

FINAL REPORT

San Bruno Mountain Gorse Control Project



Prepared for:

County of San Mateo
Environmental Services Agency
Parks and Recreation Department
455 County Center, 4th Floor
Redwood City, CA 94063-1646
Contact: Sam Herzberg
(650) 363-1823

Prepared by:

May & Associates, Inc.
182 Seal Rock Drive
San Francisco, CA 94121
415-391-1000
Contact: Loran May

In Association with:

Shelterbelt Builders, Inc.
1207 10th Street
Berkeley, CA 94710
(510) 841-0911
Contact: Mark Heath

December 2008

TABLE OF CONTENTS

0.0 EXECUTIVE SUMMARY	3
1.0 INTRODUCTION	4
1.1 Project Background.....	4
1.2 Project Goals and Objectives	4
1.3 Overview of Project Elements	7
2.0 SUMMARY OF INITIAL GORSE REMOVAL EFFORTS	8
2.1 Identification of High Priority Gorse Sites and Selection of Gorse Treatment Areas.....	8
2.2 Selection of Gorse Treatment Methods	9
2.3 Description of Initial Gorse Treatment Activities	12
3.0 SUMMARY OF FOLLOW-UP GORSE TREATMENTS	16
4.0 SUMMARY OF PILOT WETLAND RESTORATION ACTIVITIES	25
4.1 Wetland Restoration.....	25
4.2 Wetland Restoration Site Maintenance.....	28
5.0 EDUCATION AND OUTREACH ACTIVITIES.....	29
6.0 SUMMARY OF VEGETATION MONITORING	30
6.1 Vegetation Monitoring Methods.....	30
6.2 Summary of Baseline Vegetation Monitoring Site Conditions	32
6.3 Summary Comparison of Vegetation Monitoring Results 2004 to 2008	33
7.0 GORSE MAPPING AND PHOTOMONITORING EFFORTS.....	35
8.0 DEVELOPMENT OF LONG TERM MAINTENANCE PLAN.....	36
8.1 Purpose of the Long Term Maintenance Plan.....	36
8.2 Ongoing Gorse Detection and Removal	36
8.3 Optional Treatment of Secondary Invasive Species	37
8.4 Ongoing Vegetation Monitoring.....	38
8.5 Targeted Invasive Species Monitoring	38
8.6 Volunteer Stewardship Program and Staffing	39
8.7 PRIORITY MAINTENANCE ACTIONS FOR STAFF OR CONTRACTORS.....	42
9.0 RESULTS AND DISCUSSION	44
9.1 Summary of Gorse Monitoring Results	44
9.2 Summary of Results of Secondary Invasive Plant Treatments.....	44
9.3 Results of the Pilot Wetland Revegetation	45
10.0 LESSONS LEARNED.....	47
11.0 REFERENCES	50

TABLES AND FIGURES

Table 1.a Annual Gorse Success Criteria

Table 1.b Annual Pilot Wetland Restoration Success Criteria

Table 2.3. Description of Gorse Control and Project Management Activities in 2004

Table 3.1. Description of Gorse Control Follow-up and Project Management Activities in 2005

Table 3.2. Description of Gorse Control Follow-up and Project Management Activities in 2006

Table 3.3. Description of Gorse Control Follow-up and Project Management Activities in 2007

Table 3.4. Description of Gorse Control Follow-up and Project Management Activities in 2008

Table 4.1. Plants Installed at the Pilot Wetland Restoration Site

Table 6.3 Vegetation Monitoring Data Comparison, 2004 to 2008

Table 8.6. Suggested Volunteer Work Plan for Long-term Gorse Control Project

Table 9.3 Comparison of Baseline (2006) and End of Project (2008) Monitoring data at the Pilot Wetland Restoration Site

Figure 1. Project Location

Figure 2.1. Location of Gorse Treatment Areas

Figure 4.1 Location of Pilot Wetland Restoration Site

Figure 6.1 Locations of Vegetation Sampling and Photo Monitoring

APPENDICES

Appendix A. Educational Materials

Appendix B. List of Plant Species Observed

Appendix C. Site Photos and 2004 to 2008 Photo Monitoring Comparisons

Appendix D. Suggested Strategic Grassland/Butterfly Restoration Opportunities

0.0 EXECUTIVE SUMMARY

The San Bruno Mountain Gorse Control and Revegetation Project (Project) was initiated in fall 2004, with the objective of achieving sustained control of at least 31 acres of gorse (*Ulex europaeus*), an invasive non-native plant. Gorse infestations at San Bruno Mountain were evaluated and prioritized prior to control efforts, with the locations depicted in Figure 1 identified as the highest priority areas for controlling the spread of gorse.

This 4-year grant funded project included the following elements:

- initial removal of mature gorse;
- retreatment of gorse re-sprouts and seedlings in previously treated areas;
- control of secondary invasive non native plant species in selected locations within the treatment area; and
- planning and implementing a pilot wetland restoration project.

A total of 31 acres was initially identified as the highest priority for control, however the program was actually able to remove and maintain gorse within 49.5 acres (18.5 acres in excess of the original estimate) by using cost efficient control techniques.

This report summarizes all activities conducted under the 4-year grant funded program. This report is organized into the following sections:

- Project Background
- Project Goals and Objectives
- Initial Gorse Removal Efforts
- Follow-up Gorse Treatments
- Pilot Wetland Restoration Activities
- Public Education Activities
- Summary of Vegetation Monitoring Results
- Gorse Mapping and Photomonitoring
- Results and Discussion
- Lessons Learned

In summary, a total of 49.5 acres of gorse were successfully treated under the Project (Figure 1). Monitoring results collected from 2005 to 2008 indicate that the gorse removal effort was successful, with the estimated total gorse cover of 2.4% measured along the sampling transects at the end of the Project in 2008. The Project has exceeded the target goal of no more than 5% gorse seedlings and no mature plants present by the end of 2008.

Funding for the Project was provided by a grant from the State of California Proposition 12 bond fund.

1.0 INTRODUCTION

1.1 Project Background

The San Bruno Mountain Gorse Control and Revegetation Project (Project) was initiated in fall 2004, with the objective of achieving sustained control of gorse (*Ulex europaeus*), an invasive non-native plant. Gorse infestations at San Bruno Mountain were evaluated and prioritized prior to control efforts, with the location depicted in Figure 1 identified as the highest priority areas for controlling the spread of gorse.

This 4-year grant funded project included the following elements:

- initial removal of mature gorse;
- retreatment of gorse re-sprouts and seedlings in previously treated areas;
- control of secondary invasive non native plant species in selected locations within the treatment area; and
- planning and implementing a pilot wetland restoration project.

A total of 31 acres was initially identified as the highest priority for control, however the program was actually able to remove and maintain gorse within 49 acres (18.5 acres in excess of the original estimate) by using cost efficient gorse control techniques,.

Funding for the Project was provided by a grant from the State of California Proposition 12 bond fund.

1.2 Project Goals and Objectives

The overall goal of the gorse control project was to demonstrate effective control of gorse and successful restoration of a pilot wetland site.

The specific objective of the gorse control project was the sustained control of gorse, such that all mature gorse was controlled and no more than 5% vegetative cover of emerging gorse seedlings colonized the treatment area by the end of the program (December 2008). Refer to Table 1a for a summary of annual success criteria used for gorse control efforts.

Table 1a. Annual Gorse Success Criteria

Year of Project Implementation	Cover of Gorse Species (%)
1 (Fall 2005)	15
2 (Fall 2006)	10
3 (Fall 2007)	7
4 (Summer 2008)	5

Complete eradication of gorse was not considered as a realistic goal for the project for the following reasons:

- the project area is surrounded by gorse-infested areas that were not treated, therefore providing a potential source population that could re-infest the treated areas; and
- the existing gorse seed bank is suspected to be well established. Gorse seeds remain viable for many years, requiring more than 4 years of grant-funded treatment for complete eradication.

In addition to gorse control, a pilot wetland revegetation project was undertaken to demonstrate the effectiveness of active restoration at the site in controlling gorse and other invasive plant species. Success criteria for the pilot revegetation program were at least 80% survival of plantings by the end of the program in December 2008. Annual success criteria are provided below in Table 1b.

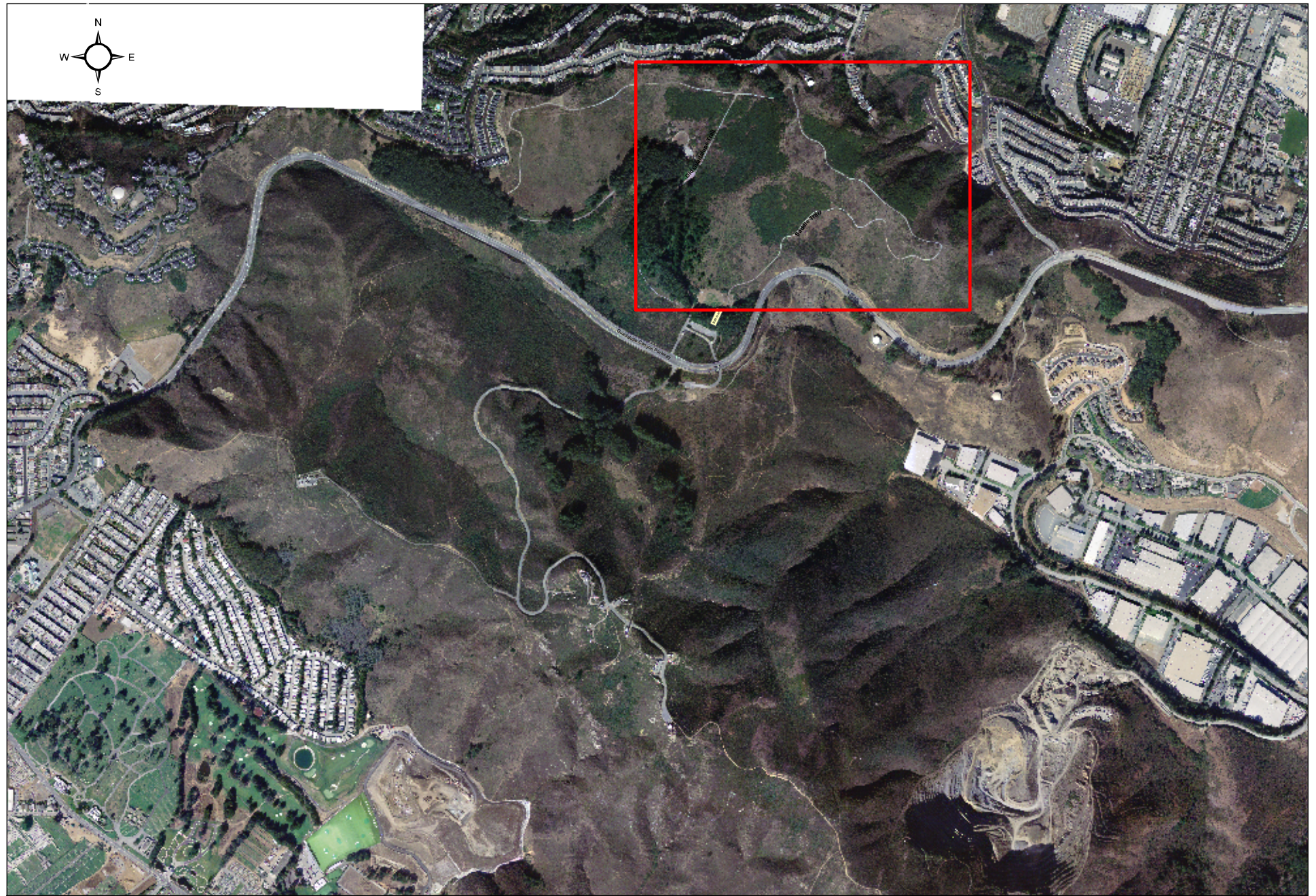
Table 1b. Annual Pilot Wetland Restoration Success Criteria

<i>Year of Project Implementation</i>	<i>Survivorship of Revegetation Plantings (%)</i>
<i>2 (Fall 2006)</i>	<i>90</i>
<i>3 (Fall 2007)</i>	<i>85</i>
<i>4 (Summer 2008)</i>	<i>80</i>

Both invasive non-native plant control and native plant species out-planting activities were undertaken as a part of the pilot wetland restoration project. An adjacent intact native wetland community was used as a reference site for revegetation.

Figure 1. Project Location

Figure 1. Project Location



 Project Area

0 312.5 625 1,250 1,875 2,500 Feet

May & Associates, Inc., October 2004

1.3 Overview of Project Elements

The San Bruno Mountain gorse control project included the following elements:

1. Identification of high priority gorse infestations and selection of the treatment area.
2. Selection of gorse treatment methods
3. Development of education and outreach materials
4. Initial treatment of mature gorse
5. Follow-up treatment of gorse re-sprouts and seedlings
6. Development and implementation of a pilot wetland restoration project
7. Annual vegetation and photo monitoring
8. Preparation of a long term monitoring plan
9. Preparation of annual work plans, progress reports, and a final report.

These program elements are described more fully in the following sections

2.0 SUMMARY OF INITIAL GORSE REMOVAL EFFORTS

2.1 Identification of High Priority Gorse Sites and Selection of Gorse Treatment Areas

One of the first actions taken under the Project was to assess San Bruno Mountain's gorse infestation areas and to prioritize and select gorse patches for treatment under of the grant-funded program. Given budgetary constraints, treatment of all gorse infestations at San Bruno Mountain was not a realistic goal of the project.

High priority gorse sites were selected using the following characteristics:

- Areas with high natural resource values (such as endangered species habitats);
- Areas adjacent to intact native ecosystems;
- Selection of sparse or outlier gorse populations (i.e. new gorse infestations that could become problem infestation sites in the future); and
- Leading edges of expanding and/or dense gorse infestation(s);

A total of 31 acres was initially identified as the highest priority for control, however the program was actually able to remove and maintain gorse within 49.5 acres (18.5 acres in excess of the original estimate) by using cost efficient control techniques.

Refer to Figure 1 for the location of the 49.5 acres of gorse treatment areas that were selected under this project.

Three types of gorse infestations were defined for this project: outlier infestations, scattered individuals, and dense infestations, defined below. Of the 49.5 acres of mature gorse that were treated, approximately 2.86 acres were considered outlier infestations; 23.73 acres were defined as scattered individuals and 22.94 acres were considered to be dense infestations.

Outlier infestations were defined as dense gorse stands (80-100% cover) which were either situated in topographical areas which made it difficult or impossible to access with heavy equipment, or were situated adjacent to sensitive ecological resources (therefore requiring minimal disturbance to protect the sensitive resources). A total of 2.86 acres of outlier infestations were identified within the selected treatment areas.

Scattered individuals were defined as individual plants or small clusters of plants that were situated within an otherwise intact natural ecosystem. Scattered individuals were mostly pioneer new infestations spreading outward from more established gorse infestation areas into nearby natural habitats. A total of 23.73 acres of scattered individuals were identified within the selected treatment areas.

Dense infestations were defined as dense gorse stands which were situated in areas that could be accessed with heavy equipment. A total of 22.94 acres were considered to be "dense" mature stands of gorse where gorse formed a monoculture of 80-100% cover of gorse (as observed at the beginning of the project).

2.2 Selection of Gorse Treatment Methods

Following selection of treatment areas, varying gorse treatments were considered, then selected for use. Selected treatment methods were based on the following selection criteria:

- Treatment efficacy (based on best available scientific research on gorse control);
- Anticipated cost-benefits assessment;
- For herbicide use, the least amount of toxicity combined with most anticipated efficacy; and
- Gorse infestation location, density, and other site characteristics that could affect treatment options.

Base on the above selection criteria, the following combination of treatments were selected for the project.

Treatment of Outlier infestations - Gorse control methods in these areas focused on mostly herbicide treatment in inaccessible areas (i.e. limited localized cutting and treating of cut stumps with herbicide, and/or foliar application of herbicide to entire plants).

Treatment of Scattered individuals – Control methods in these areas focused on contractors traversing the area to detect gorse individuals and then selecting one of the following treatment options: spot foliar treatment of herbicide, or cutting and then immediately treating the cut stumps with herbicide.

Treatment of Dense infestations – Dense stands of gorse were treated as follows.

- First mechanical methods were used to reduce the biomass of the gorse. Within dense patches of gorse where topography or rock outcrops prevented effective use of mechanical methods, hand crews used chainsaws, and applied herbicide to the cut stumps. Mechanical methods selected for this project included using large specialty forest management mulching tractors. We used two primary types of equipment: 1) rubber tracked forestry mulchers (Fecon/KMC) and 2) steel tracked excavators with mulching heads. All machines were in the 200-400 HP size classes but being tracked, they all had extremely low ground pressures. The use of these specialty tractors resulted in extremely high daily production rates with minimal ground disturbance.
- Second, the cut gorse was mulched into small pieces, and left in place to reduce potential of inadvertent seed spread from treatment areas. Mulch was 3 to 5 inches in size to facilitate rapid mulching/breakdown, and spread on site no more than 6 inches thick. Mulch was allowed to “hot compost” on site. The thick mulch was intended to suppress seedlings and prevent overwhelming seedling flush during the initial treatment period. Hot composting with mulch was expected to also help to reduce the viability of the long-lived seed bank through increased microbial activity (Chee-Sanford et al, 2006). Soil microbe – seed bank interactions are currently poorly understood but there is some evidence that seed banks can be reduced through soil management. The mulched treatment areas were then assessed regularly for presence of re-sprouts and seedlings (that were then controlled in place). This treatment was selected as the most cost effective way to treat and eliminate green waste, reduce potential for gorse seed spread from treatment areas (e.g., during transport of green waste materials), to suppress the gorse seed bank

(i.e. “cook” the seeds using the hot mulch, and to shade the soil surface to reduce seed viability).

Selection of Herbicides and Notes on Herbicide Use

The following will be considered when determining the appropriate herbicide and application methods.

Garlon4™ (Trichlopyr) was determined to be the most effective herbicide for use on woody plants such as gorse and Himalayan blackberry. It excels at penetrating the woody tissues of gorse. Garlon4™, is dicot specific and thus has limited negative effects on any surrounding native perennial grasses. The intent was to allow for continued grass seed production during gorse treatment to increase the chance that native perennial grasses will naturally colonize the newly disturbed areas.

After mechanically cutting the shrubs, stumps were treated with a 15-25% concentration of Garlon4™ and vegetable oil carrier. Herbicides were applied to the cut stumps after cutting. Smaller infestations, scattered individuals and seedlings were treated with a low volume foliar spray application of 2% Garlon4™ and surfactant in water.

All subsequent follow-up treatment of gorse seedlings and resprouts from 2006-2008 relied on low volume foliar spray applications of Garlon4™ and Aquamaster™. Applications were performed with a spray rid and backpack crews. Proper tip selection ensured adequate coverage and reduce drift. Selective, low volume mixes greatly reduced the amount of herbicide used at the project site while maintaining high efficacy. Aquamaster™ (Glyphosate) was used as a substitute for Garlon4™ in wetland areas. Aquamaster™ is an aquatic approved herbicide for areas that may be adjacent to wetland habitat. Two applications were required to effectively control the plants recruiting seedlings each year. Typically there is a seedling flush in the spring and in the fall.

FIGURE 2.1 SELECTED GORSE TREATMENT SITES

SAN BRUNO MOUNTAIN
GORSE CONTROL PROJECT

FINAL TREATMENT AREAS

Stand #	Area Treated (acres)
1	6.89
2	6.94
3	9.11
A	0.21
B1	2.99
B2	0.28
C	0.42
D	1.95
E1, E2	19.21
F	1.53
Total Area	49.53

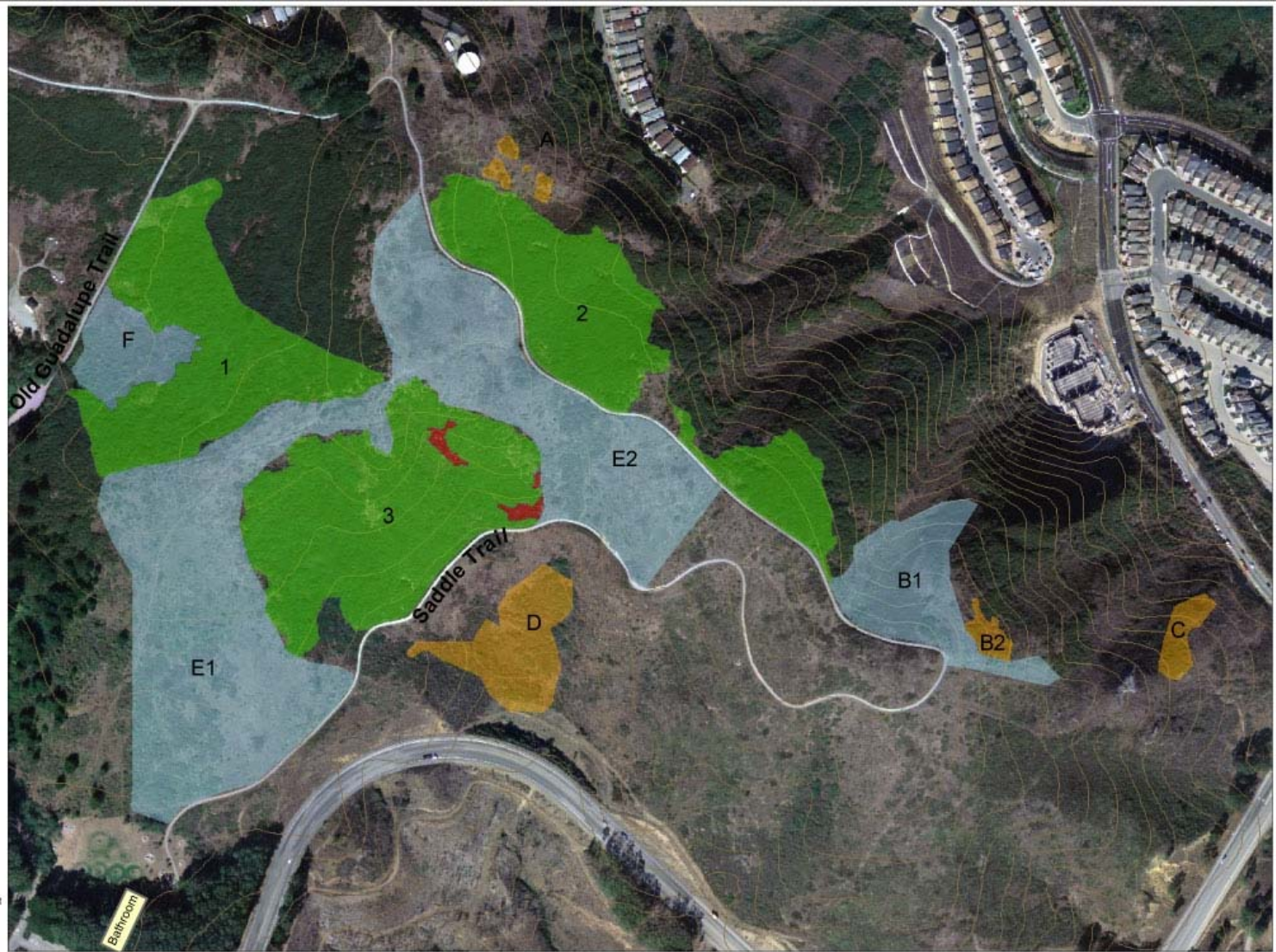
LEGEND

- Dense
- Outlier
- Scattered
- Debris Piles
- 25 ft. contour line



0 55 110 220 330 440 Feet

May & Associates, Inc., December 2008



2.3 Description of Initial Gorse Treatment Activities

Initial gorse control treatment activities that were undertaken in 2004 are summarized below in Table 2.3.

Table 2.3. Description of Gorse Control and Project Management Activities in 2004

Program Management Activities	
1.	Prepared draft Work Plan
2.	Prepared subconsultant specifications and developed individual subcontractor scopes of works
3.	Prepared and submitted Site Activity Permit
4.	Established photomonitoring points and collected baseline site photos
5.	Updated and revised project area map, identified priority stands for removal
6.	Installed temporary protective measures for environmentally sensitive areas within project area and in adjacent areas likely to be impacted by removal activity.
7.	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.
8.	Developed work performed data collection methods and began compiling data from subcontractors
9.	Developed "punch lists" for signing off on subcontractor work
10.	Conducted Environmentally Sensitive Areas (ESA) training with all contractor working on site
11.	Provided work oversight to subcontractors
12.	Initiated preparation of Year 1 annual work plan
13.	Began developing monitoring protocol for assessing performance criteria for Year 1 work
Gorse Removal Activities	
1.	Collaborated with project manager to identify ingress/egress routes to outlier populations to limit disturbance to native vegetation and prevent any impact to ESAs.
2.	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.
3.	Removed over 19 acres of dense stands of mature gorse during 24 hours of labor.
4.	Completed 660 hours of initial gorse removal on approximately 22 acres of areas identified as scattered individuals and outlier patches of gorse.
5.	Mulched and placed gorse biomass in designated areas approximately 3-5" sized pieces, and no thicker than 6" deep.
6.	Cut and treated majority of 49.5 treatment acres of gorse with a 25% concentration of Garlon 4. Treated some small, scattered individuals with a foliar spray application of 10% Garlon 4.
7.	Returned all trails and access points to pre-project condition.
8.	Installed erosion control measures where disturbance occurred from equipment.
9.	Provided project manager with work performed data for all work completed on site.
10.	Worked with Project Management to avoid fire danger during red flag warning days on San Bruno Mountain.



Photo 1. Mechanical gorse removal (2004)



Photo 2. Mulching gorse onsite (2004)



Photo 3. Finished mulched site (2004)



Photo 4. Transport of gorse to chipping/mulching site (2004)



Photo 5. Winching gorse on steep hills (2004)



Photo 6. Close up showing how much depth (2004)

3.0 SUMMARY OF FOLLOW-UP GORSE TREATMENTS

Following the initial removal of the mature gorse in 2004, vegetation treatment activities focused on controlling gorse re-sprouts and seedlings in the treatment areas. Control efforts were implemented several times per year, and included spot treatment of gorse with herbicides and mechanical removal. Beginning in 2006, as gorse seedlings became less common, an increased focus was placed on the control of secondary invasive non-native weeds such as velvet grass, Himalayan blackberry, and dock species (mostly sheep sorrel) with the goal of protecting the overall health of the recovering natural system. Because the control of secondary weeds was not the primary focus of the grant, the successful control of these species was not fully achieved during the Project timeline.

A total of 4 years of follow-up treatments were conducted, between 2005 and 2008. The following Tables 3.1, 3.2, 3.3, and 3.4 respectively summarize follow-up gorse control activities by year:

Table 3.1. Description of Gorse Control Follow-up and Project Management Activities in 2005

Program Management	
1.	Revised project area map identifying final removal boundaries
2.	Conducted annual photo monitoring
3.	Finalized Year 1 annual work plan
4.	Completed draft monitoring protocol for assessing performance criteria
5.	Prepared and Installed Bond Act interpretive sign
6.	Conducted field observations to guide Year 1 work plan
7.	Conducted reference site observations for revegetation
8.	Prepared pilot wetland restoration plan
9.	Reviewed Environmentally Sensitive Areas (ESA) training with all contractors working on site
10.	Provided work oversight to subcontractors
11.	Conducted Year 1 (2005) monitoring to assess gorse treatment areas
12.	Compiled and analyzed June-October 2005 monitoring data.
Gorse Retreatment Activities	
1.	Re-cut gorse stumps greater than 2” in height retreat with herbicides.
2.	Conducted Three follow up treatment of gorse seedlings and re-sprouts. As of June 30, 2005, 75% of the site had been effectively retreated.
3.	Monitored gorse removal areas for efficacy of treatment and alter retreatment schedule accordingly
Pilot Wetland Restoration Activities	
1.	Conducted wetland revegetation reference site monitoring in Fall 2005
2.	Finalized wetland revegetation plan
3.	Implemented initial weed control at revegetation site in July/August 2005 focusing on secondary invasive species removal



Photo 7. Close up of mulched area 1 year after mulching (2005)



Photo 8. Close up showing gorse seedlings after herbicide treatment in Year 2 (2005)



Photo 9. Gorse seedling 'flush' prior to treatment in Year 2 (2005)

Table 3.2. Description of Gorse Control Follow-up and Project Management Activities in 2006

Program Management	
1.	Prepared and submitted Pilot Wetland Revegetation Plan to the County.
2.	Conducted Year 2 Photo-monitoring
3.	Updated San Bruno project schedule
4.	Planned and implemented fall 2006 vegetation monitoring in October 2006
5.	Conducted field observations to guide Year 2 work plan
6.	Finalized Year 2 annual work plan
7.	Provided work oversight to subcontractors
8.	Conducted Year 2 (2006) vegetation monitoring to assess gorse treatment areas
9.	Compiled and analyzed June-October 2006 monitoring data.
Gorse Removal	
1.	Mowed/ Mechanically treated gorse removal areas in Summer 2006 to remove thatch buildup and expose gorse seedlings.
2.	Retreated gorse seedlings with herbicides three times in summer, fall, and winter 2006. As of November 30, 2006, 100% of the site had received three complete follow up treatments.
3.	Monitored treatment areas for efficacy of treatment and modified 2007 annual work plan accordingly
Pilot Wetland Revegetation Site	
1.	Conducted seed collection for revegetation site in May 2006.
2.	Mowed velvet grass in revegetation site in preparation of herbicide treatment, June 2006.
3.	Conducted 3 herbicide applications of velvet grass and other target non-native species within the pilot wetland revegetation site area in July, September, and November 2006.



Photo 10. Gorse seedling 'flush' prior to treatment in Year 2 (2006)



Photo 11. Gorse seedlings in Year 2 (2006)



Photo 12. Overview of wetland restoration site 2006. Note velvet grass treatment completed

Table 3.3. Description of Gorse Control Follow-up and Project Management Activities in 2007

Program Management	
1.	Updated San Bruno project schedule
2.	Planned for monitoring activities.
3.	Conducted Year 3 Photo-monitoring
4.	Compiled and analyzed June-October 2007 monitoring data.
Gorse Removal	
1.	Removed gorse seedlings throughout the site
2.	Mowed/ Mechanically treated gorse removal areas in Summer 2007
3.	Retreated gorse seedlings with herbicides three times in summer, fall, and winter 2007. As of November 30, 2007, 100% of the site had received three complete follow up treatments.
4.	Monitored treatment areas for efficacy of treatment and modified 2008 annual work plan accordingly
5.	Treated last two untreated areas of gorse (steep rocky inaccessible areas)
6.	Treated secondary invasive plants in gorse removal sites including Himalayan blackberry, sheep sorrel and velvet grass.
Revegetation Site	
1.	Installed plants in revegetation site
2.	Follow-up Himalayan blackberry and sheep sorrel treatments in fall 2007. Conducted follow up spot treatment of velvet grass



Photo 13. Overview of “Saddle area” in 2007 showing sheep sorrell infestation (reddish color) and velvet grass infestation (brownish tan color) (2007)



Photo 14. Site overview showing low density of gorse seedlings, increase in grasses and native shrubs by Year 3 (2007)

Table 3.4. Description of Gorse Control Follow-up and Project Management Activities in 2008

Program Management	
1.	Updated San Bruno project schedule
2.	Planned for monitoring activities.
3.	Conducted Year 4 Photo-monitoring
4.	Compiled and analyzed June-October 2008 monitoring data.
5.	Prepare Maintenance Plan
6.	Prepare Final Report
Gorse Removal	
1.	Removed gorse seedlings throughout the site
2.	Retreated gorse seedlings with herbicides three times in summer, fall, and winter 2008. As of December ,1 2008, 100% of the site had received three complete follow up treatments.
3.	Treated last two untreated areas of gorse (steep rocky inaccessible areas)
4.	Treated secondary invasive plants in gorse removal sites including Himalayan blackberry, sheep sorrel and velvet grass.
Revegetation Site	
1.	Follow-up velvet grass, Himalayan blackberry and sheep sorrel treatments in fall and winter 2008.



Photo 15. Site overview showing low density of gorse seedlings, increase in grasses and native shrubs by Year 4 (2008)

4.0 SUMMARY OF PILOT WETLAND RESTORATION ACTIVITIES

A pilot wetland restoration project was undertaken as part of the gorse removal grant-funded project in an attempt to show that active restoration could also be effective in controlling gorse seedling establishment. In 2005 and 2006, a pilot restoration site was identified (Figure 5.0).

4.1 Wetland Restoration

Prior to the restoration effort, the selected site supported approximately 48% non-native plant species, and 52% native plant species. Plants present at the selected site included wetland grasses and forbs, upland grasses, forbs, and scattered native shrubs, and a number of targeted non-native invasive plants, including gorse, velvet grass, Himalayan blackberry, and dock species (mostly sheep sorrel). Gorse was initially removed from the site using a combination of mechanical removal (brush cutting followed by cut and paint herbicide application), and covering with mulch (to prevent soil erosion and suppress the invasive plant seed bank). Additional control continued for all targeted plants in 2005 and 2006 with the objective of controlling most of the invasive plants at the site before active planting began.

Following initial invasive plant control, the site was planted in 2006, with additional plants installed in 2007 and early 2008. Plants selected for installation included a mixture of wetland and upland native species. Refer to the Table 4.1 below for a list of plants, planting numbers, and planting years.






These plantings have continued to grow and spread, increasing overall coverage of native species within the wetland by approximately 10 percent. Survivorship was estimated at the end of the project to be about 85% of the original 2006 installed plants, exceeding project objectives of 80% survivorship by the end of the project.

During 2006, 2007, and again in early 2008 the pilot restoration site was repeatedly spot treated for targeted invasive non-native plant species (mostly velvet grass, several dock species, and Himalayan blackberry). Despite observed reductions in invasive plant cover, velvet grass and dock are still present at the site, and will continue to be problematic at the end of the grant funded project. In contrast, gorse and Himalayan blackberry were successfully controlled by the end of the grant-funded project, with less than 1% gorse seedlings, and less than 5% re-sprouting Himalayan blackberry present at the end of the project. Both gorse and Himalayan blackberry have potential to re-colonize the site from nearby infested areas, therefore, we recommend that the pilot wetland restoration site continue to be monitored and spot treated by County staff following completion of the Project. Refer to Sections 4.2 and 5.1 below for a summary of recommended site maintenance following completion of the grant funded program.

Figure 4.1. Location of Pilot Wetland Restoration Site

Figure 4.1 Location of Pilot Wetland Restoration Site



-  Wetland Restoration Site (0.55 acre)
-  Gorse Removal Area
-  Willow Patch
-  25 ft. contour line
-  Pooled Water 2005 (~110 sq. m)



May & Associates, Inc.
182 Seal Rock Drive ~ San Francisco, CA 94121
(415) 391-1000 ~ www.mayandassociatesinc.com

Table 4.1. Plants Installed at the Pilot Wetland Restoration Site

2006		
Species	Amount	Size
Carex hardfordii	10	SC10
Juncus balticus	98	SC10
Juncus effuses	2,156	SC10
Juncus patens	1,894	SC10
Juncus phaeocephalus	170	SC10
Leymus triticoides	196	SC10
Subtotal 2006	4,524	
2007 Replacement Plantings		
Species	Amount	Size
Achillea millifolium	58	D16
Aster chilensis	77	D16
Carex barbarae	41	SC10
Festuca rubra	96	SC10
Grindelia hirsutula	45	D16
Heracleum lanatum	50	D16
Hordeum brachyantherum	98	SC10
Juncus balticus	28	SC10
Juncus effuses	254	SC10
Juncus patens	1	1 gal
Mimulus guttatus	94	SC10
Nassella pulchra	30	D16
Ranunculus californica	6	D16
Sambucus racemosa	10	D16
Subtotal 2007	888	
2008 replacement Plantings		
Species	Amount	Size
Achillea millifolium	20	2"
Eriophyllum stachaedifolium	10	D16
Hordeum brachyantherum	44	D16
Juncus balticus	100	SC10
Juncus effuses	34	D16
Juncus phaeocephalus	98	SC10
Juncus phaeocephalus	25	D16
Nassella pulchra	60	SC10
Rhamnus californica	10	D16
Sambucus racemosa	15	D16
Schrophularia californica	50	D16
Schrophularia californica	16	4"
Sidalcea malvaflora	29	D16
Total	511	
TOTAL PLANTS PRESENT 2008		3846 (=85% of original plantings)

4.2 Wetland Restoration Site Maintenance

Long-term maintenance of the pilot wetland restoration site should include the following elements, as staffing, volunteer opportunities and funding allow. These recommendations recognize that San Mateo County has limited staffing and funding to accomplish site maintenance, and suggest a combination of staff and volunteer labor could accomplish the following:

- Ongoing invasive non-native plant monitoring, especially for velvet grass, dock, Himalayan blackberry, and gorse. Spot-treatment of occurrences with herbicides, when detected. Site monitoring should be conducted in February and April for velvet grass, and August or September for Himalayan blackberry, gorse, dock, and other invasive species;
- Mulch the edges of the site with rice straw (4-8 inches thick) to provide a buffer between the restoration site and surrounding areas that are still infested with these and other invasive species (Note: although some invasive plants are wind dispersed, heavy mulch typically prevents seed germination by preventing soils-seed contact, and by suppressing the existing seed bank);
- As funding allows, consider additional plantings. Plant survivorship at the restoration site indicates that the native plants have established along a moisture gradient, with upland species such as yarrow (*Achillea millefolium*), purple needlegrass (*Nasella pulchra*), and California oatgrass (*Danthonia californica*) establishing at the highest and driest end of the planting zone, aster in the middle zone, and rushes (*Juncus* sp.) at the lowest and wettest end of the planting zone. Two species that were planted at the site, carex (*Carex barbarae*) and mugwort (*Artemisia douglasiana*) did not do well, and should be replaced with species such as aster and rushes that established well at the site. Additional plantings will help increase in plant diversity of the wetland site, and reduce areas of secondary weed colonization.

Volunteers can be integrated into this wetland restoration project to perform activities such as planting, small-scale weed control, mulching and monitoring.

5.0 EDUCATION AND OUTREACH ACTIVITIES

An important aspect of the Project was the development of a public education strategy that was used in outreach efforts. Educational materials developed under the gorse control project included the following:

- Interpretive signs posted at San Bruno Mountain to highlight and explain the gorse removal project;
- An educational brochure and informational letter targeting neighbors, interested park visitors, and others who visit the project area. Letters and fliers were distributed by the County to 1,560 adjacent property owners within 1500 square feet of the San Bruno Mountain parcel boundaries. Additional brochures were provided to the County Recreation Park staff and to all work crews for distribution to interested recreation/park users throughout the course of the grant-funded project; and
- A “question and answer” fact sheet that was used by onsite workers during active gorse removal activities. A Biological monitor was also present during large-scale mechanical removal to answer public questions about the project.

These outreach efforts were considered essential elements to garnering the support of neighbors and park recreationists/park users and to inform the public about what the goals and objectives of the Project. Refer to Appendix A for educational materials developed under the Project.

6.0 SUMMARY OF VEGETATION MONITORING

6.1 Vegetation Monitoring Methods

A vegetation monitoring program was developed to detect changes in vegetation composition in gorse control areas, with emphasis on detecting small amounts of gorse within a variety of habitats (e.g. non-native annual grasslands, coastal scrub, wetlands, butterfly habitat areas, etc) and ecological settings (e.g. within dense and sparse gorse stands, within flat, sloped, and transitional areas, and in wet and dry areas).

Several different vegetation monitoring techniques were employed for this project, with the intent that data would be compared annually to look for anomalies or skewed results between data sets. Data was also collected within both gorse treatment areas and in untreated intact control habitats (with similar site characteristics but where gorse was absent), to help correct for seasonal differences in vegetation composition between sampling years due to wet or dry seasonal conditions and other environmental variables.

Three types of vegetation monitoring methods were employed: Point/line intercept data along permanent monitoring transects; quadrat monitoring using a meter square sampling quadrat at permanent locations both in treatment and control habitats of the same type and ecological setting, and visual vegetation cover and composition estimates. These various monitoring techniques are described in more detail below.

Transects. A total of 12 permanent transects were established within dense and sparse gorse removal sites; at reference habitats (for use in assessing annual changes in vegetation not related to site treatments); and at the pilot wetland revegetation site. Refer to Figure 6.1 for the location of sampling transects. Of the 12 transects, eight were 100 meter transects, and four were 50 meter transects (due to terrain or shape of treatment areas).

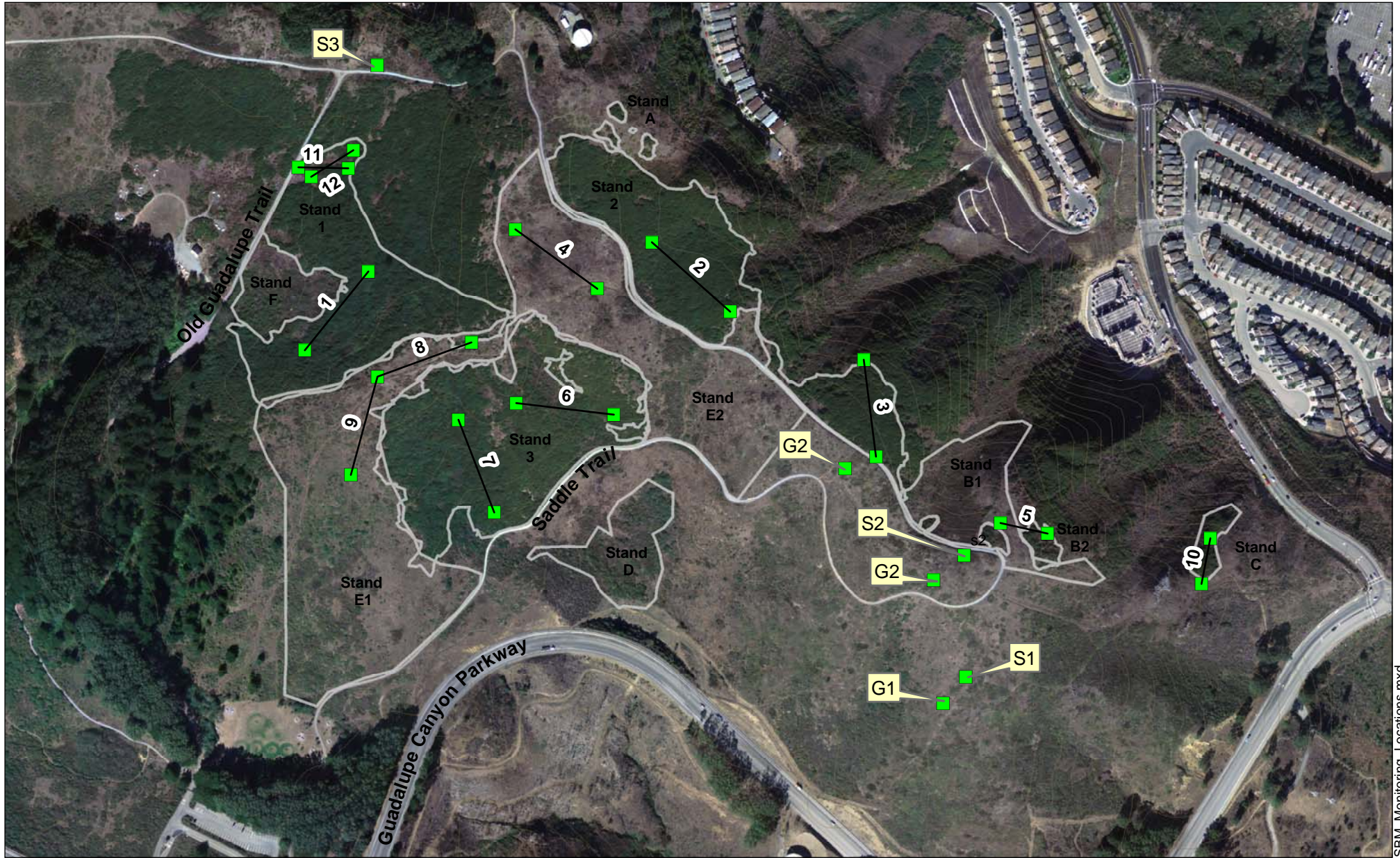
Presence/absence of gorse was recorded at 1 meter intervals along each transect. If detected, the gorse life stage (i.e. seedling or re-sprout) was noted. This monitoring methodology was intended to provide a rough assessment of presence/absence information for gorse, and is not intended to be a statistically accurate measurement of gorse cover at the site.

Quadrats. Quadrats were established at each end point of the 12 sampling transects. A total of 24 quadrats were established and monitored on an annual basis. Relative cover of gorse was recorded within each transect, and gorse life stage (i.e. seedling or re-sprout) was noted. In addition, all species present within the sampling transect were noted, and an estimate of relative native versus non-native vegetation cover was recorded. This monitoring methodology was intended to provide a cross-check for accuracy with the gorse transect data, and was intended to provide information about the overall health of the treatment areas and nearby control areas with respect to native and non-native species presence. Quadrat data is not intended to be a statistically accurate measurement of gorse cover at the site.





Visual Vegetation Cover and Composition Estimates. In addition to permanent transect and quadrat data that was collected in both gorse treatment areas and in reference control sites, a random walking transect was conducted each year to provide an overall assessment of gorse frequency and vegetative cover throughout the entire site, to record plant species observed, and to

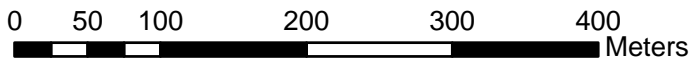
Figure 6.1 Locations of Vegetation Sampling and Photo Monitoring

Figure 6.1 Locations of Vegetation Sampling and Photo Monitoring



SBM_Monitoring_Locations.mxd

	Transect End Point/Quadrat Location		Gorse Removal Area
	Monitoring Transect		25 ft. contour line



May & Associates, Inc.
 182 Seal Rock Drive ~ San Francisco, CA 94121
 (415) 391-1000 ~ www.mayandassociatesinc.com

note and detect any other problems, if any, with secondary invasive species, erosion, social trespass, or other site issues that may have affected the outcome of the gorse control project. While the visual estimates are qualitative and not quantitative, they served as a means to help ensure that gorse frequency data along the permanent sampling points was an accurate representation of actual gorse frequency throughout the entire treatment area.

Reference Sites. A total of 6 reference sites were established for the Project. Data collected at reference sites included both transect data and quadrat data (using methods described above). Data collected at these sites was intended for comparison with data collected in gorse treatment sites, and to account for seasonal variations in native/non-native plant composition.

Pilot Wetland Restoration Site Monitoring. A total of 2 monitoring transects were established in the wetland site (i.e. Transects 11 and 12, illustrated on Figure 6.1). A total of 4 quadrat sampling sites were established in the wetland site, one at each end of the 2 wetland transects. Data collected at reference sites included both transect data and quadrat data (using methods described above).

6.2 Summary of Baseline Vegetation Monitoring Site Conditions

Baseline vegetation monitoring data was collected in 2004 before the start of gorse control. Baseline data was intended to provide a pre-Project snapshot as a starting point to track progress towards stated vegetation goals. Baseline 2004 site conditions are summarized below.

Transects. Baseline conditions in transects set in dense gorse stands had an estimated vegetative cover of 90-100% gorse. Permanent transects located in scattered gorse stands had a baseline vegetative cover of 6-25% gorse. Figure 6.1 depicts gorse stands and sampling transects used during this monitoring effort.

Quadrats. Baseline conditions within the sampling quadrats in 2004 were 65-75% nonnative vegetation and 5-35% native vegetation prior to the start of the gorse removal project. Of the non-native vegetation, gorse comprised 90-100% of the non-native vegetation present at the start of the project in 2004.

Visual Vegetation Cover and Composition Estimates. Visual vegetation cover and composition collected in 2004 was consistent with data collected at permanent transects and quadrat sampling locations. Overall, prior to the start of the gorse control efforts, gorse comprised 90 to 100% cover in areas mapped as dense gorse stands, 90 to 100% cover in outlier gorse stands, and about 5 to 25 percent cover in areas mapped as sparse gorse stands (Figure 6.1). A list of vegetation species observed was also prepared, and was updated during each monitoring year. The visual site estimates were consistent with quadrat data related to percent native and non-native vegetative cover throughout the site. In 2004 prior to the start of the gorse removal project, visual estimates indicated that the site supported approximately 25% native vegetation and 75% non-native vegetation. The list of species observed is included as Appendix B.

Reference Sites. Baseline conditions at the reference sites indicated that gorse cover was less than 1 percent with only a few scattered individual gorse seedlings detected. At the selected

reference sites, 65-75% of the vegetation observed was nonnative (mostly non-native grasses, with some invasive plants such as velvet grass, Himalayan blackberry, and dock species detected at the reference sites prior to the start of the project).

Pilot Wetland Restoration Site. Baseline conditions at the pilot wetland restoration site were assessed in 2004, prior to treatment of non-native plants at the site. At that time, the wetland restoration site supported approximately 55% non-native vegetation and 45% native vegetation (mostly growing underneath the non-native vegetation). Problem non-native species noted at this site included gorse (on upland edges), velvet grass, and Himalayan blackberry.

6.3 Summary Comparison of Vegetation Monitoring Results 2004 to 2008

Vegetation monitoring results collected from 2004 (baseline) to 2008 (end of project) are summarized below in Table 6.3. Overall, vegetation data showed a relatively steady progress towards successfully controlling gorse, with 2008 monitoring results showing 2.4% cover of gorse by October 2008. This is a positive result, and meets and exceeds the stated goal of no more than 5% cover of gorse seedlings by the end of the Project.

Table 6.3 Vegetation Monitoring Data Comparison, 2004 to 2008

Vegetation Data	Baseline (2004)	2005	2006	2007	2008
<i>Transect Data</i>					
Gorse % cover	90-100% gorse in dense and outlier stands, 6-25% gorse in scattered individual stands	7% (54% seedlings and 46% re-sprouts)	6% (90% seedlings, 10% re-sprouts)	4% (98% seedlings, 2% re-sprouts)	2.4% (100% seedlings, 0% re-sprouts)
<i>Quadrat Data</i>					
Gorse % cover	63.7%	8%	5.5%	4.5%	0.33%
Overall % cover non-native plants	67.5%	54%	78%	75%	30%
Overall % cover native plants	20%	22%	22%	25%	70.5%
<i>Reference Site Data</i>					
Overall % cover non-native plants	70%	62%	80%	78%	64.2%
Overall % cover native plants	30%	24%	20%	22%	35.8%
<i>Pilot Wetland Restoration Site Data</i>					
Gorse % cover	30%	No data taken	No data taken	2%	1%
Overall % cover non-native plants	55%	No data taken	No data taken	68%	70.5%
Overall % cover native plants	45%	No data taken	No data taken	32%	30%
Survivorship (# of plantings live)	N/A	N/A	4524 (original plant installation)	75% survivorship-888 plants installed	511 plants installed, 85% survivorship by end of program

7.0 GORSE MAPPING AND PHOTOMONITORING EFFORTS

Photo Monitoring Results (Baseline, 2005, 2006, 2007, and 2008 Comparison)

Ten (10) permanent photo monitoring points were established in 2004 prior to the start of gorse removal. In 2005, 2006, 2007, and 2008 photos were taken at the permanent photomonitoring locations to document the progress of the sites towards the overall goals of long-term gorse control and enhancement of native plant communities, including habitats for federally endangered butterfly species at the site.

An annual comparison of baseline through 2008 site conditions is provided in Appendix C. Overall, comparison of site photographs shows a dramatic shift away from gorse cover, and towards cover of native species, specifically towards grasses and forbs. The photographs also show the natural shifts between herbaceous cover and shrub cover over time. These shifts are mostly due to climatic conditions, but also may be partially attributed to the replacement of gorse (a shrub) with native shrubby species, a positive outcome of the project.

8.0 DEVELOPMENT OF LONG TERM MAINTENANCE PLAN

Continued control actions, funding, and resources are needed to sustain the significant financial and ecological investment undertaken within the past 4 years. While more than 97.4 percent of the gorse cover has been controlled by the end of the project in December 2008, the remaining 2.4 percent of gorse seedlings, if left untreated will quickly re-establish.

To address remaining activities that should be implemented to prevent reestablishment of gorse in treatment areas, a Long Term Maintenance Plan (May & Associates, Inc. 2008a) was developed. The following section summarizes the long-term maintenance needs and treatment options for the continued control of both the gorse seedlings and the targeted secondary weeds that were presented in the Long Term Maintenance Plan. This Plan also included treatment timelines, and proposed costs which are not included in this summary.

8.1 Purpose of the Long Term Maintenance Plan

The purpose of this Long-Term Maintenance Plan was to identify critical vegetation management actions that are essential to maintaining the gorse treatment areas following completion of the grant funded Project in 2008. This Plan presents recommended actions, and associated timelines and invasive control strategies considered necessary for successful long-term site management. Additionally, the Plan outlines suggested performance measures for evaluating the success of continued vegetation management actions implemented during the maintenance period. The anticipated lifespan of this Maintenance Plan is 5-7 years.

8.2 Ongoing Gorse Detection and Removal

Ongoing detection and treatment of gorse is an important aspect of the success of the Plan. As a point of comparison, there was an estimated 92.5 percent decrease from baseline conditions in the dense stand areas since 2004 (i.e. from average of 95% cover of gorse down to 2.4% average cover of gorse seedlings in 2008). Despite the dramatic improvement, the seed bank in gorse treatment areas is well established, and seedlings are expected to germinate for many years following completion of the grant-funded project. To achieve full elimination of gorse will require additional treatments following completion of the Project.

We recommend at least 3 more years of site assessment, gorse detection, and spot-treatment with herbicides at a rate of 2 times per year to achieve full eradication of the species. Following the completion of these 3 additional years, the treatment areas should be re-assessed to determine if full control has been achieved. If there are still remaining seedlings, annual site monitoring may be required to identify and, if necessary, spot-treat any new gorse infestations.

Anticipated Treatment Frequency: 2 times annually for 3 years, then an assessment of site conditions to determine if additional years of maintenance are required.

Proposed Treatment: Herbicide application Shelterbelt Builders Inc. (M. Heath pers. comm.) has successfully treated this species using a spot-application of a two percent (2%) solution of Garlon 4™ (triclopyr) and Roundup Pro™ (glyphosate), an herbicide formulated for use on brush and other woody species.

Anticipated Timing: Twice a year for 3 years, once in late spring/early summer, and again in late fall/early winter. Following the above, a site assessment should be conducted during fall to determine if additional years of maintenance will be required. If so, timing would be similar to the initial 3 years of maintenance, twice a year, once in late spring/early summer, and again in late fall/early winter.

Level of Expertise Required: Herbicide use should be approved by the County of San Mateo prior to application. Herbicides should be applied by a qualified herbicide applicator familiar with controlling wildland weeds (County staff or paid contractor) and under the direction of the written pest control recommendation from a licensed Pest Control Advisor. Oversight of this activity should be undertaken by the San Bruno Mountain Habitat Conservation Plan (HCP's) designated Biologist. Small seedlings can also be pulled by hand and with weed wrenches by trained and/or supervised volunteers. However large-scale seedling pulling by volunteers is not recommended because it has been determined to be inefficient. It can take a work crew approximately one day to remove seedlings by hand on 100 square feet (M. Heath, pers. comm.). On a small scale, volunteers could work independently if fully trained as land stewards or under the leadership of a program manager as a part of a restoration workday. All volunteer and contractor activities should be documented, so that the number of controlled seedlings can be tracked over time to evaluate the effectiveness of site maintenance actions.

8.3 Optional Treatment of Secondary Invasive Species

As staffing and funding allow, treatment of secondary invasive weeds that have been identified as problematic in the treatment areas is recommended. The following species were previously treated during the course of the grant-funded program, but if left untreated, may re-colonize and/or continue to spread in the treatment areas.

Velvet grass (*Holcus lanatus*)

Velvet grass continues to be problematic in the central portion of the gorse treatment area known as the "saddle area", particularly in areas where soils were disturbed in the past. Shelterbelt Builders Inc. (Mark Heath pers. comm.) has had successful results in treating this species using a spot-application of a one percent (1%) solution of Envoy™ (Clethodim) or 2% solution of Roundup Pro™ (glyphosate). Envoy™ is a post-emergent, grass specific herbicide that is intended for use on perennial and annual grasses. It will not adversely affect sedges or broadleaf weeds, therefore reducing the potential for impact to surrounding native plant species. Envoy™ works best on actively growing grasses, but should not be applied near standing water. Roundup Pro™ is an effective control treatment for later in the growing season (summer and fall). We recommend treating the site 2 times per year, preferably in February and April when velvet grass is actively growing, and before seed set. Mowing, in combination with herbicide treatment may also be effective. Velvet grass can be controlled with mowing followed by herbicide application, as long as the mowing occurs before the plants set seed.

An alternative control treatment is covering the infestation area with plastic or heavy mulch (seed free straw, at least 6 inches thick). This alternative treatment is considered appropriate for small and/or especially difficult areas where herbicides are ineffective in controlling the species. This treatment is most appropriate in areas that were previously dominated by mostly non-native annual grasses. Following 1-2 years of mulching or solarizing, the site should be uncovered and actively planted with native grasses or native coastal scrub species. Native grasses should be planted in areas with low risk of re-infestation by velvet grass, as the velvet grass is known to

out-compete native grasses during site establishment. In these areas, densely planted native shrubs are recommended for out-competing (i.e. shade-out) velvet grass, thereby suppressing the velvet grass seed bank and increasing the potential for successful site restoration.

Himalayan blackberry (*Rubus discolor*).

Following completion of the Project, maintenance workers and volunteers should be trained to identify the invasive Himalayan blackberry, and mark the plants for treatment. Maintenance worker and volunteers should also be trained to differentiate between Himalayan blackberry and the native California blackberry (*Rubus ursinus*) to prevent inadvertent treatment of this native species.

We have has observed positive results treating Himalayan blackberry using a spot-application of two percent (2%) Garlon™ (Triclopyr), an herbicide formulated for use on brush and other woody species. Himalayan blackberry should be treated once a year, preferably in August or September.

Curly Dock (*Rumex crispus*), Fiddle dock, (*R. pulcher*), Sheep Sorrel (*R. acetosella*)

Like Himalayan blackberry, curly dock, sheep sorrel and fiddle dock are most common in the wetland planting area, but all of these plants also occur in other areas of the site. These species prefer moist soils conditions, so are most common on the edges of wetlands. Effective treatment is similar to that described for Himalayan blackberry, and treatment can occur for all of these species concurrently. We have observed positive results treating these species using a spot-application of two percent (2%) Garlon™(Triclopyr), an herbicide formulated for use on brush and other woody species. We recommend treating once a year, preferably in August or September.

8.4 Ongoing Vegetation Monitoring

Vegetation composition monitoring should be performed as funding and staffing allow, preferably once a year for an additional 3 years following completion of the grant-funded project, and every 2-3 years thereafter. Vegetation composition data would be used to assess the following:

- Use vegetation composition data to determine subsequent year's revegetation goals and/or restoration objectives;
- Use vegetation data to assess restoration success/performance; and
- Use conditions at reference sites to calibrate data collected at treatment sites to assess performance and measure success.

Vegetation composition can be measured using a variety of methods. For this project, we recommend continuing with the vegetation monitoring methods that were established under the grant funded project, described herein.

8.5 Targeted Invasive Species Monitoring

It is recommended that the County expand these efforts and undertake a comprehensive inventory and mapping program for invasive species of concern. The outcome of this mapping effort would be a GIS database that would include, but not limited to, attributes such as distribution, cover class, patch size, feasibility for control, and adjacency to high priority ecological resources.

8.6 Volunteer Stewardship Program and Staffing

An active volunteer program is considered an important tool for maintaining cost-effective weed control and helping to gain community support and engagement. Building a successful and sustainable program however, requires an initial investment of resources and staff time, the benefits of which we believe can be reaped ten-fold over time if strategically allocated. The Plan encourages development of volunteer activities, while recognizing that, at present, San Mateo County has limited resources to undertake volunteer program capacity building.

Natural area stewardship programs are growing in popularity in urban jurisdictions as both communities and municipalities recognize the value of remnant historic ecosystems and undeveloped parkland. Some programs have developed organically through community interest and advocacy, while others have responded to regulatory requirements. Many have followed different pathways in establishing overall program goals, system-wide practices, and park-specific work plans. This is important to consider when determining the optimal overall stewardship program structure for San Bruno Mountain.

The following section outlines volunteer activities that could be undertaken within the gorse removal project area.

Continued County Parks Staff Involvement. As with all community stewardship programs that are administered on public lands, it is important that the program's goals and work plan are overseen by County staff who work in partnership with local stakeholder groups and community volunteers. Staff support is critical at both the planning and field level, to ensure that community-based activities are shaped by priority planning goals and are guided, facilitated and monitored by key field staff.

Opportunities for Partnerships and Community Engagement. The San Mateo County Parks Department offers a variety of volunteer opportunities to people of all ages, backgrounds and abilities. The focus of volunteer projects is to assist Park Ranger staff with the preservation and protection of park facilities, parklands, and native plant and wildlife habitats. Currently volunteers work at a diversity of sites throughout the County, including San Bruno Mountain. Below are two programs that specifically focus on building community awareness and engagement on San Bruno Mountain. Both programs offer the potential to increase volunteer engagement necessary to sustain the gorse and other weed control and habitat restoration efforts on the mountain.

San Mateo County Parks and Recreation Foundation. The San Mateo County Parks and Recreation Foundation (Foundation) is directly affiliated with San Mateo County and provides financial support to the County's volunteer programs and a number of priority initiatives and projects. The Foundation was established in 1998 to provide additional financial support for the recreational, environmental and educational programs and projects of the San Mateo County Department of Parks. The Foundation seeks grants and contributions from individuals, foundations and businesses, however does not manage the projects directly. The San Mateo County Department of Parks is responsible for the design, permitting, contracting and maintenance of the projects.

The Foundation works closely with the County to provide funding for special projects and programs that enhance the County Park experience for visitors or that preserve its many native ecosystems. Currently the Foundation has raised resources and assisted with the following:

- Stewardship of the County Parks.

- Preserving and Restoring Native Habitats
- Environment Education
- Volunteer Opportunities
- Bike Sunday
- Trail Improvements

The continued (and potential future expansion) of the gorse control program on San Bruno Mountain could be a compelling fundraising opportunity provided the case-making is linked directly to the unique ecological and community engagement opportunities that the project and other resource management actions provide.

Heart of the Mountain (www.heartofthemountain.com). Heart of the Mountain represents a group of dedicated volunteers working together with the County of San Mateo and the California Native Plant Society to implement priority habitat restoration projects. Currently, Heart of the Mountain is engaging volunteers in the restoration of the upper reaches of the Colma Creek's headwaters in partnership with the County of San Mateo

The California Native Plant Society (CNPS) initiated the San Bruno Mountain Stewardship Project to serve as a model that can be used by county government. Heart of the Mountain has established a number of program partners including City College of San Francisco. This program is currently led by a part-time contractor and has the potential for continued growth if provided with adequate resources. It could be expanded and/or augmented to provide additional maintenance and stewardship support for sustaining gorse control.

Creation of San Bruno Mountain Conservancy. While the Foundation certainly offers an important organizational vehicle to solicit funding for the continued gorse control and other priority non-native plants through increased volunteer engagement, the creation of a Conservancy specific to supporting the County's and stakeholders resource management and stewardship goals for the Mountain provides another viable opportunity.

If successful, the Conservancy, working in partnership with the County, could provide an umbrella for developing and maintaining volunteer activities at San Bruno Mountain.

Criteria for Prioritizing Maintenance Actions for Volunteers. Volunteers can however perform a diversity of tasks that are critical to the long-term stewardship of natural areas, specifically at San Bruno Mountain. Below is a list of suggested criteria to aid County staff in determining whether or not tasks in the Project area are appropriate for volunteers.

Suggested criteria include (but are not limited to):

- Can the activities be performed using tools that are appropriate for volunteers?
- Can the activities be performed safely by volunteers?
- Can volunteer work leverage the work of paid contractors by helping to follow-up or pre-treat weed management areas?
- How many volunteers are needed to perform the activity and is there County staff or non-profit organizational leadership and capacity to train and oversee the volunteers?
- Can the volunteer clearly visualize the impact s/he has made through his/her volunteer contribution?

Using these criteria, a suggested volunteer work plan for this long-term gorse removal project is presented below.

Table 8.6. Suggested Volunteer Work Plan for Long-term Gorse Control Project (Year 1 to be assessed prior to development of Year 2 Goals and Objectives)

Work Plan Task	Proposed Timeline-Annual Basis				Notes
	Winter	Spring	Summer	Fall	
Perform early detection weed monitoring throughout Project area	X	X	X		Suggest 1-2 well trained volunteers who provide communication to Volunteer Coordinator, r County staff.
Conduct monthly (or bi-monthly) volunteer work day to remove gorse seedlings, immature gorse spreading from leading edges of un-controlled infestations adjacent to project area and incipient infestations of other secondary weeds Additional work may also include mulching and monitoring.	X	X	X		Volunteer group size should be based upon size of infestations. Groups could be led by Volunteer Coordinator or County staff
Augment plantings/divisions in wetland area	X				See above re: coordination responsibilities

This efficacy of this work plan should be evaluated each year, and depending upon the results modified accordingly.

8.7 PRIORITY MAINTENANCE ACTIONS FOR STAFF OR CONTRACTORS.

The following section outlines staff and contractor activities that could be undertaken within the gorse removal project area following the completion of the Project.

Action 1. Update Maps and Treatment Monitoring Information (January – March)

As time and funding allow, gorse distribution maps should be updated to determine where edges of existing patches are expanding as well as identify newly established infestations. Any additional patches discovered during the initial treatment phases should be added to existing distribution maps to guide future work. Additionally, data regarding person hours per patch for each treatment type could also be extrapolated from monitoring data. This could be analyzed to determine the actual effort required to treat each patch, both historically and for future work. Summarizing the information from the last 3 years of maintenance will lead to better time management, budgeting and efficiency for future treatments.

Additional Notes: Paper maps produced for field navigation and treatment should clearly outline, but not cover and hide the treatment areas so crews can actually use the imagery to assist in search and navigation.

Action 2. Implementation - First Gorse Seedling Treatment (May – July)

Herbicide carried in backpacks is the optimum tool for this task. During application treatments, it is highly recommended that contractors and staff use GPS track logs or paper maps that can be updated each day to ensure that every patch is treated.

Additional Notes: Trained specialty restoration crews that can thoroughly search, clearly identify and treat gorse in complex native vegetation environments will be critical for successfully accomplishing this task. Crews must be able to identify all life stages and variations of this plant and be able to predict where it is likely to occur within patches.

Although fewer large plants occur each year, seedling recruitment will continue until the seed bank is exhausted. Treating these areas each year will take similar amounts of time during the time when the seed bank is still present, and for a few years after the seed bank is almost exhausted. The majority of effort for this task is largely based on hiking and searching time, not actual treatment time. Prematurely reducing the amount of time allocated to treating these areas because plants are not obviously apparent can reduce the effectiveness of the overall treatment, and ultimately result in more work in the long-term.

GPS track logs, paper map work logs and/or crew briefing/debriefing each day are critical to insure that each and every patch is thoroughly addressed. GPS track logs have worked well in past projects as a digital record of treating each patch. Paper maps or other equivalent protocol would be acceptable as long as daily records are maintained and reviewed on a regular basis and shared with all project partners.

Action 3. Implementation - Second Gorse Seedling Treatment (September – November)

It is critical to treat each patch/infestation two times a year as it is inevitable that some plants are escape treatment during the first pass. Even the most trained contractor/staff will likely miss a small percentage of seedlings given the terrain, dense coastal scrub and the mild coastal environment which yields year-round seedling recruitment.

Additional Notes: Though a single treatment pass seems adequate for a trained crew, environments are very complex, challenging and variable which ultimately lead to some missed targets. The challenge of treating every single individual necessitates multiple treatments each season. The utilization of quick action herbicides such as glyphosate and triclopyr helps with intra-season follow-up attempts. Failure to implement secondary treatments will allow some escapement which will ultimately lengthen the control period.

Action 4. Performance Review (August – October)

Gorse management team members should review treatment maps and herbicide use record following each treatment season. Maps should be adjusted as necessary if any additional individuals or patches are found.

Additional Notes: If areas are discovered with unusual seedling abundance, additional methods should be considered to treat seedlings or the seed bank directly.

9.0 RESULTS AND DISCUSSION

9.1 Summary of Gorse Monitoring Results

Based on 2008 monitoring results, the gorse control effort has been successful in meeting the stated project goals and objectives. The total gorse cover along the sampling transects was estimated at 2.4% by the end of Year 4 (2008), exceeding the stated project objective of no more than 5% gorse cover by the end of the Project. Of the gorse that was present along the sampling transects in 2008, 100% were seedlings indicating that treatments to date had been completely successful in controlling mature plants. Visual estimates of the site made in 2008 are similar to transect data, also indicating that all mature gorse plants have been successfully removed.

The site however, will still require ongoing maintenance to control germinating gorse seedlings, limit the establishment of secondary weeds and to ensure the full transformation of the treatment areas to a functioning coastal ecosystem. Refer to Section 8 above for information on recommended long-term site maintenance.

9.2 Summary of Results of Secondary Invasive Plant Treatments

A number of secondary invasive non-native plants colonized the project site following the removal of the mature gorse in 2004. The most problematic species that were encountered from 2004-2007 include:

- Velvet grass (*Holcus lanatus*)
- Himalayan blackberry (*Rubus discolor*)
- Sheep sorrel (*Rumex acetosella*)
- Curly dock (*R. crispus*)
- Fiddle dock (*R. pulchra*)

The primary objective of the grant funding was control of gorse. Therefore, control efforts for secondary invasive species such as velvet grass and sheep sorrel were limited to treatments that could be accomplished within the gorse treatment areas and the pilot wetland revegetation area.

Control of Himalayan blackberry and velvet grass was initiated in 2006, with control of dock species (mostly sheep sorrel) initiated in 2007. Control of these species has been somewhat successful, with the species responding well to spot-treatment of herbicide (Mark Heath, pers. comm. 2008). By the end of the grant funded project, treatments of Himalayan blackberry had been reduced to less than 5 percent cover within the Project site and approximately 6 percent within the pilot wetland restoration site. This represents an acceptable outcome for the grant-funded project however, more extensive long term treatment will be required to achieve full control, an outcome that is outside the scope of the grant-funded program.

Likewise, although sheep sorrel, fiddle dock, and curly dock were repeatedly treated at the plot wetland restoration site, these dock species will require ongoing maintenance to achieve sustained control at the site.

Velvet grass in particular continues to be a problem at all sites. The species is well established at the pilot wetland restoration site and has also colonized openings in coastal scrub habitat well as deeper-soiled moist grassland areas throughout San Bruno Mountain. While we recommend actively maintaining this species at the pilot wetland restoration site during the maintenance phase, it may not be realistic to expect to control it throughout the gorse treatment areas and the rest of San Bruno Mountain. A much more comprehensive control effort would be required to control velvet grass at San Bruno Mountain, an outcome that is well beyond the scope of this project.

9.3 Results of the Pilot Wetland Revegetation

Active revegetation in the pilot wetland restoration area yielded mixed results. Overall, the pilot wetland restoration effort was considered less than successful. Approximately 85 percent of the original plantings survived and native vegetation cover in the wetland sampling sites increased by approximately 10 percent by the end of the Project. Specifically, grasses decreased substantially (22%) and forbs increased 22% within the wetland sampling sites, a direct result of active site planting and successful establishment of the planted wetland planting materials. Wetland planting areas are expected to continue to spread and fill in with wetland plants following completion of the grant-funded project. The wetland planting effort was considered successful.

Upland sampling points however indicated a reverse trend: native plant cover dropped 18% in upland areas. Grasses increased 56%, forbs decreased 47%, scrub decreased by 6%, and litter and bare earth were mostly unchanged at upland sampling sites. This is considered a less than favorable result of the Project. Most of the increase in non-native cover and grasses in upland areas is due to the exponential spread of velvet grass in and near the pilot wetland restoration site. Despite efforts to control this invasive species from 2006 to 2008, it remains present, and continues to be a threat to the pilot wetland restoration site. To control its spread following completion of the Project, the site was treated with herbicide again in 2008 and the perimeter heavily mulched with seed-free straw. Heavy mulch is expected to create a containment line that will likely reduce future spread. Additional site maintenance will be required to help maintain the wetland restoration site following completion of the grant funded project.

A comparison of baseline and final end-of-project vegetation monitoring results at the pilot wetland sites are presented below in Table 9.3.

Table 9.3 Comparison of Baseline (2006) and End of Project (2008) Monitoring data at the Pilot Wetland Restoration Site

Vegetation Type	Percent Cover				Net change
	Baseline (2006) Wetland Quadrats	End of Project (2008) Wetland Quadrats	Baseline (2006) Upland Quadrats	End of Project (2008) Upland Quadrats	
Native	70%	80%	58%	40%	Increase of 10% native species in wetland and a decrease or 18% in upland
Non-Native	30%	20%	42%	60%	Decrease 10% non-native plants in wetland and an 10% increase in upland

Vegetation Type	Wetland Quadrats		Upland Quadrats		Average (Combined Upland and Wetland Sites)		Net Change
	Baseline (2004)	End of Project (2008)	Baseline (2004)	End of Project (2008)	Baseline (2004)	End of Project (2008)	
Grass	57%	35%	14%	70%	35%	52.5%	Decrease in grasses at wetland site by 22%, Increase of grasses at upland sites by 56%
Forb	43%	65%	61%	14%	52%	39%	Increase of forbs at wetland site by 22%, Decrease of forbs at upland sites by 47%
Scrub	<1%	<1%	22%	16%	11%	8%	Scrub at wetland site unchanged. Decrease of scrub at upland site by 6%,
Riparian	<1%	<1%	<1%	<1%	<1%	<1%	Unchanged, baseline to end of project
Litter/Bare Earth	0	0	4%	1%	2%	0.5%	Decrease of 2% in bare earth by end of project

Plant Survivorship (# of plantings live)	Baseline 2004	2005	2006	2007	2008
		N/A	N/A	4524 (original installation)	3724 (888 plants installed 2007, 75% survivorship end of year)

10.0 LESSONS LEARNED

As with any long-term vegetation management project, many of the original assumptions about effective gorse control, retreatment of gorse, green waste management, control of secondary invasive plants, and natural site revegetation were learned during the Project through trial and error. This section attempts to capture the “lessons learned” from this project, with the hope that other weed management professionals working on similar projects might benefit from both our successes and our failures.

One of the cornerstones of our proposed approach to gorse control was the theory that cutting and chipping gorse in dense stands, then hot-mulching the gorse green waste in-place would solve several problems: first, it would greatly reduce project costs related to transport and disposal of green waste at a landfill. Second, hot mulching was intended to reduce the potential of inadvertently spreading gorse by tightly managing it within the treatment area. Third, “hot” mulching was intended to activate microbial communities in the soil to consume the remaining gorse seeds in the topsoil, and effectively shading the soil surface to help prevent widespread gorse seedbank flushes.

While this approach was greatly successful at some of the above (i.e. reducing green waste disposal costs and controlling inadvertent spread of gorse from the treatment area), it has yet to be determined how effective it was at reducing the seedbank within the soil. To date, gorse seedlings are still covered by a combination of thick gorse and velvet grass mulch. In the short term during the management period, the mulch layer limits the emergence of seedlings each year to an easily manageable level. There has been insufficient time to determine if there is a long term advantage at reducing the overall size and quality of the seedbank. If composting mulch is ineffective at reducing the seedbank, the emergence of gorse seedlings is likely to increase as the mulch layer degrades in future years. This will in turn require the additional commitment to managing the seedling flushes.

One shortfall of the hot mulch approach is that we greatly underestimated the effects that the soil nitrification from the breakdown of the gorse mulch would have on the spread of secondary weeds onsite. Similar mulch-in-place projects in San Mateo County conducted by the San Francisco Public Utilities Commission at its Crystal Spring Reservoir site also had similar unanticipated negative results. Where dense vegetation was mowed and the green waste left onsite to mulch in-place, there was an infestation of secondary invasive plants.

It is unknown whether the gorse mulch aided in the spread of velvet grass, one of the most problematic secondary invasive species at San Bruno Mountain. It is clear that velvet grass was present, and already spreading through the ‘saddle area’ of San Bruno Mountain prior to the start of the gorse control project, therefore it would be incorrect to assume that the mulching, in and of itself caused the spread of this species. It is possible however that the nitrification of the soils did help its spread, an inadvertent adverse effect of the project. One possible modification would

be to denitrify the soils after gorse is treated. The addition of high carbon materials such as wood dust or chips to removal areas may reduce the available nitrogen in soils and help retard non-native plant invasions.

Another suggestion is to conduct all invasive plant removal projects as multiple plant control projects, rather than single species control projects. If we had we planned to, and controlled simultaneously all of the invasive species (gorse, Himalayan blackberry, dock, velvet grass, rattlesnake grass etc) from the selected treatment areas from the beginning of the project (rather than focusing our efforts only on gorse for the first few years), we would have been much more likely to have achieved sustained control of all invasive plants (except for velvet grass, which may never have been controlled at the site, as described in more detail below).

One last suggestion is to consider conducting gorse removal in high value endangered species habitat. Gorse in this area is typically diffuse individual pioneer plants; controlling these outlier plants could be undertaken at relatively low cost, and would yield very big habitat improvements for several endangered and rare butterfly species. Refer to Appendix D for a summary project description for a possible gorse removal project in butterfly habitat.

We have clearly demonstrated that gorse control can be cost effective using a combination of mowing, and herbicide application, even for dense and mature stands of gorse. However, we were (as predicted) not able to eradicate the species within the 4-year grant funded project. It is unknown how long gorse seeds remain viable in the soil. Future gorse removal projects should consider securing long-term funding or volunteer support to maintain the sites and continue to control gorse seedlings after the majority of the plants have been controlled for 3, 5, up to 20 years after initial removal efforts are undertaken. It cannot be emphasized enough that failing to invest in the continued maintenance and control of gorse seedlings for an extended time after initial removal efforts will result in the re-colonization of the site with gorse. The evidence is clear. The rate of spread from a handful of gorse pioneer plants into surrounding wild lands is exponentially faster than the natural restoration processes involved in converting the treatment areas back to healthy functioning ecosystems of native plants. Therefore, it is virtually impossible for gorse to be eliminated from a site without prolonged and sustained human intervention. We are however confident that through a combination of natural regeneration; active planting and site restoration; and sustained maintenance (treatment) of gorse seedlings, gorse could be eliminated from San Bruno Mountain.

The task however is only just begun. While we were able to successfully treat 49.5 acres of gorse, many more acres of gorse remain untreated at San Bruno Mountain, acting as source populations for the re-infestation of this invasive plant back into the treatment areas. Funding the remainder of the gorse removal efforts for the entire san Bruno Mountain, combined with funding sustained maintenance of the previously treated areas for at least 5 more years is the only way to guarantee that the progress made in controlling gorse under this grant funded project is not lost to re-colonization of gorse over time.

While we were able to treat 18.5 more acres of gorse than was originally included in the grant funded program, and also were able to extend our treatments to secondary invasive plants for 3 full years, we were not able to eradicate the entire suite of secondary invasive plants that invaded the treatment areas, for the same reasons given for the gorse project above. We did however achieve sustained control of a variety of secondary invasive plants at the pilot wetland restoration site, including Himalayan blackberry, curly dock, Italian thistle, poison hemlock, cape ivy, hairy cat's ear, lotus, and vetch.

We were less than successful at controlling velvet grass, rattlesnake grass, and sheep sorrel, three secondary invasive species that are very widespread throughout San Bruno Mountain as a whole. Due to the diffuse and widespread nature of these species, we recommend a separate control plan be developed and implemented for these remaining problematic species. Such a plan would most likely include active habitat conversion to achieve control, if control is found to be a feasible option at this point in time.

11.0 REFERENCES

11.1 Printed References

- Bastow, J.L., E.L. Preisser, D.R. Strong. 2008. *Holcus lanatus* invasion slows decomposition through its interaction with a macroinvertebrate detritivore, *Porcellio scaber* Biological Invasions (10)2 191-199.
- Chee Sanford, J.C., Williams, M., Davis, A.S., Sims, G.K. 2006. Do microbes influence seed bank dynamics? Weed Science. 54(3):575-587.
- Chee Sanford, J.C., Holman, T.J., Connor, L.M., Williams, M., Davis, A.S., Sims, G.K. 2005. Microbial interactions with weed seeds [abstract]. North Central Weed Science Society. 60:16.
- Elzinga, Caryl L.; Salzer, Daniel W.; Willoughby, John W.; Gibbs, James P. 2001. Monitoring plant and animal populations. Malden, MA: Blackwell Science, Inc. 360 p.
- May & Associates, Inc. 2008a. San Bruno Mountain Long Term Site Maintenance Plan, Gorse Control Project. Prepared for San Mateo County Environmental Services Agency Parks and Recreation Department. San Francisco, CA. 27 pages.
- May & Associates, Inc, 2006. Decision-Making Guidelines for Vegetation Management, San Mateo County Parks. Prepared for San Mateo County Recreation and Parks Department. San Francisco, CA.
- May & Associates, Inc. 2005, 2006, 2007, and 2008. Various Letter Reports: San Bruno Mountain Gorse Project, Monitoring Results. Prepared for San Mateo County Recreation and Parks Department. San Francisco, CA.

11.2 Personal Communications

- Heath, Mark. Restoration Ecologist, Shelterbelt Builders. Various meetings and telephone conversations from 2005 to 2008. Work: (510) 841-0911 Email: mark@shelterbeltbuilders.com

Appendix A. Educational Materials

SAN BRUNO MOUNTAIN GORSE CONTROL AND REVEGETATION PROJECT

About San Bruno Mountain

San Bruno Mountain encompasses 3,000 acres of open space at the northernmost tip of the Santa Cruz mountains. A mountain of ecological diversity amidst a sea of urban development, San Bruno is home to 3 species of federally protected butterflies. The Mission Blue (*Icaricia icarioides missionensis*), Callippe Silverspot (*Speyeria callippe callippe*), and San Bruno Elfin (*Incisalia mossii bayensis*) butterflies are all listed as endangered species under the Endangered Species Act. These butterflies are found in few other places in the world and are dependent on native grassland habitat for their individual host plants.

San Bruno Mountain is also home to 14 species of rare or endangered plant species whose habitat is threatened by encroaching invasive plant species (weeds). These species include coast rock cress, Franciscan wallflower, and San Francisco lessingia.

The native ecosystems on San Bruno Mountain have been increasingly threatened by a number of weedy species, the most invasive of which include gorse, eucalyptus, and French broom. Other invasive species found on the mountain include Portuguese broom, sweet fennel, cotoneaster, English ivy, Cape ivy, Bermuda buttercup, and Himalayan blackberry.

Gorse (*Ulex europaeus*)

Gorse (also known as Irish Furze) is a non-native invasive plant (weed) that is threatening the health of the native habitats of San Bruno Mountain.



Gorse on San Bruno Mountain:

Gorse was introduced to San Bruno Mountain sometime in the 1920's. By 1981, gorse had spread to cover approximately 330 acres of the Mountain. Through management work conducted by San Mateo County through the San Bruno Mountain Habitat Conservation Plan (HCP), gorse was reduced to less than 100 acres by 2003. Through this grant, gorse will be further reduced by an additional 31 acres.

Where does it come from?

Gorse is native to central and western Europe. In addition to California, where it has been reported in most coastal counties, it is widespread in Washington, Oregon, and along the Atlantic coast. Gorse has also been reported as an exotic in Australia, New Zealand, Costa Rica, and the Hawaiian Islands.

Why is it a problem?

- Gorse spreads quickly through native habitat, creating dense, impenetrable stands which prevent native plant species from growing.
- Gorse alters the soil chemistry making it inhospitable to many native plant species.
- Its high oil content, dense growth habit, and high flammability of seeds and foliage make gorse a potential fire threat.

How does it spread?

- Gorse produces high numbers of seeds, which can remain viable in soil for up to 30 years or more.
- Plants grow quickly, producing seeds in as few as 18 months, at a rate of 500-600 seeds per square meter.

What are we doing?

- To protect and enhance the native habitats of San Bruno Mountain, we are undertaking an invasive plant control program that will control this species over the next 4 years.
- In 2004 we removed over 31 acres of mature gorse, comprised of dense stands as well as individual plants scattered throughout native habitat.
- From 2005 through 2008, we will continue to do maintenance within the project area, removing all new seedlings and re-sprouts of gorse. During this maintenance phase, we will also revegetate a small, wetland seep along the Old Guadalupe Trail with native species including willows, rushes, and sedges.



View of the south eastern side of the Saddle Trail before Gorse removal. Notice the dense patches of dark green gorse in the background. Native coyote brush, poison oak, and lizard tail can be seen in the forefront in lighter shades of green. Notice other patches of gorse as you walk around the saddle trail. How is it different from the native grassland habitat?



View of the south eastern side of the Saddle Trail after Gorse removal. Notice the bare patches where dense gorse has been removed to make way for the establishment of native species. Walking by the site you may notice a layer of mulch, much like you would use in your garden. This is ground up gorse plants, and is helping to suppress other weeds from emerging.

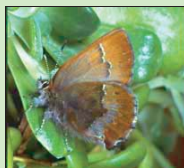
San Bruno Mountain Endangered Butterfly Species and Their Host Plants



Mission Blue Butterfly
Icaricia icarioides missionensis



Silver leaf lupine
Lupinus albus



San Bruno Elfin Butterfly
Incisalia mossii bayensis



Pacific Stonecrop
Sedum spatulifolium



Callippe Silverspot Butterfly
Speyeria callippe callippe



Johnny Jump-up
Viola pedunculata



How can you help?

- Plant native plants.
- Participate in restoration efforts on the Mountain.
- Stay on designated trails to prevent transporting weed seeds into pristine habitat.
- Volunteer your time.

To get involved in what's going on in your neighborhood, contact:

County Park Volunteer Coordinator
Nick Ramirez (650) 599-1306
nramirez@co.sanmateo.ca.us

Friends of San Bruno Mountain
Doug Allshouse (415) 334-4711
Doug@earthlink.net

The Heart of the Mountain: San Bruno Mountain Stewardship Project
Joe Cannon (650) 355-6635



Another Project to Improve California Parks Funded by the 2000 Parks Bond Act. The Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000

Ruth Coleman, Director, California Department of Parks and Recreation

Mike Chrisman, Secretary for Resources

Arnold Schwarzenegger, Governor



Contact Us:

San Mateo County Parks and Recreation:

Sam Herzberg - (650) 363-1823
SHerzberg@co.sanmateo.ca.us

May & Associates, Inc.:

Jen Zarnoch - (415) 850-4276
JenZarnoch@MayandAssociatesInc.com

Mission Blue



Callippe Silverspot



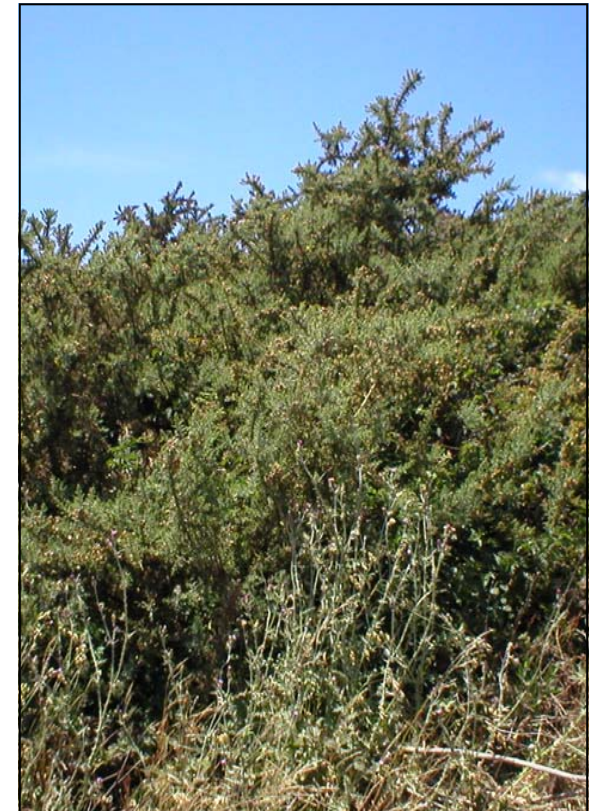
Funding

This project is made possible by generous funding from the Proposition 12 Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Fund.

About San Bruno Mountain

- San Bruno Mountain encompasses 3,300 acres of open space at the northernmost tip of the Santa Cruz mountains.
- San Bruno Mountain is home to 3 species of endangered butterfly, and one threatened butterfly species. The endangered Mission blue, Callippe silverspot, and San Bruno elfin butterflies are found in few other places in the world.
- The Mountain is home to 14 species of rare or endangered plant species whose habitat is threatened by encroaching invasive plant species (weeds). These species include coast rock cress, Franciscan wallflower, and San Francisco lessingia.
- The native ecosystems on San Bruno Mountain have been increasingly threatened by a number of weedy species, the most invasive of which include gorse, eucalyptus, and French broom. Other invasive species found on the mountain include sweet fennel, cotoneaster, English and Cape ivies, and Himalayan blackberry.

San Bruno Mountain Gorse Removal and Pilot Revegetation Project



Project Background

Why:

Gorse (also known as Irish Furze) is a non-native invasive plant (weed) that is threatening the health of the native habitats of San Bruno Mountain.

What:

To protect and enhance the native habitats of San Bruno Mountain, we are undertaking an invasive plant control program that will control this species over the next 4 years.

When:

- 2004 - We anticipate removing 31 acres of mature gorse, comprised of both dense stands of gorse and scattered individual plants.
- 2005 - 2008 - We will remove all new seedlings and re-sprouts of gorse within the 31 acre removal area.
- 2006 - We will revegetate a small, wetland seep with native species, including willow, elderberry, and dogwood.

Where:

- San Bruno Mountain in San Mateo County.

Who:

- A team of experienced contractors will be removing the gorse and planting native species .

Gorse (*Ulex europaeus*)

Why is it a problem?

- Gorse spreads quickly through native habitat, creating dense, impenetrable stands which prevent native plant species from growing.
- Gorse alters the soil chemistry making it inhospitable to many native plant species.
- High oil content, dense growth habit, and high flammability of seeds and foliage make gorse a potential fire threat.

How does it spread?

- Gorse produces high numbers of seeds, which can remain viable in soil for up to 30 years or more.
- Plants grow quickly, producing seeds in as few as 18 months, at a rate of 500-600 seeds per square meter.

Where does it come from?

- Gorse is native to central and western Europe. In addition to California, where it has been reported in most coastal counties, it is widespread in Washington, Oregon, and along the Atlantic coast. Gorse has also been reported as an exotic in Australia, New Zealand, Costa Rica, and the Hawaiian Islands.



Why control weedy plants?

Weedy plants can increase fire danger.

Weedy species tend to increase fuel loads, resulting in hotter and more frequent fires.

Weedy plants change ecosystem functions.

Weedy plants can change the physical character of the vegetation, altering the habitats used by our local wildlife. Weedy species crowd out natives, reducing the amount and type of foods available for wildlife (e.g. seeds, fruits, and berries).

Weedy plants displace native plants.

Native plants provide wildlife habitat and scientific, genetic, economic, historic and aesthetic values that contribute to our quality of life.

How can YOU help?

- Plant native plants.
- Participate in restoration efforts on the Mountain.
- Stay on designated trails to prevent transporting weed seeds into pristine habitat.
- Volunteer your time.
- To get involved in what's going on in your neighborhood, contact:

County Park Volunteer Coordinator:

Nick Ramirez (650) 599-1306
nramirez@co.sanmateo.ca.us

Friends of San Bruno Mountain:

Doug Allshouse (415) 334-4711
Dougsr@earthlink.net

The Heart of the Mountain: San Bruno Mountain Stewardship Project

Joe Cannon (650) 355-6635
Restore_ecology@earthlink.net

Fact Sheet
San Bruno Mountain
Invasive Plant Control and Revegetation Project

BACKGROUND

In September 2004, San Mateo County Parks and Recreation began an ambitious project – the control of non-native gorse on San Bruno Mountain. Gorse is a large spiny invasive shrub that has been spreading rapidly at San Bruno Mountain, threatening native habitats and associates endangered and threatened species such as the Mission blue butterfly.

This project is funded through a grant from the Proposition 12 Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Fund. San Mateo County Parks and Recreation Parks has retained the services of Shelterbelt Builders, and May & Associates, Inc., that, along with their team of contractors, will implement the project. This project is part of the existing conservation effort on San Bruno Mountain being conducted under the Habitat Conservation Plan. Shelterbelt and May & Associates, Inc. are working closely with Thomas Reid Associates (responsible for San Bruno Mountain Habitat Conservation Plan implementation and oversight) to maximize the efficacy of our collaborative work. The goal of the San Bruno Mountain Habitat Conservation Plan is to allow limited development around the mountain and protect and restore the habitat of federally listed endangered butterflies that rely on grassland habitats for their survival.

WORK PERFORMED IN 2004

The initial phase of the San Bruno Mountain Invasive Plant Control and Revegetation Project was initiated in September 2004 and was completed in November 2004. A total of 31 acres of mature gorse were removed. Highlights of the work performed in 2004 include:

- Prepared a project brochure and informational letter to inform the general public and project neighbors.
- Updated the nonnative plant GIS mapping data layer with current gorse mapping information for the project area.
- Prepared bid specifications and a work plan to guide the work of the subconsultants during removal and control of the gorse.
 - Removed 31 acres of mature gorse, (i.e. removed 22 acres of dense gorse using heavy equipment and 9 acres of dense and scattered gorse using hand crews).
 - Treated resulting gorse biomass (mulched onsite and left to solarize).
- Installed erosion control as necessary before the 2005 winter rains.

FUTURE ACTIVITIES

The maintenance phase of the project will begin in the spring of 2005, and continue until August 2008. Over the next three years, the project will focus on:

- Re-treating gorse in the 31 acre treatment area, including treating gorse resprouts and controlling the species' seed bank.
- Monitoring the restored sites, and controlling any secondary weed species (e.g., mustard, hemlock, cape ivy) that try to establish at the sites.
- Implementing a small revegetation project.
- Reducing remaining gorse cover to 5% or less by August 2008.
- Investigating supplementary grant funds for additional work at San Bruno Mountain.

SAN BRUNO GORSE CONTROL AND REVEGATION PROJECT

Trail Temporarily Closed

We are currently removing 31 acres of an invasive non-native plant called Gorse (*Ulex europaeus*). Weed removal will be followed by a small wetland restoration project in Spring 2005, and routine gorse control. This 4-year project will be conducted by a team of experienced contractors working under the direction of the County. The goal is to reduce the spread of gorse and increase the health and size of native vegetation which provides essential habitat for several endangered butterfly species. Funding for this 4-year effort is provided by a grant from the Proposition 12 bond fund.

**Contact: Sam Herzberg at San Mateo County Parks and Recreation (650) 363-1823 or
Jen Zarnoch at May and Associates, Inc. (415) 850-4276**



SAN BRUNO GORSE CONTROL AND REVEGATION PROJECT

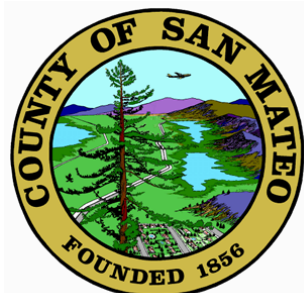
PLEASE USE CAUTION


HERBICIDE TREATMENT IN PROGRESS ALONG SADDLE TRAIL

PORTIONS OF THE TRAIL MAY BE TEMPORARILY CLOSED FOR YOUR SAFETY

We are currently removing 31 acres of an invasive non-native plant called Gorse (*Ulex europaeus*). Non-native plant removal will be followed by a small wetland restoration project in 2006, and routine gorse control. This 4-year project will be conducted by a team of experienced contractors working under the direction of the County. The goal is to reduce the spread of gorse and increase the health and size of native vegetation which provides essential habitat for several endangered butterfly species. Funding for this 4-year effort is provided by a grant from the Proposition 12 bond fund.

**Contact: Sam Herzberg at San Mateo County Parks and Recreation (650) 363-1823 or
Jen Zarnoch at May and Associates, Inc. (415) 850-4276**





San Bruno Mountain Gorse Control and Revegetation Project

**Loran May & Jen Zarnoch
May and Associates, Inc.**

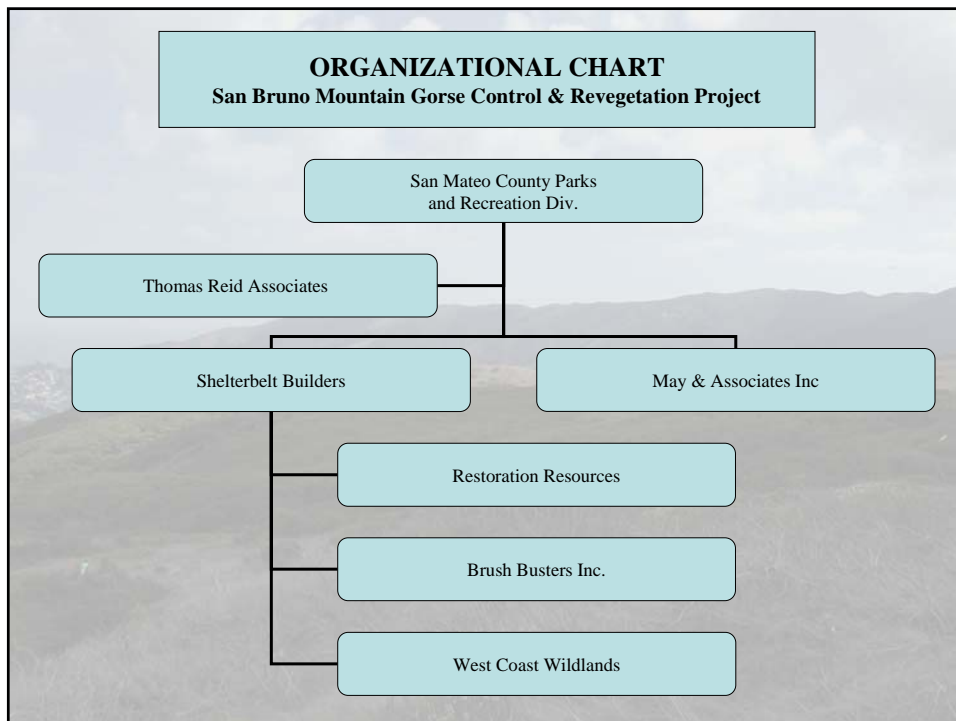


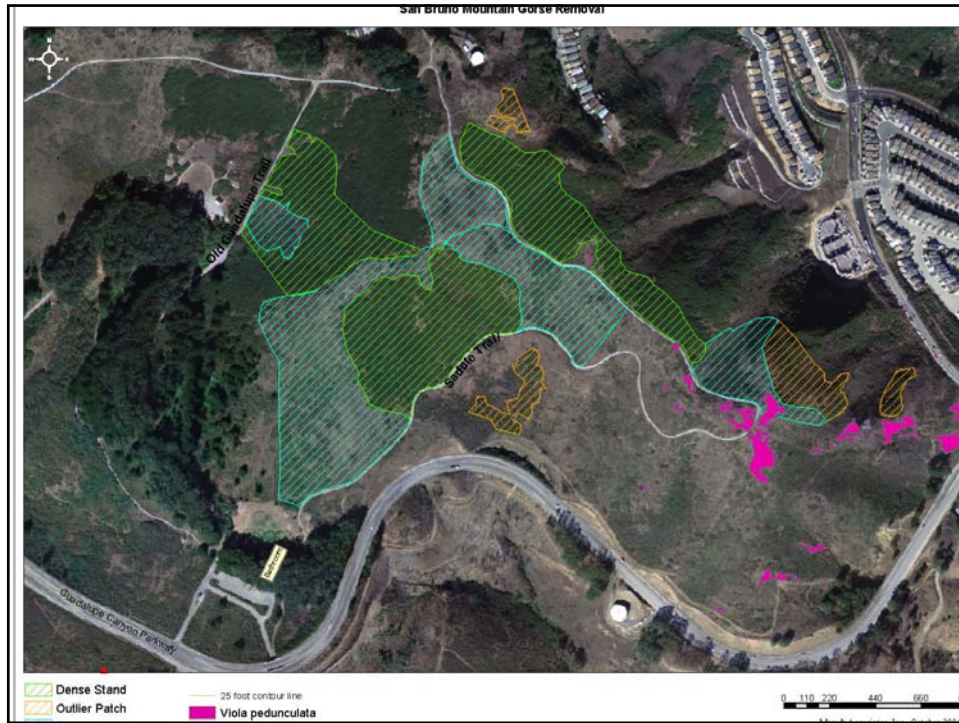
Project Goals and Objectives

- Remove 31 Acres of mature gorse (2004)
- Treat resprouts within 31 acre removal area (2005-2008)
- Conduct small pilot revegetation project (2006)

Project Funding Provided Through

- Proposition 12 Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Fund.





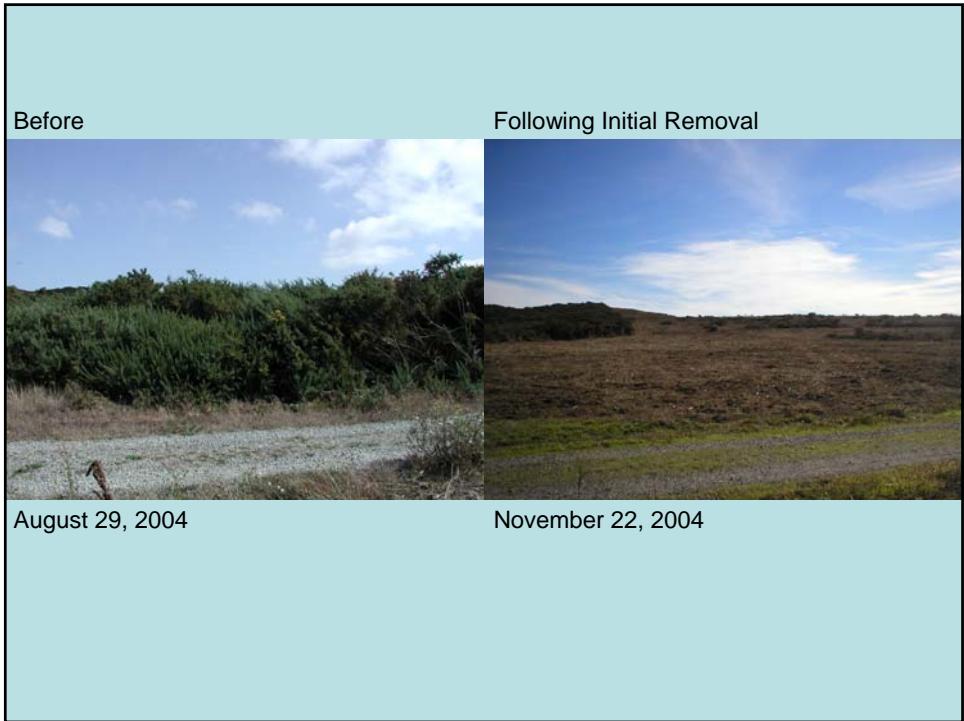
Status of Project

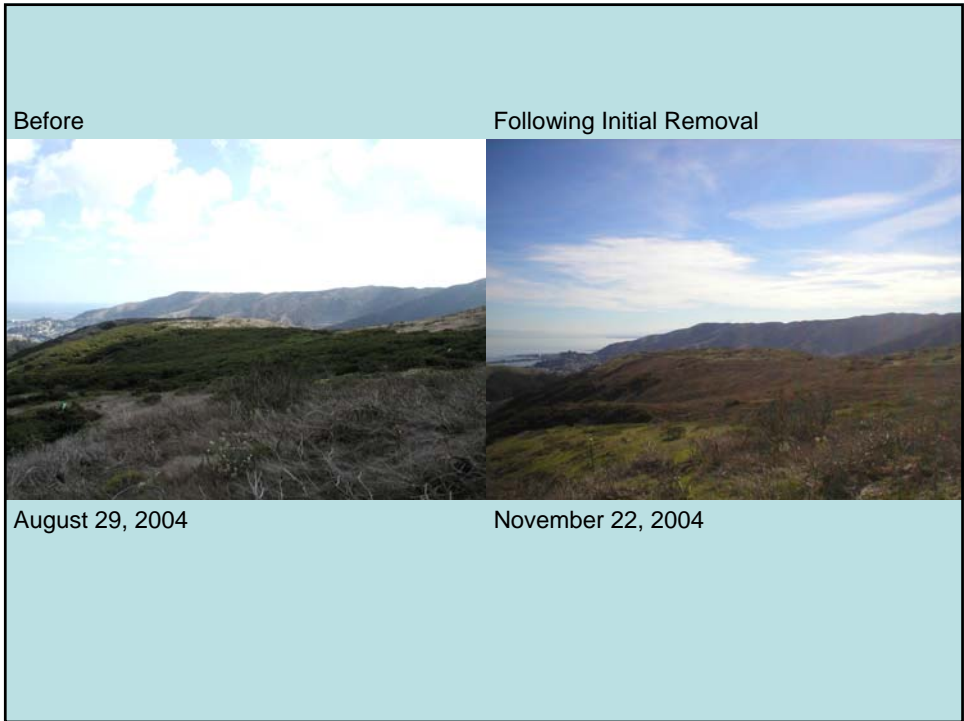
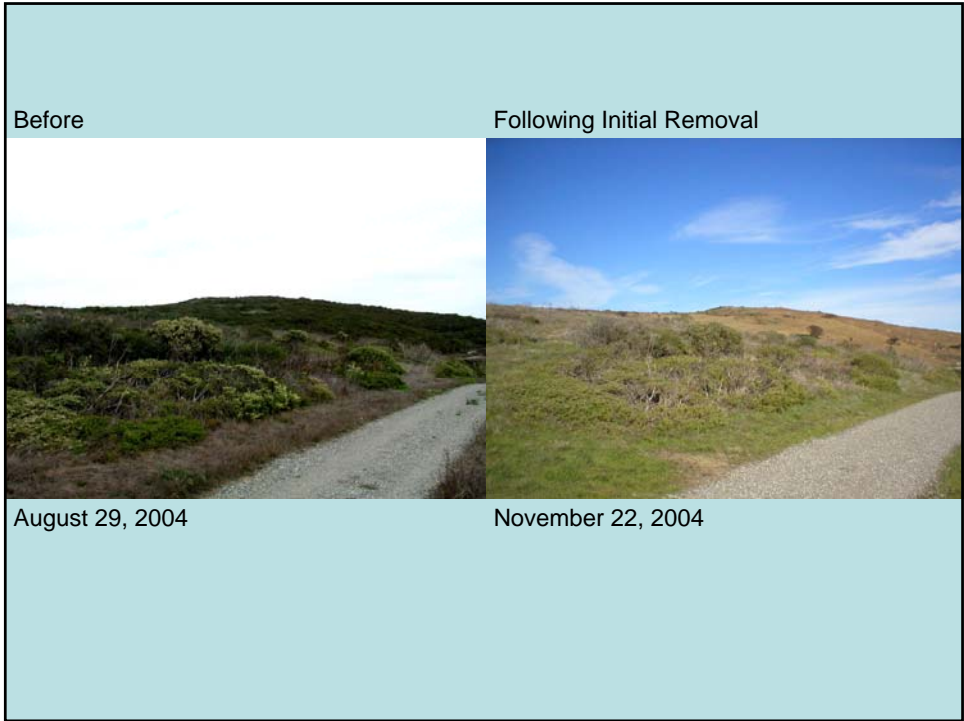
- Updated gorse mapping
- Prepared bid specs and work plan
- Removed 31 acres of mature gorse:
 - 22 acres of dense gorse was removed using heavy equipment
 - 9 acres of dense and scattered gorse was removed by hand crews to protect sensitive species.











Looking Ahead...

- **Treat Resprouts and Control Seed Bank**
 - Anticipate 3 treatments in 2005
 - Continued treatment and control through 2006-2008
 - 5% gorse cover by August 2008
- **Implement Revegetation**
- **Monitor gorse cover and invasion by secondary invasive species** (ex. mustard, cape ivy, hemlock, etc.)
- **Investigate supplementary grant funds for additional work on the Mountain.**

Appendix B. List of Plant Species Observed

<i>Scientific name</i>	Common name
<i>Achillea millefolium</i>	common yarrow
<i>Aira caryophylla</i>	European annual hairgrass
<i>Anagallis arvensis</i>	scarlet pimpernel
<i>Angelica sp.</i>	cow parsnip
<i>Artemisia californica</i>	California sagebrush
<i>Artemisia douglasiana</i>	mugwort
<i>Aster chilensis</i>	Aster
<i>Avena fatua</i>	wild oat
<i>Baccharis pilularis</i>	coyote brush
<i>Brassica kaber</i>	summer mustard
<i>Briza minor</i>	little quaking grass
<i>Briza maxima</i>	Rattlesnake grass
<i>Bromus diandrus</i>	ripgut brome
<i>Bromus hordeaceus</i>	soft chess
<i>Carduus pycnocephalus</i>	Italian thistle
<i>Castilleja affinis ssp. affinis</i>	Indian paintbrush
<i>Chamomilla suaveolens</i>	pineappleweed
<i>Chlorogalum pomeridianum</i>	soaproot
<i>Cirsium vulgare</i>	bull thistle
<i>Clarkia sp.</i>	clarkia
<i>Conium maculatum</i>	poison hemlock
<i>Conyza canadensis</i>	Canadian horseweed
<i>Danthonia californica</i>	California oat grass
<i>Delphinium sp.</i>	larkspur
<i>Dichelostemma congestum</i>	ookow
<i>Dudleya sp.</i>	Dudleya
<i>Eleocharis macrostachya</i>	creeping spikerush
<i>Elymus glaucus</i>	blue wildrye
<i>Epilobium canum</i>	California fuschia
<i>Eriogonum sp.</i>	naked-stemmed buckwheat
<i>Erodium cicutarium</i>	red-stemmed filaree
<i>Eriophyllum stachyadifolium</i>	Lizardtail
<i>Eschsholtzia californica</i>	California poppt
<i>Foeniculum vulgare</i>	sweet fennel
<i>Fragaria chiloense</i>	wild strawberry
<i>Galium aparine</i>	bedstraw
<i>Geranium dissectum</i>	Cut leaf geranium
<i>Geranium molle</i>	dove's-foot geranium
<i>Gnaphalium luteo-album</i>	weedy cudweed
<i>Grindelia sp</i>	Gumplant
<i>Hemizonia sp.</i>	Tarweed
<i>Heracleum lanatum</i>	cow parsnip

Appendix B. List of Plant Species Observed (Continued)

<i>Heterotheca grandiflora</i>	telegraph weed
<i>Hirschfeldia incana</i>	Mediterranean mustard
<i>Holcus lanatus</i>	Velvet grass
<i>Holocarpha sp.</i>	tarweed
<i>Hordeum brachyantherum</i>	meadow barley
<i>Hordeum murinum ssp. leporinum</i>	foxtail barley
<i>Hypochaeris glabra</i>	smooth cat's-ear
<i>Hypochaeris radicata</i>	rough cat's-ear
<i>Iris douglasii</i>	Douglas's iris
<i>Juncus balticus</i>	Baltic rush
<i>Juncus bufonius</i>	toad rush
<i>Juncus patens</i>	spreading rush
<i>Juncus xiphiodes</i>	irisleaf rush
<i>Lamium amplexicaule</i>	clasping henbit
<i>Lathyrus sp.</i>	wild pea
<i>Leontodom taraxicoides</i>	lesser hawkbit
<i>Lolium multiflorum</i>	Italian ryegrass
<i>Lotus purshianus</i>	Pursh's lotus
<i>Lotus scoparius</i>	California broom
<i>Lupinus albifrons</i>	Silverleaf lupine
<i>Lupinus bicolor</i>	miniature lupine
<i>Lupinus succulentus</i>	arroyo lupine
<i>Luzula comosa</i>	Luzula
<i>Madia gracilis</i>	slender tarweed
<i>Madia madioides</i>	woodland tarweed
<i>Madia sp.</i>	Common madia
<i>Marrubium vulgare</i>	horehound
<i>Matricaria matricarioides</i>	pineapple weed
<i>Medicago polymorpha</i>	bur-clover
<i>Melica californica</i>	California melic
<i>Mellilotus indica</i>	Indian sweet-clover
<i>Microseris douglasii ssp. douglasii</i>	Douglas' microseris
<i>Mimulus aurantiacus</i>	bush monkeyflower
<i>Monardella sp.</i>	monardella
<i>Nassella pulchra</i>	purple needlegrass
<i>Nasella sp.</i>	small needlegrass
<i>Picris echioides</i>	bristly ox-tongue
<i>Plantago coronopus</i>	broadleaf plantain
<i>Plantago lanceolata</i>	English plantain
<i>Poa annua</i>	annual bluegrass
<i>Polypogon monspeliensis</i>	annual rabbit's-foot grass
<i>Psilocarphus tenellus var. tenellus</i>	slender woollyheads
<i>Pteridium aquilinum</i>	bracken fern

Appendix B. List of Plant Species Observed (Continued)

<i>Ranunculus californicus</i>	buttercup
<i>Raphanus sativus</i>	wild radish
<i>Rhamnus californica</i>	California coffeeberry
<i>Rubus discolor</i>	Himalayan berry
<i>Rubus ursinus</i>	California blackberry
<i>Rumex acetosella</i>	Shepherd's dock
<i>Rumex pulcher</i>	fiddle dock
<i>Rumex crispus</i>	Curly dock
<i>Salix sp.</i>	Willow
<i>Sanicula crassicaulis</i>	Pacific sanicle
<i>Satureja douglasii</i>	yerba buena
<i>Scrophularia californica</i>	California figwort, California bee plant
<i>Senecio vulgaris</i>	common groundsel
<i>Sidalcea malviflora</i>	checker bloom
<i>Silene gallica</i>	common catchfly
<i>Silybum marianum</i>	milk-thistle
<i>Sonchus oleraceus</i>	sow thistle
<i>Spergularia rubra</i>	ruby sand-spurry
<i>Stellaria media</i>	common chickweed
<i>Toxicodendron diversilobum</i>	poison-oak
<i>Trifolium dubium</i>	little hop clover
<i>Trifolium hirtum</i>	rose clover
<i>Trifolium sp.</i>	small-headed clover
<i>Trifolium willdenovii</i>	tomcat clover
<i>Triteleia laxa</i>	lthurriel's spear
<i>Ulex europaea</i>	Gorse
<i>Vulpia sp.</i>	rattail fescue
<i>Wyethia angustifolia</i>	narrow-leaved mule-ears



Photo Point 10C BASELINE (2004)



Photo Point 10C (2005)



Photo Point 10C (2006)



Photo Point 10C (2007)



Photo Point 10C (2008)

Appendix C. Site Photos and 2004 to 2008 Photo Monitoring Comparisons



Photo Point 1A BASELINE (2004)



Photo Point 1A (2005)



Photo Point 1A (2006)



Photo Point 1A (2007)



Photo Point 1A (2008)



Photo Point 1B BASELINE (2004)



Photo Point 1B (2005)



Photo Point 1B (2006)



Photo Point 1B (2007)



Photo Point 1B (2008)



Photo Point 1C BASELINE (2004)



Photo Point 1C (2005)



Photo Point1C (2006)



Photo Point1C (2007)



Photo Point1C (2008)



Photo Point 1D BASELINE (2004)



Photo Point 1D (2005)



Photo Point 1D (2006)



Photo Point 1D (2007)



Photo Point 1D (2008)



Photo Point 2A BASELINE (2004)



Photo Point 2A (2005)



Photo Point 2A (2006)



Photo Point 2A (2007)



Photo Point 2A (2008)



Photo Point 2B BASELINE (2004)



Photo Point 2B (2005)



Photo Point 2B (2006)



Photo Point 2B (2007)



Photo Point 2B (2008)



Photo Point 2C BASELINE (2004)



Photo Point 2C (2005)



Photo Point 2C (2006)



Photo Point 2C (2007)



Photo Point 2C (2008)



Photo Point 2D BASELINE (2004)



Photo Point 2D (2005)



Photo Point 2D (2006)



Photo Point 2D (2007)



Photo Point 2D (2008)



Photo Point 3A BASELINE (2004)



Photo Point 3A (2005)



Photo Point 3A (2006)



Photo Point 3A (2007)



Photo Point 3A (2008)



Photo Point 4A BASELINE (2004)



Photo Point 4A (2005)



Photo Point 4A (2006)



Photo Point 4A (2007)



Photo Point 4A (2008)



Photo Point 4B BASELINE (2004)



Photo Point 4B (2005)



Photo Point 4B (2006)



Photo Point 4B (2007)



Photo Point 4B (2008)



Photo Point 5A BASELINE (2004)



Photo Point 5A (2005)



Photo Point 5A (2006)



Photo Point 5A (2007)



Photo Point 5A (2008)



Photo Point 5B BASELINE (2004)



Photo Point 5B (2005)



Photo Point 5B (2006)



Photo Point 5B (2007)



Photo Point 5B (2008)

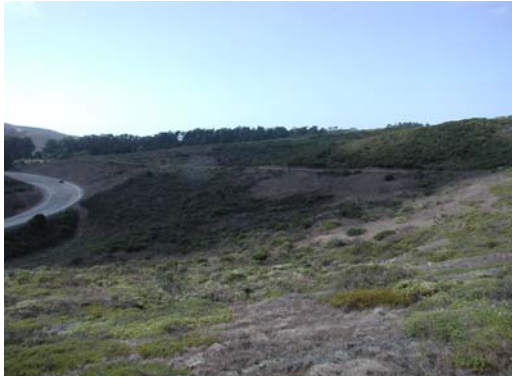


Photo Point 6 BASELINE (2004)



Photo Point 6 (2005)



Photo Point 6 (2006)



Photo Point 6 (2007)



Photo Point 6 (2008)



Photo Point 7 BASELINE (2004)



Photo Point 7 (2005)



Photo Point 7 (2006)



Photo Point 7 (2007)



Photo Point 7 (2008)



Photo Point 8A BASELINE (2004)



Photo Point 8A (2005)



Photo Point 8A (2006)



Photo Point 8A (2007)



Photo Point 8A (2008)



Photo Point 8B BASELINE (2004)



Photo Point 8B (2005)



Photo Point 8B (2006)



Photo Point 8B (2007)



Photo Point 8B (2008)



Photo Point 8C BASELINE (2004)



Photo Point 8C (2005)



Photo Point 8C (2006)



Photo Point 8C (2007)



Photo Point 8C (2008)



Photo Point 9 BASELINE (2004)



Photo Point 9 (2005)



Photo Point 9 (2006)



Photo Point 9 (2007)



Photo Point 9 (2008)



Photo Point 10A BASELINE (2004)



Photo Point 10A (2005)

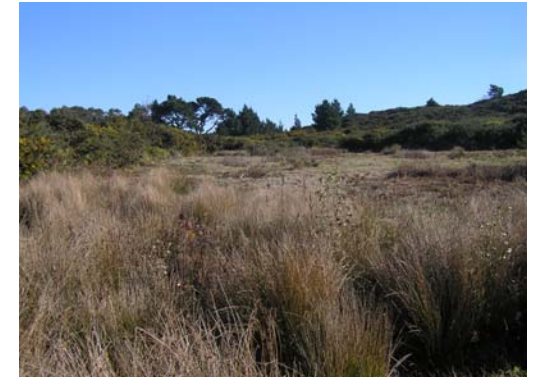


Photo Point 10A (2006)



Photo Point 10A (2007)



Photo Point 10A (2008)



Photo Point 10B BASELINE (2004)



Photo Point 10B (2005)



Photo Point 10B (2006)



Photo Point 10B (2007)



Photo Point 10B (2008)



Photo Point 10C BASELINE (2004)



Photo Point 10C (2005)



Photo Point 10C (2006)



Photo Point 10C (2007)



Photo Point 10C (2008)

Appendix D. Suggested Strategic Grassland/Butterfly Restoration Opportunities

San Bruno Mountain supports a high diversity of rare and endangered butterflies, and perhaps some of the most viable butterfly habitat for these species in the entire San Francisco Bay Area. Butterfly monitoring is a key management component under the San Bruno Mountain Habitat Conservation Plan (HCP). Highlighting the sensitivity and high ecological value of the San Bruno Mountain resources in a regional context will provide a strong and compelling case for future grantors to fund grassland/butterfly habitat restoration at San Bruno Mountain.

A comprehensive restoration program for the Saddle Area of the mountain will provide long term control of current and future invasive plants and create valuable new habitat for rare species. A long term restoration program will ensure the future project area will be maintained and enhanced with increased biodiversity and ecological stability. Long term maintenance activities for gorse control could be directed into new restoration projects that provide easier avenues for grant funding and stewardship program development thus insuring the project continues to grow and remain popular.

Active revegetation can reduce long-term maintenance costs by suppressing the ability of early successional weeds such as gorse and velvet grass from colonizing treated areas. Additionally, once established, dense native plant cover can also provide a means to reduce the rate of spread and level of maintenance for species such as gorse and other targeted species on San Bruno Mountain. We recommend pursuing the restoration of the Saddle Area with strategic revegetation of coastal scrub and prairie species. Scrub is effective at suppressing many invasive species and native scrub can be converted to coastal prairie as part of an overall project to balance both communities along the Saddle. We recommend exploring strategic revegetation strategies such as coastal scrub plant species be actively planted into former gorse infested areas to help suppress velvet and gorse seedlings. More stable native scrub areas without weed seed banks could then be converted to coastal prairie where butterfly habitat could be expanded.

Sophisticated butterfly habitat modeling is also recommended to guide the overall restoration strategy. We recommend modeling the distribution of predicted butterfly habitat. This would be based upon ecological parameters (such as soils, slope, aspect, etc.) necessary to support viable host plant populations. The product would be a GIS-based data set that could be used to further prioritize gorse (and other targeted invasive non-native plants) control activities as well as define restoration objectives within predicted habitat areas. For example, understanding the predicted distribution of *Viola pedunculata* would provide a tool for determining which gorse patches should be further controlled and what the vegetation composition of restored habitat would require.