absolute number of occupied cells showed no statistical trend (Figure 11). But the absolute number of occupied cells is also misleading, because of the decreasing number of total cells surveyed over time. We conclude therefore that the best measure of trends in occupancy involves analysis of the proportion of cells occupied, when limited to those cells where the species was observed at least once (Figure 12). For these cells with at least one observation, neither butterfly shows a significant trend in the number of cells occupied over time.

Given that no overall trends in the proportion of the range occupied by either species exist, the analysis concentrates on trends within individual cells over time. The limits of such trend analysis extend to the 218 cells that were occupied at least once by mission blue butterfly, and 165 cells that were occupied at least once by Callippe silverspot butterfly. Figure 13 depicts the cells for each species that were surveyed at least 10 years with each species present at least once, showing the proportion of years the butterfly was present. It also depicts cells where a trend during the study period was detected ($p<0.20$). These results are based on occupancy for years surveyed, and so do not represent differences in survey frequency over time.

The cells with trends ($p<0.20$), including those surveyed fewer than 10 years, were evenly split for mission blue butterfly (40 positive, 40 negative, with 2 cells occupied every year surveyed), and for Callippe silverspot butterfly (14 positive, 15 negative, with 6 cells occupied every year surveyed) (Figure 17). The most stable cells for both species are concentrated in the northeast ridge, but this is also the location with a far greater proportion of the negative trending cells. For Callippe silverspot butterfly, the northern half of the study area (cell numbers < 150) contains 11 of 15 negative trending cells (73%) but only 5 of 14 positive trending cells (36%). A similar, but less dramatic pattern is seen for mission blue butterfly.

Survey data provided adequate data to observe the importance of topographic relief to the two species. For mission blue butterfly (Figure 16), the proportion of male butterflies seen within ridgeline areas was extremely close to the proportion of males in the whole population (68.9% vs. 68.3%), and the same was true for females (26.1% vs. 26.5%). For Callippe silverspot butterfly (Figure 15), males were in slightly greater proportion within the 25-m buffer zones (41.2% vs. 37.8%) while females were present in slightly lower proportion than observed in the population (34.6% vs. 40.6%). The percentage Callippe silverspot butterflies of unknown sex was greater within ridgeline buffers than in the population as a whole (24.2% vs. 21.4%). These results are consistent with the observation that male Callippe silverspot butterfly use hilltops more than females. This use is by no means exclusive, however.

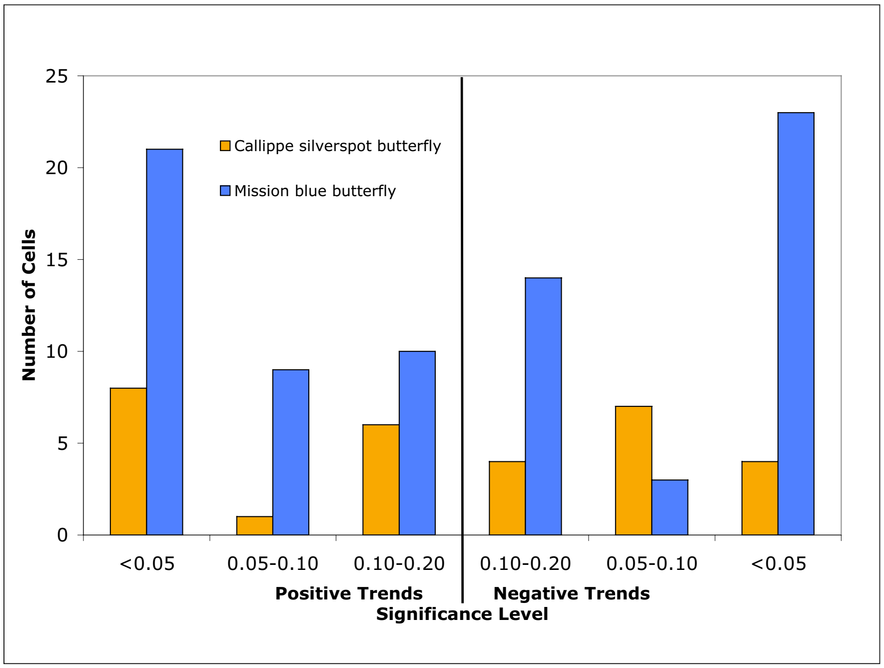

Figure 17. Significance of trends in presence by cell for Callippe silverspot butterfly and mission blue butterfly.

Discussion

The wandering transects violates most tenets of survey design. It is "convenience sampling" (Anderson 2001), providing no replication for comparison. This does not suggest that the surveys were easy to complete — to the contrary, fieldwork on San Bruno Mountain is notoriously difficult and physically taxing. Rather, the design was opportunistic rather than pre-structured, making it haphazard rather than random. Ample scientific literature was available at the time that the survey technique was designed to indicate the value of replication in the form of fixed, repeated transects (Pollard et al. 1975, Pollard 1977). Failure to follow such methods, or to develop a statistically rigorous sampling scheme, reduced the scientific value of the monitoring program. The lack of regularly repeated transects also hampers the application of subsequent techniques to estimate population size and other flight period characteristics (Zonneveld 1991). When techniques to estimate search efficiency became available, these were not incorporated into the survey design (Buckland et al. 1993, Brown and Boyce 1998). The wandering surveys may have other benefits for those managing the natural resources at San Bruno

Mountain, such as detection of invasive plants. They are nevertheless deficient as a technique to gather data about butterflies from which statistical inferences can be made.

The purpose of this analysis, however, is to evaluate what information can be gained from the wandering transect surveys. Notwithstanding the deficiencies in survey design, we believe that sufficient information can be gained from the surveys to describe, however imperfectly, the distribution of the two butterfly species over time. Some researchers believe that survey data that lacks an estimate of search efficiency is useless for scientific analysis (Anderson 2001, 2003), but we do not subscribe to this extreme view. The assumptions that we have made, most importantly that a survey length of 250 m within a cells is sufficient to detect the butterflies if present, provide a conservative analysis of the situation. As discussed above, false negatives are possible, but false positives will be very rare. By switching from emphasis from abundance to occupancy, the effects of search efficiency on the results is diminished, but not eliminated. The analysis does not allow inference to cells that were not surveyd. In contrast, had the survey routes been chosen randomly, and repeated, inference could have been drawn about areas not surveyed.

For the period 1982–2000 the distribution of Callippe silverspot butterfly and mission blue butterfly in those areas surveyed at San Bruno Mountain was stable. The distribution of the population experienced changes as certain areas were colonized (or were more regularly occupied) and others exhibited trends toward local extinction.

Many of the significant trends in occupation for both Callippe silverspot butterfly and mission blue butterfly were located in cells that were occupied fewer than 50% of the times surveyed. These trends can be caused by a single year or two of presence at the end of the survey period for a positive trend or at the beginning for a negative trend. While interesting if connected to known changes in habitat conditions, they are of less interest to an assessment of the overall health of the population. Of considerably more interest are those cells where the butterfly has been located for a significant proportion of years surveyed (> 70%) and yet is exhibiting a negative trend.

For Callippe silverspot butterfly a series of cells with greater than 70% occupancy show negative trends, all of which are found in the northern portion of the study area (70, 71, 95, 113, 131, 107, 125). In comparison, only two cells in this northern region showed positive trends (54, 73).

The mission blue butterfly also exhibited negative trends in a number of the cells that were occupied a large proportion of surveyed years. These include the northwest portion of the study area (24, 25), the northeast (54, 73, 74, 75, 131, 107) and one in the southern portion of the site (190). Many of the trends detected for mission blue butterfly were found in cells where the butterfly was present less than 50% of the time.

The Northeast Ridge appears to be an important location for both butterflies, but especially Callippe silverspot butterfly. Here is the greatest concentration of cells that reliably support the butterfly. Yet, it seems that the edges of this area have become degraded, for example the western end of the industrial park and directly north from it, and the eastern edge of the HCP boundary. The scope of our analysis, which does not include any vegetation information, does not allow explanation for these trends.

The cell-by-cell trend analysis similarly reveals areas of concern for mission blue butterfly. A cluster of cells in the northwestern corner of the study area exhibits negative trends. The core of the northeast ridge area has negative trends, but several positive trending cells are found to its east, and south of the industrial park.

While information relevant to the management and conservation of these species has been extracted here from the wandering transects, it is evident that the survey methodology can be improved. A companion report addresses this issue in detail. This report, however, provides our best analysis of the survey data, and we believe that it has yielded sufficient information to identify areas in need of management action, as well as those areas important to the survival of these two listed butterfly species.

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Analysis of Butterfly Survey Data and Methodology from San Bruno Mountain Habitat Conservation Plan (1982–2000).

2. Survey Methodology

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Cover Photo:
Mission blue butterfly at San Bruno Mountain, March 2003 (T. Longcore)

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Introduction

The butterfly monitoring scheme for the San Bruno Mountain Habitat Conservation Plan from 1982 to 2000 was plagued with a number of methodological difficulties. These included a haphazard rather than random survey design, no repeatability between years, and varying geographic coverage. While some information can be extracted from the "wandering surveys" conducted on San Bruno Mountain, a more rigorous survey design is necessary to allow managers to draw statistically significant inferences about the status of the butterflies and their responses to management actions. Indeed, since 1998, standardized transects have been established to monitor butterflies at San Bruno Mountain.

This report discusses the factors that should be considered in the further development of a new monitoring protocol. While it provides as detailed guidance as possible, the ultimate survey design must incorporate the considerations of those who will implement the surveys. Feasibility on paper does not always translate well to the field.

This report draws on the analysis of mission blue butterfly and Callippe silverspot butterfly survey data completed by USC. It adds to that analysis a quantitative description of the flight period of each butterfly, derived from survey data collected 1982-2000.

Survey Methodologies

The survey methodology for both butterfly species should be revised to meet the conditions necessary for statistical inference across the whole study area. The surveys should assess the relative population size from year to year, as well as the distribution of occupancy. Based on Longcore et al. (2003) I recommend a combination of fixed transects and presence surveys, both using the 250 m grid system developed to analyzed the "wandering transects" (Figure 1).

Fixed transects

The purpose of fixed transects (i.e., "Pollard walks", Pollard 1977) is to provide a repeatable measure to draw inference about the overall population size in any given year, and to describe the abundance curve of the butterflies within any given season to aid in analysis of presence data. The transects cannot be placed simply in the locations with the most butterflies because of the phenomenon of regression to the mean. Rather their locations must be chosen randomly from the universe to which inference is to be made. Because the survey methodology intends to draw inference about the entire San Bruno Mountain Habitat Conservation Plan area, the first inclination is to select fixed transect sites randomly from all cells. It may be reasonable, however, to assume that locations within the Habitat Conservation Plan area that have not supported butterflies for the past 20 years are unlikely to support them in the future, and even if butterflies were introduced, they would not behave differently than other previously occupied area. If this assumption is acceptable, then fixed transects can be chosen randomly from the universe of cells that have been occupied in the past by each or both butterflies, which would avoid the frustrating possibility of conducting fixed transects at locations unoccupied by the butterfly.

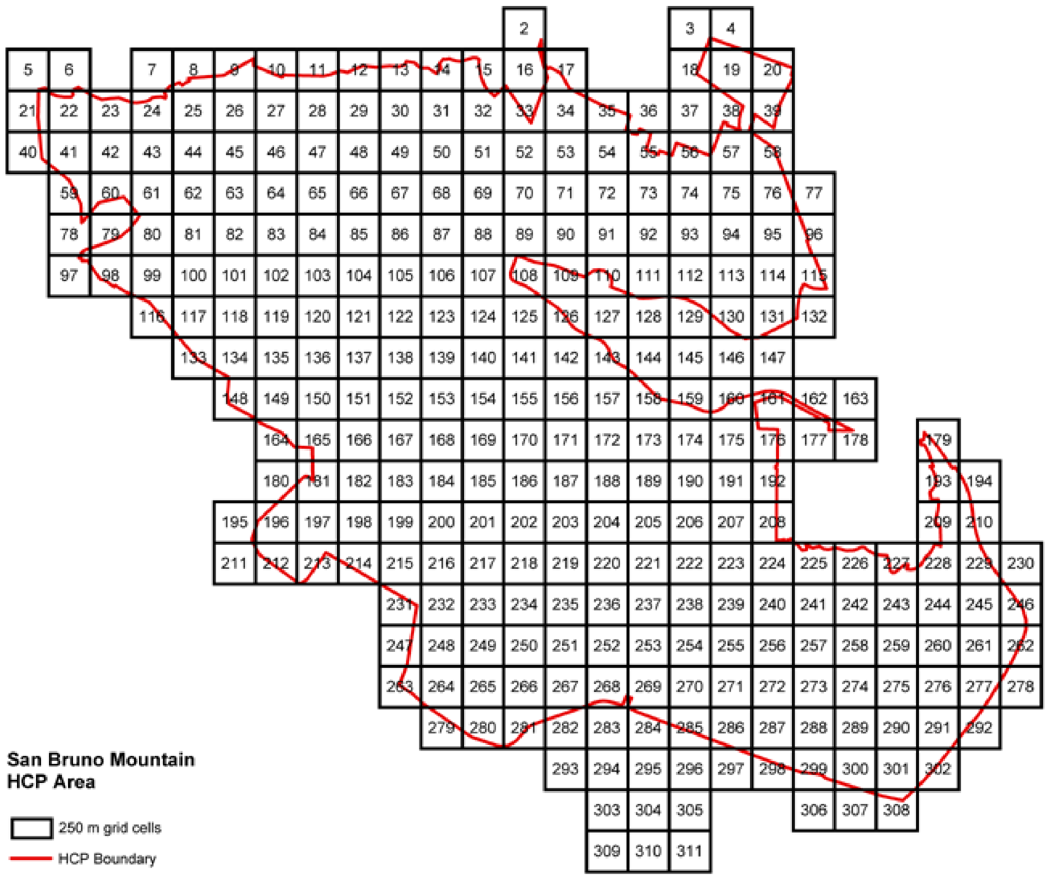

Figure 1. Numbered grid for analysis of butterfly survey data, San Bruno Mountain HCP.

The next questions are the number of fixed transects, their length, and frequency of survey. These interrelated issues are influenced by the availability of resources. It is imperative for population estimation techniques that fixed transects be conducted at least every ten days during the flight season of each butterfly. Further, they should be sufficiently long within each cell to fully survey that cell (>250 m). The layout of the survey within the cell should follow the guidelines established by Thomas (Thomas 1983) so that the transect is not a sample of the habitat within the cell, but rather a complete survey. The number of these transects then depends on a power analysis in which one must assume the amount of variation between sites. Effectively this variation should be low, and relatively few (e.g., 5) fixed transects are required relative to the total number of cells (310).

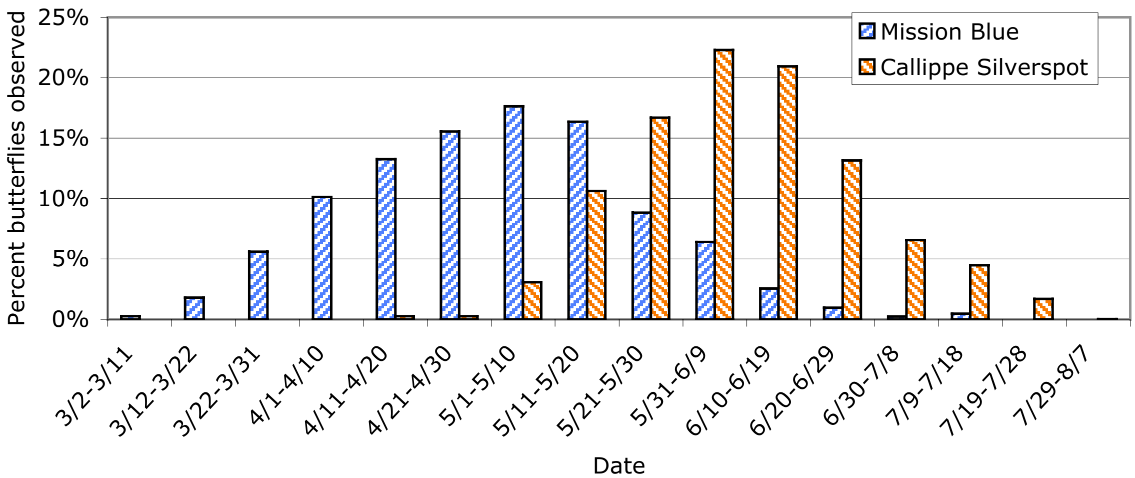

Figure 2. Distribution of adult mission blue butterfly and Callippe silverspot butterfly observations by date, 1982-2000.

The flight season of mission blue butterfly and Callippe silverspot butterfly combined almost always falls within a 140 day window from March 12 to July 28. Most years the combined season will be shorter. As a practical matter, abundance transects will take at a maximum 14 visits during this period.

Presence Surveys

The number of fixed transects must also be balanced against the desire to have spatial and temporal resolution of trends in occupancy, which require a different type of survey. Presence surveys must be spread throughout the flight season of the butterfly species, according to the characteristics of the species (Zonneveld et al. 2003). The number of surveys, the size of the population to be detected, and probability of encountering a butterfly are interrelated. With fewer surveys, the probability of encountering a small population decreases. More surveys or more butterflies always increase the probability of encounter, and a demand for greater probability of encounter requires either a larger population to detect or more surveys. For any survey methodology, one must decide two of the variables to determine the third. For example, if only four surveys are possible financially and a 95% confidence of locating a population is desired, only populations of a certain size (e.g., 10 individuals) will be detected with that confidence. Analysis of these tradeoffs are necessary to devise a survey methodology; once data are collected, complete analysis of them can calculate the actual detection probability, taking into account many factors that determine visibility of the species (MacKenzie et al. 2003).

Drawing on analysis of other butterfly species (Zonneveld et al. 2003), I suggest three surveys, spaced optimally, to evaluate cells for presence. Counts need not be conducted on such visits, only presence or absence recorded. All three visits must be made, even if presence is already established, to allow for application of the best available trend analysis algorithms (MacKenzie et al. 2003). Three surveys should be adequate to detect populations of five or more visible butterflies within a cell 90% of the time (see Figure 3, Zonneveld et al. 2003). Subsequent analysis will determine the actual detection probability.

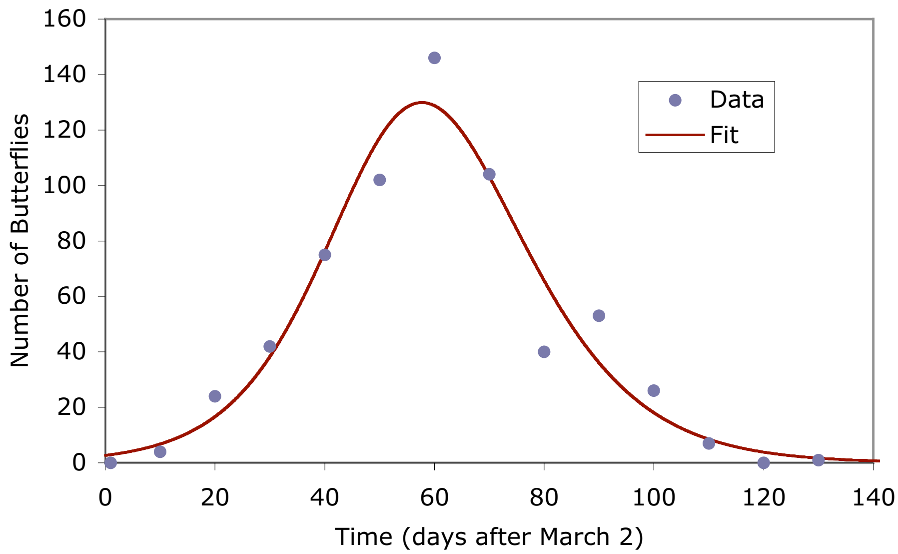

Figure 3. Fit by INCA of Zonneveld model to observed abundance curve of mission blue butterfly by ten-day increments at all locations across San Bruno Mountain, 1990.

The question then arises of how to time the surveys to maximize the chance of encountering each species during presence surveys. Zonneveld et al. (2003) provide guidance for this question, and a table to identify the optimal spacing of five survey days based on known flight period characteristics. These characteristics are the death rate of the butterfly (alpha, α), the spread of emergence of the butterfly within years (beta, β), and the variation (s.d.) in date of peak emergence (mu, μ) over time. I produced estimates of these values by aggregating survey data from each year of wandering transect data (1982–2000) at SBM into ten-day periods, and fitting the Zonneveld model to the abundance curve with INCA (INsect Count Analyzer) (Zonneveld 1991; Longcore et al. 2003). This can only be expected to provide a very rough estimate, because the use of aggregate data from nonreplicated transects violates assumptions of the model. Nevertheless, the model fit these aggregate data for many years for both species (e.g., Figure 3) with the use of prior information to constrain the death rate. I used the results of these analyses to assign each of the variables to low, moderate, or high categories as defined by Zonneveld et al. (2003).

Table 1. Estimated flight period characteristics of mission blue butterfly and Callippe silverspot butterfly at San Bruno Mountain, 1982–2000.

	Mean death rate (α)	Mean dispersion of eclosion (β)	Mean date of peak eclosion (μ)	Variation in peak eclosion (s.d. μ)
Callippe silverspot	0.16 (moderate)	5.8 (moderate)	June 4	14.7 (high)
Mission blue	0.15 (moderate)	8.9 (high)	April 20	10.7 (moderate)

These results provide an indication for the general range of these flight period values for each species, but should be interpreted with consideration of the numerous assumptions violated in the application of the model deriving them. The estimates are consistent with observable patterns in the flight period of the two species. For example, the flight season for mission blue butterfly is generally spread out over a greater period, while Callippe silverspot butterfly has a more distinct peak in most years — this qualitative observation is confirmed by the higher beta value for mission blue.

Based on these estimates of flight period characteristics and Table 1 in Zonnveld et al. (2003), surveys for mission blue should be conducted all approximately five days following the average peak emergence. For Callippe silverspot, the same analysis suggests surveying three times, ten days before peak emergence, five days after, and twenty days after.

Implementation of this general advice must be done in the field, with consideration of appropriate weather conditions to survey. Ideally, the presence surveys for mission blue butterfly should be conducted during an intensive period during the end of April and the beginning of May. Presence surveys for Callippe silverspot should be conducted during the last week of May, second week of June, and end of June (Table 2).

Cost and Feasibility

Combining the survey scheme for both species would allow surveys during the overlapping portion of the flight season to be used to record information about both species. In doing so, it is possible that certain sites will be chosen for surveys that have never supported one or the other species. This has certain benefits, because by selecting presence survey sites by random from the cells occupied at one time by either species allows for inference to these cells as well.

The total hours required for abundance surveys for both species (fixed transects) is 14 visits times 5–10 sites times an average of 1.5 hours per survey, or 210 hours. At an average cost of $50/hour for permitted surveyors, the cost would be $5,250–10,500.

Presence surveys should take approximately one hour on average per cell, including travel time. Equal effort should be expending for each species, with three visits per cell. Presence surveys should be conducted separately for each species following the timing suggested above. Because the survey scheme should provide information about specific habitat areas to guide management, the return interval for surveying cells should be relatively short (2-3 years). A three year return interval for mission blue butterfly (218 cells) would require 73 cells surveyed per year at a cost of $10,950, and for Callippe silverspot butterfly (165 cells), 55 cells per year at a cost of $8,250. The cost of abundance and presence surveys together would be $24,450–29,700, not including data analysis and report preparation.

Table 2. Suggested frequency and dates for fixed transects (abundance surveys) and cell surveys (presence surveys) for mission blue butterfly (MB) and Callippe silverspot butterfly (CS).

Date	Abundance Survey	Presence Survey
3/12–3/22	MB	
3/23–3/31	MB	
4/1–4/10	MB	
4/11–4/20	MB	
4/21–4/30	MB	MB (3 intensive)
5/1–5/10	MB	
5/11–5/20	MB, CS	
5/21–5/30	MB, CS	CS
5/31–6/9	MB, CS	
6/10—6/19	MB, CS	CS
6/20–6/29	MB, CS	CS
6/30–7/8	CS	
7/9–7/18	CS	
7/19–7/28	CS	

Thus, for approximately $30,000 per year a survey scheme could be implemented that would allow for comparison of population sizes across years and permit statistical inference about the status and trends of these two butterfly species. This estimate depends on the actual time required for each type of survey and the actual cost of hiring surveyors. It should provide, however, a framework for discussion.

The cost estimate does not include the cost of setting up the grid of cells on San Bruno Mountain. This initial effort will be costly, and require a substantial off-season effort with a Geographic Positioning System unit to identify the corners of each cell. This effort would identify cells that cannot or should not be surveyed for some reason, providing information to adjust the survey design.

Well-trained volunteers could contribute significantly to the proposed survey effort. The presence surveys could be assigned to volunteers once the cell system was established, and a volunteer could be responsible for conducting six appropriately timed visits to one or many cells each year. Such volunteers should be permitted by the U.S. Fish and Wildlife Service. Given the enormous effort expended by volunteers on behalf of San Bruno Mountain over the years, such integration of volunteers into the survey protocol may be possible.

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Appendix D: San Bruno Elfin Analysis:

We used a two factor ANOVA with Scheffe post-hoc tests to test whether there was a significant difference between years and survey points for the number of San Bruno elfin (SBE) that we observed per transect.

Difference between years.

We found that there was a significant difference between years (F=7.04, p <0.0001; Fig. 1). Scheffe post-hoc tests show that this difference was primarily due to the relative abundance of SBE in 2001. Data from the year 2001 were significantly different from 1999, 2000, 2003 and 2004 (p-values all <0.05). There were no other year by year comparisons that were significantly different (only comparisons involving 2001 were significant). In 2004 SBE numbers were low compared to 2001 and 2002, but similar to 1998, 1999, 2000, and 2003. There is no significant trend across years for SBE by either correlation or regression analysis.

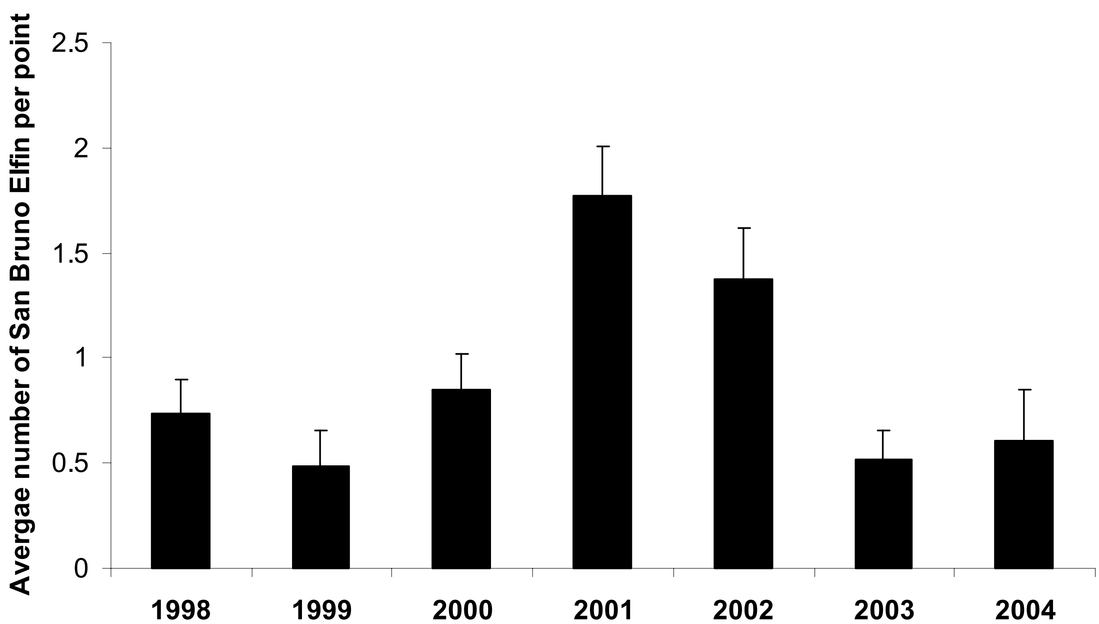

Figure 1. Average number of San Bruno elfin butterflies observed per transect per year. Error bars represent the standard error of the mean.

Difference between points.

Across all years surveyed, there was a significant difference between survey points for the average number of SBE observed per 5 minute survey (F=3.68, p<0.0001; Fig. 2). Point 13 had the highest mean observation number, while points 10,11,14,18, 20 and 22 all had very low mean SBE number (Fig. 2). There is no significant interaction between year and survey point, which suggests that SBE numbers per survey point varied in parallel from year to year (Fig.3).

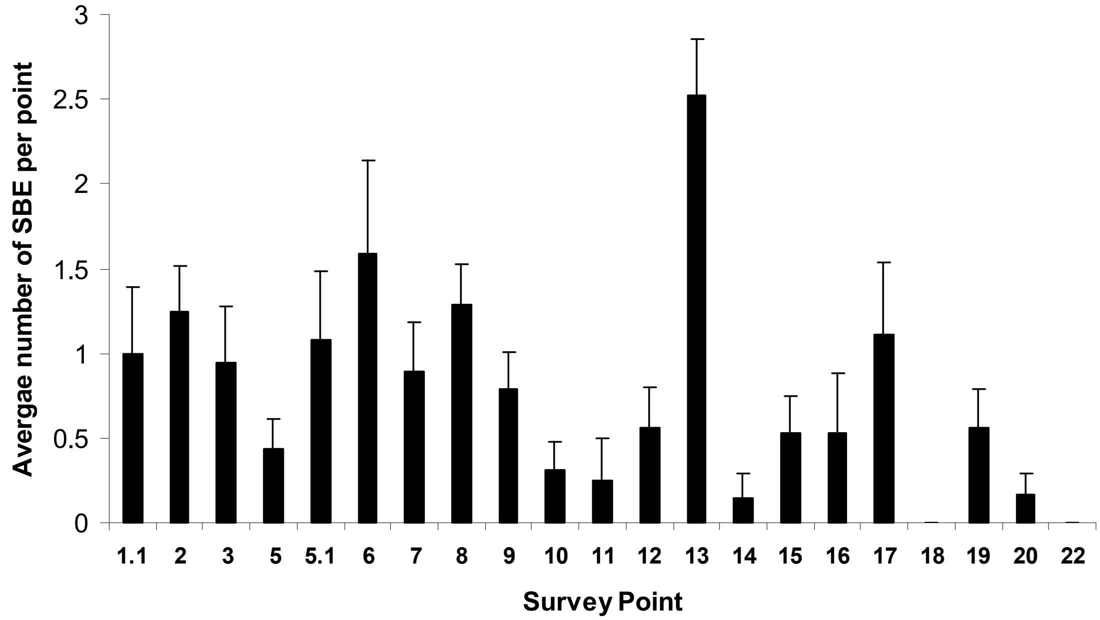

Figure 2. The difference between survey points for the average number of SBE observed per 5 min survey. These are averages for the period 1998 to 2004. Error bars are the standard error of the mean.

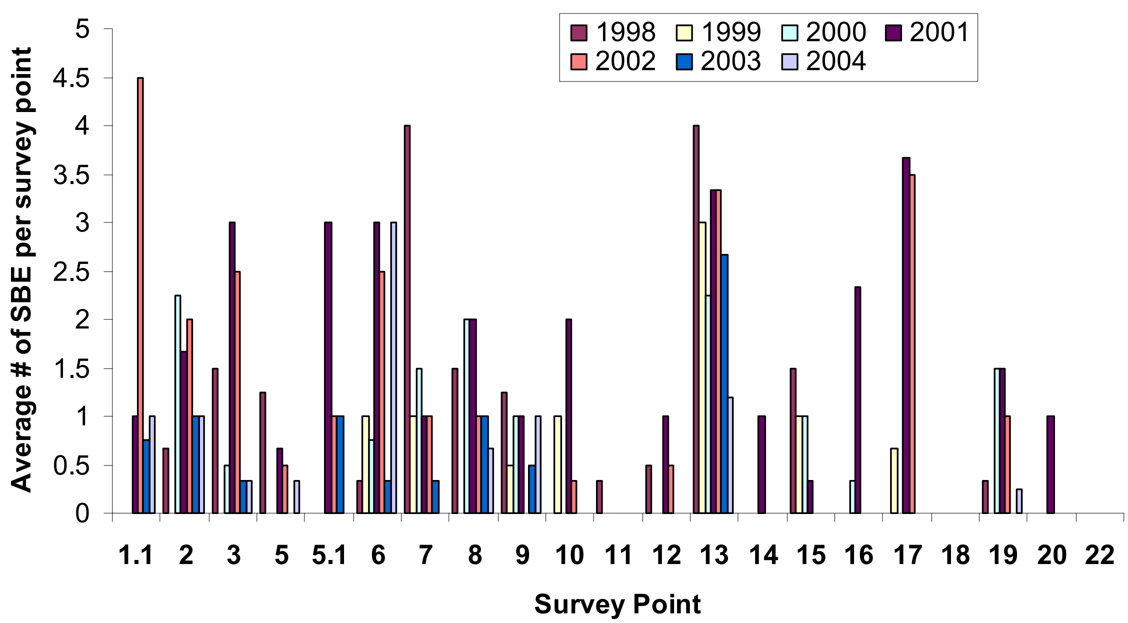

Figure 3. The difference between years within transects for the average number of SBE observed per survey point.

DESIGN

Dependent variables

Name	**Code**
# SBE	#S

Type of analysis: OLS ANOVA

Factors

Name	**Code**	**Nested in**	**F/R**	**Kind**
Point #	P#	()	Fix	Disc
Year	Yr	()	Fix	Disc

Partial (Type 3) Sums of Squares

Interactions up to 1 - way

No Modifications

RESULTS

General Results

311 total cases

ANOVA

Analysis of Variance For **# SBE**
No Selector

Source	**df**	**Sums of Squares**	**Mean Square**	**F-ratio**	**Prob**
Const	1	255.704	255.704	165.96	≤ 0.0001
P#	20	113.322	5.66609	3.6774	≤ 0.0001
Yr	6	65.1083	10.8514	7.0427	≤ 0.0001
Error	284	437.588	1.5408		
Total	310	612.296			

Results for factor Yr

Coefficients

Expected Cell Means

Scheffe Post Hoc Tests

	Difference	**std. err.**	**Prob**
1999 - 1998	-0.477734	0.2912	0.8458
2000 - 1998	-0.162635	0.2701	0.999118
2000 - 1999	0.315099	0.2869	0.976275
2001 - 1998	0.837106	0.2727	0.155619
2001 - 1999	1.31484	0.2901	0.00280773
2001 - 2000	0.999741	0.2651	0.0299636
2002 - 1998	0.391998	0.2762	0.917734
2002 - 1999	0.869732	0.2943	0.193561
2002 - 2000	0.554633	0.2665	0.632393
2002 - 2001	-0.445108	0.2693	0.84088
2003 - 1998	-0.453791	0.2685	0.826064
2003 - 1999	0.0239436	0.2859	1
2003 - 2000	-0.291156	0.2572	0.972352
2003 - 2001	-1.2909	0.2618	648.362e-6
2003 - 2002	-0.845788	0.2623	0.113281
2004 - 1998	-0.474671	0.2673	0.788629
2004 - 1999	0.00306336	0.2827	1
2004 - 2000	-0.312036	0.2558	0.959819
2004 - 2001	-1.31178	0.2582	360.611e-6
2004 - 2002	-0.866669	0.2618	0.0939677
2004 - 2003	-0.0208803	0.253	1

TABLE A-7. SAN BRUNO ELFIN FIXED POINT DATA: 2004.

Data sorted by fixed point number.

Year	Week	Date	Point #	# SBE	Temp	Wind ave	Time Start
2004	3	18-Mar	1.1	0	27.1	1.0	11:59
2004	2	11-Mar	1.1	2	72	3.0	
2004	5	1-Apr	1.1	0	19.4	7.2	12:29
2004	6	9-Apr	13	0	20.3	.8	10:15
2004	2	11-Mar	13	0	70	2.0	
2004	6	9-Apr	13	2			1:00
2004	3	18-Mar	13	4	23.8	0.8	10:42
2004	5	1-Apr	13	0	16.8	2.8	10:23
2004	3	19-Mar	15	0	22.8	9.6	12:50
2004	5	2-Apr	15	0	22.1	5.6	10:45
2004	2	11-Mar	15	0	74	1.0	2:22
2004	6	9-Apr	15	0	21.4	1.9	10:32
2004	6	9-Apr	16	0	18.2	2.7	10:45
2004	3	19-Mar	16	0	19.9	11.1	1:04
2004	5	2-Apr	16	0	18.7	4.4	10:59
2004	2	11-Mar	16	0	74	2.0	2:47
2004	6	9-Apr	17	0	19.1	2.3	11:02
2004	5	2-Apr	17	0	24.7	1.5	11:14
2004	3	19-Mar	17	0	21.9	3.6	1:18
2004	2	11-Mar	17	0	75	5.0	3:31
2004	5	1-Apr	19	0	14.4	4.6	10:10
2004	6	9-Apr	19	0	24.9	1.3	11:55
2004	3	18-Mar	19	0	23.8	2.2	10:28
2004	2	12-Mar	19	1	22.2	1.5	12:20
2004	2	12-Mar	2	2	18.7	0.5	10:40
2004	5	1-Apr	2	0	16.5	7.6	12:37
2004	3	18-Mar	2	0	25.1	1.5	12:08
2004	5	1-Apr	20	0	14.7	4.4	9:50
2004	2	11-Mar	20	0	72	1.5	
2004	3	18-Mar	20	0	21.2	4.2	10:07
2004	6	9-Apr	20	0	25.2	1.4	11:30
2004	2	12-Mar	3	0	22.2	1.1	11:17
2004	5	1-Apr	3	0	18.6	6.4	12:52
2004	3	18-Mar	3	1	26.4	1.7	12:24
2004	2	12-Mar	5	0	22	1.0	11:05
2004	1	4-Mar	5	0	18.1	1.9	12:23
2004	3	18-Mar	5	0	23.1	3.0	12:56
2004	5	1-Apr	5	1	15.0	2.6	12:10

Year	Week	Date	Point #	# SBE	Temp	Wind ave	Time Start
2004	2	11-Mar	5.1	0	72	4.0	
2004	1	4-Mar	5.1	0	15.3	2.2	11:58
2004	3	18-Mar	5.1	0	26.9	1.0	11:39
2004	5	1-Apr	5.1	0	18.0	6.2	11:53
2004	5	1-Apr	6	11	19.6	3.0	11:37
2004	6	9-Apr	6	0	15.3	2.6	12:45
2004	1	4-Mar	6	0	19.6	2.2	11:33
2004	2	11-Mar	6	0	72	3.5	
2004	3	18-Mar	6	1	25.3	1.3	11:22
2004	3	19-Mar	7	0	22.7	2.7	11:56
2004	6	9-Apr	7	0	22.3	1.9	11:54
2004	5	1-Apr	7	0	15.9	8.3	10:57
2004	2	11-Mar	7	0	70	6.0	
2004	3	19-Mar	8	0	22.2	4.7	12:10
2004	5	1-Apr	8	0	17.0	5.0	11:10
2004	2	12-Mar	8	2	22	2.0	10:30
2004	6	9-Apr	8	0	13.3	1.4	12:11
2004	1	4-Mar	8	0	13.6	1.7	10:52
2004	3	18-Mar	9	3	25.0	1.2	10:59
2004	5	1-Apr	9	0	17.2	4.0	10:40
2004	6	9-Apr	9	0	25.1	2.2	11:39
2004	2	12-Mar	9	1	20.8	2.4	10:02

Appendix E. Invasive Species: Acreages Treated in San Bruno Mountain HCP Area in 2004. Areas treated are shown on Figure 6. Work Performed by West Coast Wildlands, Inc.

Quarter	Months	Acres	Invasive Species	Areas
1	January – March	**118**	Fennel French Broom Gorse Pampas Grass Bristly Ox-Tongue Portuguese Broom Annual grasses Blue Gum Eucalyptus Field Mustard Oxalis Cotoneaster Poison Hemlock Italian Thistle Monterey Pine Cape ivy Himalaya Blackberry Ox-Eye Daisy Wild Radish Prickly Lettuce	Wax Myrtle Ravine (upper) Wax Myrtle Ravine (lower) Guadalupe Canyon Parkway Linda Vista/Bay Vista Callippe Hill/ Arnold Slope Brisbane Saddle (Unit 1) Saddle (Unit 2) Saddle (Unit 3) Red-tailed Canyon Radio Road Summit Bitter Cherry Ridge April Brook Colma Creek Ridge Trail East
2	April- June	**395**	Fennel French Broom Portuguese Broom Gorse Cape ivy Poison Hemlock Italian Thistle Wild Radish Field Mustard Cotoneaster Bristly Ox-tongue Blue gum eucalyptus Himalaya blackberry Ox-eye Daisy English ivy Red Valerian Velvet Grass Bull Thistle English Plantain Milk Thistle Curly Dock Prickly Lettuce	Callippe Hill/ Arnold Slope Saddle (Unit 1) Saddle (Unit 3) Wax Myrtle Ravine (upper) Red-tailed Canyon Northeast Ridge Fenceline Dairy Ravine NER Water tank/ Spumoni Linda Vista/ Bay Vista West Peak Ridgelines Hoffman Area April Brook Kamchatka Ridge Pt. Pacific/ Village in the Park Hillside Terrabay Habitat Hill West of Quarry Owl Buckeye Canyon

Quarter	Months	Acres	Invasive Species	Areas
3	July – September	**36**	Cotoneaster Gorse Acacia Himalaya blackberry Poison Hemlock Cape Ivy English Ivy Bristly Ox-tongue Wild Radish Field Mustard French broom Blue-gum Eucalyptus Fennel	Wax Myrtle Ravine (upper) Saddle (Unit 1) Saddle (Unit 3) Alta Vista
4	October - December	**36**	Gorse Cotoneaster Cape ivy English Ivy Blue-gum Eucalyptus Acacia Fennel French Broom Italian Thistle	Saddle (Unit 3) Alta Vista Dairy Ravine Old Ranch Road Wax Myrtle Ravine (upper) Botanic Garden Day Camp Callippe Hill/ Arnold Slope Brisbane Office Park Bitter Cherry Ridge
Total		**585**		

This total of 585 acres represents the number of acres of invasive plants treated on San Bruno Mountain in 2004 using herbicide, hand control, and/ or mowing methods by West Coast Wildlands (WCW). This total was calculated by digitizing the areas mapped on the back of daily record sheets used by WCW field crews. Most areas receive at least two treatments over the course of a year, however overlapping work areas were not included in the total. Acreages for each quarter are approximated. The location where this work was conducted on San Bruno Mountain is shown in Figure 6.

Acreages treated can sometimes vary significantly year to year because the density of invasive species varies depending on the invasive plant and stage of the infestation. For example, during the second quarter of 2004, a significant amount of work was done on fennel, which tends to be spread out over large areas, requiring crews to treat large, low density infestations. In contrast, gorse and broom infestations tend to be much denser, and acreages treated are therefore smaller as control efforts are more concentrated.

Invasive species control crews must also adapt to weather conditions. Crews often need to move to different sites as weather conditions change, to avoid spraying during windy conditions. Spray work is typically done in the mornings during calm conditions, and as the winds pick up in the afternoon, crews switch to doing handwork and/or mowing.

Summary of New Invasive Species Controlled in 2004 and General Observations
(Mike Forbert, West Coast Wildlands)

In general, work in 2004 focused on maintaining butterfly habitat and reducing stands of invasive species that have been worked on for years, while trying to incorporate aggressive new species into the work effort.

- *Ehrharta longiflora* was found in areas along Wax Myrtle Ravine, Old Ranch Road, and near Building No. 9 on Radio Road. It was removed by hand with follow-up treatments of Roundup Pro at 2%. The non-natives within the area are treated once a month and the site is monitored for any new Ehrharta observations. The Ehrharta on Radio Road has been treated since 2002 and control in this area has been added to West Coast Wildland's scope of work. The Friends of San Bruno Mountain and Bay Area Mountain Watch have been helpful in alerting the Habitat Manager when new infestations are observed.

- *Leucanthemum vulgare* (ox-eye daisy) has been treated at Dairy Ravine, Wax Myrtle Ravine, and April Brook since 2002. 2003 saw a five-fold increase of the plant at Dairy Ravine. So far ox-eye daisy has not returned to the lower section of Wax Myrtle Ravine after the fire in July 2003. The April Brook infestation is currently under control. This plant was found above the East Helix and Cypress grove areas.

- The main non-native grasses found in the perennial grassland butterfly habitat are *B. maxima, Avena spp.* and *L. multiflorum*. Mowing is being used more frequently within butterfly habitat areas to control these grasses.

- Gorse maintenance in the Saddle is ongoing and remains necessary since seedlings continue to emerge years after the mature stand has been controlled.

- *Oxalis pes-caprae has* expanded in upper Tank Ravine and other parts of the mountain despite efforts to control it. Efforts have been successful in controlling this plant in lower Tank Ravine. New infestations of this plant were treated in Dairy Ravine and along the summit trail in 2004 and early 2005. This plant has the ability to devastate areas leaving bare spots after seed production and die-off, which opens up the area for Oxalis to expand as well as new invasive species to colonize.

- Mustard, Italian thistle, fennel, wild radish, and bristly ox-tongue are in abundance along the eastern end of the Ridge Trail (Southeast Ridge) and are increasing. This area has been treated more intensively in the last two years and will need future treatments. Wild radish was found above Western Ravine above Buckeye Canyon and the south side of

Ridge Trail Road. French broom has been significantly reduced in this area, but future treatments are necessary.

- *Acacia sp*. The Acacia trees in upper Wax Myrtle Ravine were frilled and treated w/ Garlon 2% and by late 2004 they were showing the effects of the treatment. Observation of the dieback will be monitored through the 2004/2005 HCP invasive Species control year. Acacia within Dairy Ravine is spreading and needs to be controlled.

- *Avena spp*. (wild oat). No distinguishing changes of the infestation at this point.

- *Briza maxima* (rattlesnake grass. No distinguishing changes of the infestation at this point.

- *Carduus pycnocephalus* (Italian thistle). Fluctuation in presence from year-to-year. This species is frequently treated when observed. This plant shows dieback for a few years with the possibility of infestation re-occurring at a later time (2+ years).

- *Carpobrotus edulis* (hottentot fig, iceplant). The main infestation of this plant in Site 3, Saddle (Unit 3) has been controlled.

- *Centaurea calcitrapa* (purple star thistle). Main observation is on the Summit Trail SSW as you leave the paved area of West Peak Ranger Station. This plant is treated annually as part of the Ridge Trail West HCP efforts.

- *Centranthus ruber* (red valerian). Site locations are Guadalupe Cyn Parkway and Ridge Trail East in an old quarried site. Treated annually. This species has spread rapidly on the cut slopes above North Hill Drive and Guadalupe Canyon Parkway.

- *Conium maculatum* (poison hemlock). Main infestation is in April brook plains & Old Eucalyptus grove, Site 26, Saddle area. This species has been treated with herbicides and has been reduced by approximately 25% in April Brook. New infestations of this plant in Dairy Ravine and other areas have increased.

- *Cortaderia jubata* (Jubata/Pampas grass). Treated new infestations located in Wax Myrtle Ravine after the July 2003 burn. Follow up work will need to continue.

- *Cotoneaster sp.* (Cotoneaster). Three large plants (trees) were removed at the intersection of Fern Rock trail and the old Eucalyptus trail. The cut stumps were treated with 25% Garlon and the site will be observed for emerging seedlings. This species colonizes moist, northfacing slopes often within dense scrub. It requires control work, but does not spread as rapidly as other species such as broom and gorse.

- *Cytisus striatus* (Portuguese broom). The Cytisus has shown some additional infestations throughout the western region of SBM. I have been using an alternate herbicide method called 'thin line' application as prescribed on the Usage Label. This requires a 25% solution of Garlon and crop oil and has had excellent results. Because the broom produces few leaves for a proper foliar application, we have been changing to this strategy to get the trichlopyr to translocate through the bark to the cambium and phloem layer.

- *Erodium cicutarium* (filaree). Observed moving into Lower Tank Ravine. This species expands significantly after burns, and has dramatically increased within the grasslands of Wax Myrtle Ravine since the wildfire in July 2003.

- *Eucalyptus globulus* (blue gum Eucalyptus). Controlled in Wax Myrtle and Dairy Ravines.

- *Foeniculum vulgare* (fennel). This plant is controlled Mountain-wide. More concentrated effort has gone into the Tank Ravine/Juncus Ravine/ and Hillside area due to additional funding from Myer's development. HCP efforts have focused on upper areas from the summit trail down, and Myer's development has funded control work on the slopes just above lower Tank Ravine and Hillside school. Efforts are being made on closing the gap between HCP control work and the currently funded Developers' invasive Species control work.

- *Genista monspessulana* (French broom). Broom seedlings were found along the south side of Ridge Trail, above Buckeye Canyon.

- *Hedera helix* (English ivy). This plant has received treatment at Kamchatka Pt., April Brook and Dairy Ravine.

- *Holcus lanatus* (velvet grass). This grass is a problem on several slopes on the Mountain. It has been expanding into the Botanical Garden area of Dairy Ravine. This area was mowed in 2004.

- *Hypochaeris radicata* (Hairy Cats-ear). Observed but not treated

- *Lactuca virosa* (wild lettuce). Treated mainly along the Ridge Trail as part of annual followup.

- *Lobularia maritima* (Lobularia/Sweet Alyssum). Observed but not treated

- *Lolium multiflorum* (Italian wild rye). Lolium was mowed in Red Tail Canyon.
- *Lythrum salicaria* (purple loosestrife). One (sterile) plant removed from the Saddle bog area.
- *Myoporum laetum* (Myoporum). Observed but not treated.
- *Phalaris stenoptera* (Harding grass). Main infestation is located at northeast end of Preservation Parcel and treated through Myer's Development funding.
- *Picris echioides* (bristly ox-tongue). Prevalent throughout grassland areas (i.e. Dairy Ravine, Wax Myrtle Ravine, Southslope, Ridge Trail. Treated when possible.
- *Pinus radiata* (Monterey pine). Seedlings were removed at Bitter Cherry Ridge.
- *Rubus crispus* (curly dock). Occasional sightings and often found with sheep sorrel. Treated when located within butterfly habitat areas.
- *Rubus discolor* (Himalaya blackberry). Main infestation in Dairy and Wax Myrtle Ravines. These areas are treated annually.
- *Rumex acetosella* (sheep sorrel). Occasional sightings and often found with curly dock. Treated when located within butterfly habitat areas.
- *Scabiosa atropurpurea* (Pincushion plant). Observed but not treated.
- *Silybum marianum* (milk thistle). Found in relatively small numbers throughout areas where thistles are located.
- *Solanum sp.* (nightshade). Mainly treated in Wax Myrtle Ravine. Emerged extensively throughout the upper ravine area. This species typically comes in and dominates areas on moist slopes within the first few years after a burn. It is usually diminishes in area substantially within a few years as other plants become established.
- *Ulex europaeus* (gorse). Extensive gorse control was conducted this year as part of a State Parks grant to control gorse in the Saddle, and within the Wax Myrtle Ravine area as part of on-going invasive Species control.

2004 Butterfly Island Year End Report
SAN BRUNO MOUNTAIN

January 31, 2005

Prepared by

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2003/04 (Year 5) Island Planting Summary

Colma Creek Watershed

The Colma Creek planting islands are considered established with little need for management. Lupine have been observed to be establishing from seed at CC1 and Mission Blue butterfly larvae have been observed at CC2. After excellent survivability 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) and year 5 (2003/04) required no additional plants, as each island is sufficiently dense with butterfly host and nectar plants. Six species of nectar plants were planted for three years at both sites; they include *Aster chiloensis*, *Cirsium quercetorum*, *Erigeron glaucus*, *Eriogonum latifolium*, *Heterotheca sessiflora*, and *Horkelia californica*. Coast buckweat (*Eriogonum latifolium*) and golden aster (*Heterotheca sessiflora*) established very well at each of the sites.

This year, maturing coyote brush (*Baccharis pilularis*) was pruned back within and surrounding the planting islands. This brush was planted by Rana Creek Habitat Restoration following the removal *Eucalyptus* trees many years ago. The brush continues to fill-in areas that are now be managed as grassland butterfly habitat. The coyote brush is cut to the base and allowed to resprout the following year.

Dairy Ravine

These 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 is situated on a saddle with shallow, rocky soils and has become the model for this area of Dairy Ravine. *Aster chiloensis*, *Cirsium quercetorum*, *Erigeron glaucus*, *Eriogonum latifolium*, *Heterotheca sessiflora*, and *Horkelia californica* were all planted at DR1. *Eriogonum* and *Erigeron* have both established very well throughout the island.

Dairy Ravine 2 and 3, which were created in 2000 and 2001, have both been abandoned since annual grass competition was severe and very few lupine were able to establish in these islands. DR 4 (Elfin Ridge) now has very dense stands of *Sedum*, both naturally occurring and planted, which extends the Elfin butterfly habitat up along the ridge separating Dairy Ravine from Wax Myrtle canyon.

Two new islands were created last year in 2002/03. DR5 was created downslope from DR1. This island , like DR1, has shallow rocky soils along a ridge line with little annual grass competition. DR6 was created in the Friends of San Bruno Mountain Botanical Garden in lower Dairy Ravine. Both islands have performed extremely well with high survivabilities. 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. A mowing/hand weeding regime continued in this year to aid in plant establishment. Long term control of surrounding radish and cape ivy in the neighboring willow grove will aid this island to establish and spread throughout the area.

Saddle

After two years of great lupine establishment without much weed competition, annual grasses and other exotic annuals continue to increased at the site. The thick gorse mulch that prevented annual establishment for the first two years at this island site 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 in 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. For the last two years, we have taken advantage of the lack of invasive grasses to outplant hundreds of native perennial bunch grass plugs. 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 and we hope to fill-in all bare ground areas with native grasses and herbaceous perennials to support the butterfly host plants. 89 additional lupine were added in 2002/03 to supplement previous year's plantings. The lupine and nectar plants are very robust and grow very quickly in the post-gorse nitrogen enriched soils. *Phacelia californica* and *Eriogonum latifolium* are the two top performing nectar plants at the site. Natural recruitment has been recorded for both species in the second year as well as for the lupine.

The early heat spell in 2004 resulted in much plant stress and die back in this island. Many of the lupines examined in the summer of 2004 appeared dead. Many had been well established plants that were several years old. It is uncertain at this point if the plants died or were just severely stressed. Plants may spring back from a forced dormancy this growing season.

Weed management and Stewardship

GCP Site

The GCP site continues to be mowed throughout the Spring growing season. After 4 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.

Colma Creek

The restored coastal scrub between CC1 and CC2 continues to mature. Four successive years of weed management have reduced the amount of radish, mustard, hemlock, and thistle 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	25 - 47% over 1 year
Heteromeles arbutifolia	86	1 gallon	30 - 35% over 1 year
Artimisia californica	22	1 gallon	13 - 59% over 1 year
Eriophyllum staechadifolium	17	1 gallon	10 - 59% over 1 year
Prunus ilicifolia	10	1 gallon	5 - 50% over 1 year
Monardella villosa	12	1 gallon	5 - 42% over 1 year

Riparian Tree Planting Zone

Species	Number Planted	Size	Survivability
Cornus californica	12	1 gallon	5 dogwoods survive
Cornus californica	4	5 gallon	
Salix lasiolepsis	8	5 gallon	19 willows survive
Salix lasiolepsis	30	pole cuttings	
Myrica californica	6	D16	

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 was fair considering all plants were installed late in the season in post-burn hydrophobic soils. Plants were watered in once at the time of planting but no budget was available for summer watering during the establishment period. Detergents were added to the initial watering to help break up the hydrophobicity of the soils. Weed control will be critical for the establishment of the grasses and wetland plants. Annual grasses, thistles and gorse is already begun to recolonize the area. Diligent weed control in future years will insure these recent plantings continue to survive and establish.

Quarterly Report
San Bruno Mountain Gorse Removal and Revegetation Project
Work Performed from Oct 6 to December 31, 2004

Program Management

- Prepared draft Work Plan
- Prepared subconsultant specifications and developed individual subcontractor scopes of works
- Prepared and submitted Site Activity Permit
- Established photomonitoring points and collected baseline site photos
- Updated and revised project area map, identified priority stands for removal
- Installed temporary protective measures for environmentally sensitive areas within project area and in adjacent areas likely to be impacted by removal activity.
- Prepared project brochure and informational letter targeted at neighbors. Letters and fliers were distributed by the County to 1,560 adjacent property owners within 1500 square feet of the parcel boundaries. Additional brochures were provided to all work crews for distribution to interested recreation/park users.
- Developed work performed data collection methods and began compiling data from subcontractors
- Developed “punch lists” for signing off on subcontractor work
- Conducted Environmentally Sensitive Areas (ESA) training with all contractor working on site
- Provided work oversight to subcontractors
- Initiated preparation of Year 1 annual work plan
- Began developing monitoring protocol for assessing performance criteria for Year 1 work

Gorse Removal

- Removed over 22 acres of dense stands of mature gorse during 24 hours of labor.
- Completed 660 hours of initial gorse removal on approximately 26 acres of areas identified as scattered individuals and outlier patches of gorse.
- Mulched and placed gorse biomass in designated areas approximately 3-5” sized pieces, and no thicker than 6” deep.
- Cut and treated majority of gorse with a 25% concentration of Garlon 4. Treated some small, scattered individuals with a foliar spray application of 10% Garlon 4.
- Collaborated with project manager to identify ingress/egress routes to outlier populations to limit disturbance to native vegetation and prevent any impact to ESAs. Installed chain link fencing and landscape fabric along ingress/egress routes where appropriate to lessen the impact of the T200 bobcat was used for debris removal.
- Returned all trails and access points to pre-project condition.
- Installed erosion control measures where disturbance occurred from equipment.
- Provided project manager with work performed data for all work completed on site.
- Worked with Project Management to avoid fire danger during red flag warning days on San Bruno Mountain.
- Gorse stumps initially cut greater than 2” in height were recut and retreated with herbicide application.

Future Activities

Spring 2005:

- Monitoring protocol for assessing performance criteria for Year 1 work will be finalized
- Bond Act interpretive signs will be designed and installed
- Reference site monitoring will be conducted and plant palette prepared for revegetation
- Field observations to guide Year 1 work plan will be conducted
- Targeted plant species for revegetation will be propagated
- Follow-up photomonitoring will be conducted
- Removal of resprouting gorse within project area boundaries will continue

BrushBusters

Stand #	Area Treated (acres)
1	6.89
2	6.94
3	9.11
Total Area	22.94

Restoration Resources

Stand #	Area Treated (acres)
A	0.21
B1	2.99
B2	0.28
C	0.42
D	1.95
E1, E2	19.21
F	1.53
Total Area	26.59

San Bruno Mountain Watch Coastal Conservancy Grant Progress Report
August 2004

Shelterbelt (SBI) has been actively working on San Bruno Mountain during the spring/summer months of 2004. Using crew sizes that range from 2 to at times 10 people, SBI has been removing noxious weeds that are plaguing the various canyons within the mountain. The canyons and other sites that have been worked on so far are; Buckeye Canyon, Owl Canyon, Devil's Arroyo, Wax Myrtle Canyon, and Brisbane Acres.

The largest portion of the work done by SBI has occurred in Buckeye Canyon. Buckeye Canyon is where the Lippman School Community –based Broom Project has taken place. A large patch of French Broom located behind Lipman School was the focus for the first phase of work for the mountain. SBI crews worked consistently at the site for two weeks, removing French Broom using weed wrenches and handsaws. A full-size crew was brought in on the final day to buck down the large piles of French Broom into mulch using chainsaws. Aside from the work done at Lipman School, SBI has also spent four days removing stands of Hemlock located in the lower reaches of the canyon with the use of weed wrenches. One day has been spent bagging Italian Thistle by hand growing along Buckeye Creek.

The next site SBI has spent considerable time at is Owl Canyon, specifically at the Quarry slag pile located at the western side of the canyon. Here, SBI crews have spent roughly two weeks removing French Broom from the slag pile to prevent it from spreading further into Owl Canyon and out of the surrounding coastal scrub and grasslands. The broom removal was done using weed wrenches. More removal is still needed.

SBI has spent two weeks at the upper slopes of Devil's Arroyo. Striated Broom has established itself on the upper slopes of Devil's Arroyo. SBI has already pushed one large patch down slope towards the industrial park and is currently working on doing the same with another large patch. 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. More removal is still needed.

Wax-Myrtle Canyon is another site SBI has spent a few days at this summer. Wax-Myrtle Canyon was the site of a large wildfire in 2003. This site had contained large amounts of broom and gorse along the canyon slopes. After the fire, it has been possible for SBI to perform follow-up work at this site to prevent gorse and broom from reestablishing itself. The majority of the work was done around native plants that SBI had planted as part of restoration and re-vegetation efforts after the fire. Gorse and broom sprouts were removed using Pulaski's, weed wrenches, and hand pulling. More removal is still needed.

SBI is still working on treating all of these sites in accordance with the timeline created for controlling specific species, according to 2003/04 Workplan, as well as conducting year round stewardship for other species of concern.

-Kevin Ghalambor
Crew Supervisor

Introduction:

For the past three years the “Heart of the Mountain” stewardship project has been restoring the native plant communities of the Colma Creek headwaters and the Bog trail area. This effort was initiated by Pete Holloran of the Yerba Buena Chapter of the California Native Plant Society(CNPS) It was created “to serve as a model stewardship program for parks in San Mateo County” and “to build community stewardship into restoring the native plant communities of the Colma Creek headwaters” The project was managed by Mary Petrilli for CNPS for three years. During that time, it was successful in involving numerous community members who controlled invasive non-native plant populations within the project area, and revegetated these areas with local native plants.

In 2004, San Mateo County received Proposition 12 funds to continue the efforts started by CNPS. This proposed plan details the goals and implementation strategy for restoration during the next three year’s by the San Mateo County fire safe crews, contractors and the stewards of the “Heart of the Mountain”. The stewardship program is currently sponsored by the nonprofit organization “The Watershed Project”.

Justification:

Riparian habitat throughout the Bay area and particularly on the San Francisco peninsula has been drastically reduced due to urbanization. This plant community is important in providing crucial habitat for migrating birds and in particular neo-tropical migrants moving up and down the Pacific flyway. The habitat along the upper eastern arm of Colma Creek is a mature relatively intact willow riparian community that supports a diverse bird fauna. Because of this the area is enjoyed by many local bird watchers. Blue gum eucalyptus (*Eucalyptus globulus*) dominates a 300 foot section of the headwaters of the Colma Creek watershed. Our goal is to enhance this important natural resource by reconnecting the native riparian community corridor along Colma creek to the creek’s headwaters area.

Eucalyptus was imported from Australia and planted throughout California starting in 1853 for its fast growth and perceived potential for use as lumber (Williams, 2002). Although its value as a lumber source is minimal it continued to be widely planted as a windbreak due to its fast growth.

The effect that a particular species has on the hydrology of an area can be best understood by considering its effect on runoff or water yield, low and high flows, and evapotranspiration. A study comparing the water use of various widely planted forest plantation species showed that Eucalyptus had the highest water uptake of all of the tree species tested (Srivastava and Misra, 1987). There have been numerous studies showing the increased water use by blue gum eucalyptus by either demonstrating increases in water flows following its removal, or measuring reduction in the water yields of areas planted with the species.

In native stands of eucalyptus in Australia, water yield increases were correlated to the percent of a catchment logged and these yields declined as the eucalyptus reestablished (Cornish, 1993). In another study the removal of eucalyptus forest increased water yield from a native catchment by as much as 47 percent. (Brenand Papworth, 1991)
In a study where eucalyptus was planted into a grassland, within ten years the presence of the newly planted blue gums reduced the water yields by 16 percent (Samraj, et.al. 1988). A

detailed study of the effects of blue gum eucalyptus plantations demonstrated that it significantly reduced both high and low flow water yields and that the reduction in these flows increased as the eucalyptus stand increased with age (Sikka et. al. 2003). For example, in the first 10 years of growth, a eucalyptus plantation that was planted into a grassland, it was able to extract moisture from the upper soil layers but had not yet tapped into the water table (Samraj et.al. 1988). This is in part due to the fact that eucalyptus have a specialized root system consisting of a deep tap root with lateral shoot roots at different levels so that the trees can take advantage of any available soil water.   A study in Israel showed that mature eucalyptus will use moisture from the water table even when surface sources are available (Cohen et. al. 1997).

Overall there is ample evidence that blue gum eucalyptus will use significant amounts of both surface moisture as well as ground water. These trees that can grow upwards of two hundred feet, and clearly offer far higher amounts of leaf surface available for evapotransporation than that the 20 to 30 foot high coast live oak, or native willows. The presence of numerous eucalyptus trees in a watershed, particularly when growing in or adjacent to a creek, poses a direct threat to that wetland due to this species size, speed of growth and proven high water use. This is particularly the case when it establishes in small watersheds with naturally low flows.

Another justification supporting the implementation of this project is that it also provides continuing support for the ongoing successful “Heart of the Mountain” stewardship project that has invested three years worth of work into restoration of the sites important natural resources.

Location:

This site is located on San Bruno Mountain in San Mateo County and California State Park property, south of the summit parking lot (Plate 1). The project area begins at the headwaters of Colma Creek, and includes the wet meadow habitat west of where the Old Guadalalupe Road intersects the Colma Creek drainage, and continues east on either side of Colma Creek until the pedestrian bridge crossing by the Bog trail. There are also a number of small non-native invasive plant infestations located throughout the larger Bog trail loop that will also be removed and revegetated as resources allow.

Project Goals:

1. To enhance the native plant communities within the Colma Creek headwaters and Bog trail areas by removing and controling invasive non-native plants and revegetating those areas with native plants.
2. To increase the summer and fall flows of upper Colma Creek by removing the eucalyptus trees in and directly adjacent to the creek.
3. To actively involve the community in the stewardship of this area through restoration workdays, and education programs in invasive plant removal and outplanting.

Prioritization for Restoration:

1.) The highest priority area for invasive plant removal and restoration is the riparian corridor habitat along and adjacent to the creek. This is due to the high wildlife diversity that this increasing rare community type supports, and the fact that restoration in this area would create an uninterrupted creek corridor from the headwaters across the site down to Guadalupe Canyon Parkway (Plate 1).

2.) The second priority areas will be the control of several medium-sized patches of Himalayan blackberry located throughout the larger Bog trail area (Plate 1).

3.) The third priority for invasive plant control and restoration is the treatment of numerous small patches of Himalayan blackberry (*Rubus discolor*), cotoneaster (*Cotoneaster pannosa*), Cape ivy (*Delairea odorata*), English ivy(*Hedera helix*), sheep sorrel(*Rumex acetosella*), Purple velvet grass (*Holcus lanatus*), poison hemlock (*Conium maculatum*), mustard (*Brassica nigra*), wild radish (*Raphanus sativus*), and bull thistle (*Cirsium vulgare*). These smaller populations of invasive species will be treated as part of the ongoing volunteer activities.

Invasive Non-Native Plant Control:

Table1: Proposed areas for invasive removal and revegetation (see Plate 1).

Areas	Square feet	small trees under 12" dbh	large trees over 12" dbh	plant community to be restored	# of plants on 3ft. centers	# of plants on 4ft. centers
A	9,950	~36	~6	wet meadow	1,106	622
B	11,700	~61	~28	75% coast scrub	975	550
				25% riparian	325	180
C	19,500	~39	~17	75% coast scrub	1,625	914
				25% riparian	542	305
D	10,750	0	0	coast scrub	1,194	672
Totals	**51,900**	**~106**	**~51**		**5,760**	**3,250**

Note: Area A is the site above the road, area B runs from the foot bridge to the road, along the west side of creek, area C runs from the east side of the creek from the foot bridge to the road, and area(s) D are along the lower bog trail in four isolated patches.

Tree Removal

The preferred alternative for tree removal is to have one tree contractor fall all trees, large and small. Approximately 150 trees will be felled within the project area (see Plate 1 for map of project area). 100 of the trees are less than 12 inches in diameter and around 50 are larger than 12 inches in diameter. All trees will be felled out of the creek channel area to minimize impacts to the creek channel. After felling, the large trees will be skidded to the inactive Day Camp area along a dirt maintenance road or staged along Old Guadalupe Road. Small trees and any associated limbs and slash would be staged neatly along Old Guadalupe Road or in other appropriate locations for later processing by County Fire Safe Crews.

Three options remain for large tree trunk disposal (see Appendix C for complete discussion). The large trunks would be either be; 1) moved to an appropriate location within the park and stacked or arranged; 2) skidded to the Day Camp area and chipped on-site with a large tree chipper; or loaded on trucks and hauled away to a biofuel generation facility. The County will evaluate the costs and benefits of each method with a diverse selection of arboriculture, tree service and timber harvest companies at the time of removal. The preferred alternative to wood disposal is #2 - chipping on-site. The chips generated from this operation would be utilized to deter understory invasive vegetation next to the project area, suppress mud and invasives in the ropes course area and used as beneficial mulch on other revegetation projects in the park. The task of moving chips around would be accomplished by a combination of volunteer labor from the Heart of the Mountain project and school groups from Wilderness School's ropes course and paid contractors.

The smaller trees and associated slash from the tree removal will be chipped and dispersed throughout the *Eucalyptus* forest understory by County Fire Safe Crews. Both the crew's and the arborist's activities will be scheduled such that they take place outside of the bird nesting season. (March 1-August 15th). A bird nesting survey will be conducted by volunteers prior to tree removal activities.

In addition to tree and slash removal, County Fire Safe Crews will remove all of the targeted invasive non-native plant infestations in the headwaters area. This will include uprooting all invasives such as Himalayan blackberry and English ivy with stems larger than a quarter inch in diameter to prevent resprouting and some small tree removal (see Appendix B for specifications). These activities will take place after bird nesting season (March 1-August 15th).

Following the initial and thorough removal of invasive brush and trees within the area, erosion control can be installed in the project area. The following winter the "Heart of the Mountain" program will then revegetate and maintain the site by removing any targeted non-native plants that might reinvade the newly opened habitat while the native scrub is becoming established.

Other Invasives

Additionally, the Heart of the Mountain volunteer program will continue to work on controlling other pioneer populations of target invasive species listed below throughout the rest of the Bog trail site:

English ivy (*Hedera helix*) is the dominant invasive species in the understory of the eucalyptus and Monterey cypress stands. It is located throughout the project area and will need to be removed prior to any native plant revegetation. Hand removal of the above-ground portion followed by removal of the main roots with pulaskis or pick-mattocks. Follow-up removal of resprouts will be conducted as needed. Seedlings from bird dispersed seed will also be removed.

Purple velvet grass (*Holcus lanatus*) is distributed throughout the site, particularly in the wet meadow areas along the lower Bog trail. This species has established adjacent upper the upper creek site. Because of its presence next to the proposed restoration site it will need to be actively controlled prior to seed set to reduce the potential for further colorization. The best control method for this perennial grass is hand removal of the whole plant including roots, ideally before seed set in early summer. If seeds are present, removed grasses should be bagged to prevent further seed dispersal. Repeated removal for a number of years is required because the seed bank is believed to remain viable for several years.

Cape ivy (*Delairea odorata*) is a highly invasive South African vine that has colonized over a third of the site. This species is very difficult to control or eliminate because it can spread vegetatively through stolons. It can reproduce a new population from just one node dropped or left behind, so complete removal including all of the roots and shoot material is necessary. Although complete eradication of this plant may be difficult to impossible from the site due to its current establishment among dense native scrub and willow riparian stands, the goal is to eradicate it from the restoration area. This effort would be coordinated with the complete removal of all other non-native understory vegetation which will allow follow up removal of any resprouts.

Removal of Cape ivy requires careful hand removal. Repeat follow up removal of all of the roots and stems is required every couple of months for a year to assure complete eradication. All plant and root material of cape ivy needs to be composted in the adjacent eucalyptus forest where Cape ivy is already present.

Poison hemlock (*Conium maculatum*) is present in several dense stands across the larger bog trail site. No populations have been observed in or adjacent to the upper creek restoration area.

Two of the main poplations in the bog area were controlled this year (2004), and will require at least an additional two years of follow-up. The other populations will need to be controlled this summer.

Hand pulling of poison hemlock is effective, especially prior to seed set, and easiest when the soil is wet. Because of the biennial nature of the plant, the primary tap root system needs to be pulled or it will resprout. Its seeds are viable for over three years so pulling before seed set is important and elimination from an area will require at least a four year commitment.
Poison hemlock is a highly toxic plant and gloves need to be worn when working with it. Hands should be washed after removal and before eating any foods.

Himalayan blackberry (*Rubus discolor*) is present in patches throughout both the overall site, as well as the upper creek restoration area. This species, along with Cape and English ivies are the dominant invasives in the understory of the eucalyptus proposed for removal along the creek. These Himalayan blackberry infestations will be removed, including the main tap root by the County fire crews, ideally leaving only new seedlings for the volunteer program to control in coming years.

Mechanical removal may be the most effective ways of removing the upper portions of mature plants. Most mechanical control techniques, such as cutting or using a weed wrench, are suitable for Himalayan blackberry. Care should be taken to prevent vegetative reproduction from cuttings.

Removing rootstocks by hand digging is a slow but effective way of destroying Himalayan blackberry, which resprouts from roots. The work must be thorough to be effective because every piece of root that breaks off and remains in the soil may produce a new plant.
Perennial weeds such as Himalayan blackberry usually require several cuttings before underground plant parts exhaust their reserve food supply. If only a single cutting can be made, the best time is when plants begin to flower. At this stage the reserve food supply in the roots has been nearly exhausted, and new seeds have not yet been produced.

Pampas grass (*Cortaderia jubata*) is not currently on the site but has been removed recently suggesting there is seed fall blowing into the site from upwind. Because we will be exposing # of acres as part of restoration this species may seed into the site and will need to be removed prior to seed set.

Pulling or hand grubbing jubata grass seedlings is highly effective. Seedling leaves are shiny, stiff, and erect. For larger plants, however, a pulaski, mattock, or shovel are the safest and most effective tools for removing established clumps. To prevent resprouting, it is important to remove the entire crown and top section of the roots. Detached plants left lying on the soil surface may take root and reestablish under moist soil conditions. A large chainsaw, gas powered hedge trimmer or weed-eater can expose the base of the plant, allow better access for removal of the crown, and make disposal of the detached plant more manageable. Infestations sometimes can be averted by planting disturbed sites with desirable vegetation to prevent jubata grass seedling establishment.

Panic veldt grass (*Ehrharta erecta*) is currently growing around the main parking area adjacent to the bog trail area and needs to be controlled there as wellas monitored along the trail to assure it does not spread into the site.

Ehrharta control efforts are still new, and more information is needed. Manual removal of Ehrharta must take care to remove the buried base of the plant, or resprouting will occur. Removal by hand is labor-intensive and will probably stimulates germination from the seedbank. Extremely high densities of emerging seedlings have been observed following manual removal. Manual removal must be repeated as plants emerge from the seedbank. Regardless of the method used, more than one year of treatment will be necessary, due to its extensive seedbank, the persistence of which is unknown.

Erosion control:

Before any tree or vegetation removal takes place upslope of the creek a silt fence will be installed along the upper edge of the creek channel to prevent sediment from flowing into the water of the creek. Additionally for the areas cleared upslope of the creek certified weed free straw will be spread at 6 inches deep (USFS Standard of 600sq. ft./bale) and straw wattles will be installed every 10-20 foot intervals along the creek bank to slow and dissipate any surface runoff across areas cleared of invasive vegetation. These erosion control efforts will be monitored at least once a week during the rainy season and any problems will be immediately addressed.

Propagation:

Doug Allshouse with the “Friend of San Bruno Mountain” Mission Blue Nursery will be growing most of the plants for the project. The costs per plant are $ 1.50 for 4 inch pots, $ 1.25 for 2 inch pots, and $ 1.00 for grasses in leach tubes. These prices are excellent when compared to costs at other native plant nurseries and the Mission Blue nursery focuses exclusively on growing plants from San Bruno Mountain propagule sources, so we are assured locally adapted natives. Table # below shows the cost per acre for revegetation on 3 and 4 foot planting centers. Planting individual native plants on three foot planting centers is ideal to establish a dense enough cover of native shrubs and forbs to compete with non-native plant species and prevent reinvasion. Planting on four foot centers will require 60% less plants and there associated costs, but will require more maintenance weeding while the open space between plantings fills in from seedlings of the original plantings. Due to limited funds we will plan to plant on four foot centers and try to fund raise the cost of the addition plants.

The Fort Funston nursery has over the past few years donated space and potting materials to the “Heart of the Mountain” project and can continue to provide space for propagating 1,500 to 2,000 native plants. This will still require several volunteer workdays at the Funston nursery to seed and transplant the natives.

Table 2: Per acre costs for propagating native plants on 3 and 4 foot planting centers.

pot size	cost per plant	# of plants on 3 ft. centers	cost $	# of plants on 4 ft. centers	cost $
4 inch pots	$1.50	2600	$3,900.00	1500	$2,250.00
2 inch pots	$1.25	2600	$3,250.00	1500	$1,875.00

grasses in leach tubes	$1.00	560	$560.00	250	$250.00
totals		5760	$7,710.00	3250	$4,375.00

Species Selection:

Species proposed for revegetation were generated from native plants listed for the "Saddle Area" from "A Flora of San Bruno Mountain". (Mc Clintock et. al., 1990) The primary plant community that will be revegetated in the areas up slope away from the creek channel will be coastal scrub. (Table 3) This plant community surrounds the site and will be effective once established at discouraging reinvasion of the area by non-native invasive plant species. In addition a species list of rushes and sedges (Table 4) that can be revegeted directly through field divisions was generated as well as a native annual species list for annual species need to be directly seeded on to the restoration areas. Additionally, a native plant list for the wet meadow area above the road and the creek corridor below the road (Table 4) was generated for revegetation of these plant communities.

Due to the long term grazing history in and around the site, fire suppression and the invasion of numerous exotic species, there are no undisturbed ideal reference sites to mirror. So the estimation of the relative proportion of each species within a plant community mix is based on general observations of the adjacent plant communities and similar local plant communities.

Each species has been placed into one of the following relative abundance categories; abundant (7%), common (5%), occasional (2-3%), infrequent (1%) and rare (0.2%). These percentages were used to generate the

Table 3: Coastal scrub species list with relative percentages for outplanting goals.

Botanical Name	Common Name	%
Achillea millefolium	Yarrow	5
Anaphalis margaritacea	Pearly Everlasting	1
Artemisia californica	California Sagebrush	7
Baccharis pilularis	Coyote Brush	7
Calystegia occidentalis	western morning-glory	0.2
Castilleja wightii	Wight's Paint Brush	1
Chlorogalum pomeridianum	Soap Plant	1
Danthonia californica var. California	California Oatgrass	5
Elymus glaucus	wild rye	5
Eriogonum latifolium	Wild Buckwheat	5
Eriophyllum staechadifolium	Lizard-tail	7
Festuca rubra	Red fescue	2
Grindelia hirsutula	Gum Plant	3
Heracleum lanatum	Cow Parsnip	1
Heteromeles arbutifolia	Toyon, Christmas Berry	0.2
Hordeum brachyantherum	Meadow barley	5
Horkelia californica	California Horkelia	3

Iris douglasiana	Douglas Iris	1
Iris longipetala	Coast Iris	1
Lupinus variicolor	Varied Lupine	3
Marah fabaceus	Manroot	0.2
Mimulus aurantiacus	Bush Monkey Flower	7
Monardella villosa	Coyote Mint	1
Nassella pulchra	Purple Needlegrass	5
Phacelia californica	California Phacelia	2
Potentilla anserine	Potentilla	3
Rhamnus californica	Coffeeberry	7
Sambucus racemosa var. racemosa	Red elderberry	0.2
Satureja douglasii	Yerba Buena	3
Scrophularia californica	Bee Plant	7
Solanum umbelliferum	Blue Witch	0.2
Solidago spathulata ssp. spathulata	Coast Goldenrod	1
Total		100

Table 4: Native species list for creek and wet meadow revegetation.

Botanical Name	Common Name	creek	wet meadow
Agrostis exarata	spike bent grass		x
Artemisia douglasiana	Mugwort	X	
Carex barbarae, densa	Santa Barbara sedge	X	x
Carex densa	dense sedge	X	x
Carex harfordii	Harford's sedge	X	x
Carex obnuta	Slough sedge	X	x
Carex subbracteata	Carex	X	x
Carex tumulicola	foothill sedge	X	x
Cornus sericea ssp. Sericea	Creek or American Dogwood	X	
Danthonia californica	California oat grass		x
Deschampia cespitosa	Tufted hairgrass		x
Equisetum arvense	Common Horsetail, Field Horsetail	X	x
Equisetum telmateia ssp. Braunii	Giant horsetail, Horsetail fern	X	x
Heracleum lanatum	Cow Parsnip	X	x
Heteromeles arbutifolia	Toyon, Christmas Berry	X	
Hordeum brachyantherum	Meadow barley	X	x
Horkelia californica	California Horkelia	X	
Juncus balticus	Rush	X	x
Juncus effusus var. brunneus	Bog Rush	X	x
Juncus effusus var. pacificus	Pacific Bog Rush	X	x

Juncus occidentalis	Rush	X	x
Juncus patens	Spreading Rush, Common Rush		x
Juncus phaeocephalus	Rush	X	x
Lonicera involucrate	Coast Twinberry	X	
Marah fabaceus	Manroot	X	
Marah oreganus	Wild Cucumber, Man-root	X	
Mimulus guttatus	Common Monkey Flower	X	x
Myrica californica	California Wax Myrtle	X	
Oemleria cerasiformis	Oso Berry	X	
Potentilla anserine	Potentilla	X	x
Rosa gymnocarpa	Wood Rose	X	
Salix lasiolepis	Arroyo Willow	X	
Sambucus racemosa var. racemosa	Red elderberry	X	
Scirpus cernuus	low club rush	X	x
Scrophularia californica	Bee Plant	X	
Sisyrinchium californicum	Golden-eyed grass		x
Stachys ajugoides var. rigida	Hedge Nettle	X	x
Trifolium wormskioldii	Cow Clover, Coast Clover		x
Urtica dioica ssp. Holosericea	Coast Nettle	X	
Vicia gigantean	giant vicia	X	

Propagule Collection Site Selection:

All of the seeds collected for revegetation and direct seeding will come from San Bruno Mountain to assure that all plants are locally adapted. Most of the native seed has been and will be collected from within the watershed of Colma Creek with the majority coming from the adjacent slopes and bog trail area.

Native seed has been collected by the dedicated volunteer Leroy French and by the "Heart of the Mountain" volunteers. Seeds have been and will be collected by hand in paper envelopes or grocery bags. To protect propagule resources, no more than 10% of the seeds from any 1 population or individual plant will be collected throughout the season. Seeds will be collected from each species throughout its ripening season in order to include a diverse range of flowering times in the collection pool. Divisions will be extracted using flat-bladed shovels leaving the majority of the parent plant and root stock to assure regrowth.

Outplanting:

Map 1 includes a detail of the areas scheduled for invasive removal and subsequent revegetation the following fall. The native coastal scrub mix will be planted at a density of a plant every 3 to 4 sq. ft. Planting on three foot centers is ideal to establish full native plant cover within several years of revegetation and prevent the reinvasion of aggressive non-natives. Planting on four foot centers may be necessary if we can't raise funds to pay for the additional plants. Larger species such as toyon (*Heteromelies arbutifolia*) and California wax myrtle (*Myrica californica*) will be planted as individuals or in clusters of 1 to 3. Most scrub species and all the sub-shrubs and grasses will be planted in clusters of 3 to 7 individuals to mimic natural patchiness. Clusters of the remaining individual species will be randomly distributed within the planting areas.

Outplanting will be phased over three years starting in the November of 2005 and continuing through February 2009. All outplanting will be accomplished through community volunteer workdays and will take place between November following the first rains and finish by the end of January to assure newly planted plants can become established before the on set of the dry season in late April to mid May. Because of this need to plant during the first half of the rainy season, any invasive tree or vegetation removal will need to be finished by mid November or revegetation of that area will need to be postponed to the following November. Several native annual species such as the California poppy and annual lupine will be directly seeded on the site following outplanting of the perennial natives.

To transport the thousands of plants to the site for planting days will require the availability of a county flat bed truck to transport plants from both the Friends of San Bruno Mountain nursery in South San Francisco and the Fort Funston nursery.

Site Preparation:

All invasive plant removal and erosion control measures will need to be installed prior to the onset of winter rains in November for an area to be revegetated that year. Due to the restrictions of bird nesting season (March 15 through August 15), large scale invasive tree and brush removal for a particular area will need to be accomplished either the winter before or within the August 15th through November 15th timeframe. If delays in work push the completion of planting past the end of January the plants will need to be held over until the following year due to inadequate establishment time during the rainy season and the inability to irrigate on this remote site.

Due to the healthy population of brush rabbits on San Bruno Mountain some species will require installation of herbivore protection in the form of small plastic mesh cylinders. Additionally, the single cable fencing that is currently installed adjacent to the active restoration site will need to be placed on either side of the roadway to prevent visitors from trampling the newly planted natives.

Documentation:

A baseline of photo-points will be taken to establish original conditions of the site and then subsequent years to visually document the changes. All on site activities as well as volunteer hours will be documented through “worked performed” data sheets to be totaled at the end of each year in a project progress report.

At the completion of the three year project a concluding report will be written to document all of the activities and accomplishments. This report will include a maintenance plan for future stewardship of the site and fund raising priorities for continuation of the volunteer “Heart of the Mountain” program.

Stewardship:

Seed gathering, outplanting, and ongoing invasive plant species control within the restoration areas will be accomplished with the assistance of community volunteers during regularly scheduled volunteer workdays. Volunteer recruitment and management will be the job of the Stewardship Coordinator. The position description and associated budget are attached (Appendix A) The “Heart of the Mountain” stewardship position is sponsored by the non-profit “The Watershed Project”.

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Below are specifications for vegetation removal by the San Mateo County fire-safe crews:

1.) Prior to any vegetation removal crews doing work on the site Heart of the Mountain staff will provide the crew with a short training on the sensitivity of the native plants present and the sensitivity of the creek. Prior to work starting in an area priority native plant species will be flagged or salvaged to reduce the impact.

2.) The priority areas of invasive vegetation have been mapped (Plate 1) and prioritized.

3.) Large logs generated during the removal will need to be cut into no greater than two-foot lengths and hauled by the crews to the old group campsite just above the site.

4.) Removal of Himalayan blackberry, English ivy and other shrubby invasive vegetation will be completed using power tools such as brush cutters and/or hedge trimmers. Plants will be cut back to the root stalk and any root stalk wider than ½ inch will be grubbed out using hand tools to prevent resprouting.

5.) The debris generated by brush removal will be hauled by the county fire crews into the adjacent tree stands (see map) and allowed to decompose.

6.) Due to bird nesting season which runs from March 15th through August 15th , trees and/or large scale brush removal will take place between August 16 through March 14th.