Willowy Monardella (*Monardella viminea*) Census and Monitoring Surveys Final Report

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EXECUTIVE SUMMARY

This report presents the results of the 2012 census and monitoring surveys for the federally endangered willowy monardella (*Monardella viminea*) at Marine Corps Air Station (MCAS) Miramar. A census of all suitable willowy monardella habitat and known historic locations within the nine watersheds on the Station was completed from July 1 to July 17, 2012. Every willowy monardella clump was mapped using sub-foot accuracy global positioning system (GPS) units to allow for future comparison to the baseline data established in 2012. In addition, a standardized approach of mapping clumps was used to allow for comparison with future census efforts. A total of 1,181 willowy monardella clumps were mapped in six watersheds. Willowy monardella were found in Sycamore Canyon, West Sycamore Canyon, San Clemente Canyon, Spring Canyon, Murphy Canyon, and Elanus Canyon. Willowy monardella were not found in Quail Canyon, Oak Canyon, or Rose Canyon. Rose Canyon was the only canyon where willowy monardella had been observed in the past but not in 2012.

At each of the willowy monardella clumps identified during the census the following data was collected: life stage of the clump, phenology of the clump, and location of the clump within the drainage. Each clump was tagged with individually numbered plant tags using a standardized method for placement. Natural history observations were also collected for all plants observed during the census and at all plants within the monitoring plots. Natural history observations were primarily of pollinators and herbivory. West Sycamore Canyon had the highest number of clumps in the vegetative phenological stage, which is possibly a result from the high amounts of herbivory observed in the secondary drainages of the watershed. The majority of clumps were located on the alluvial benches within the primary drainages. Within secondary drainages clumps were more commonly found within the main drainage.

Monitoring was also completed at 17 monitoring plots previously established by the San Diego Natural History Museum (SDNHM). In each monitoring plot every clump was mapped and measured. The standardized methods for mapping used during the census were also utilized within the monitoring plots. In addition to the sampling of willowy monardella in the monitoring plots, vegetation sampling was performed at each plot.

Willowy monardella were observed in 14 of the 17 monitoring plots. Monitoring plots D, E, and M no longer had willowy monardella. Monitoring plot I, in West Sycamore Canyon, had 25 clumps which was the highest total in the 17 monitoring plots.

Vegetation data was collected at each of the monitoring plots to compare to baseline data collected in 2003 and 2004. Species diversity decreased in all of the monitoring plots where baseline data was available except for monitoring plots G, H, and K where species diversity increased.

The census and monitoring efforts performed in 2012 provide a more consistent, quantitative method to identify changes in the willowy monardella population on MCAS Miramar. The census map provides locations of the species for management of Station activities and will help identify locations of concern. After future census efforts, spatial changes in species distribution can be identified by comparing the future census map to the baseline map developed in 2012. Population numbers will be directly comparable.

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1.0 INTRODUCTION

This Final Report for willowy monardella (*Monardella viminea*) census and monitoring surveys on Marine Corps Air Station (MCAS) Miramar, California was prepared in accordance with Task Order FZN7 under Contract N62470-08-D-1008. Tetra Tech, Inc. (Tetra Tech) provides the project history, methodology, and 2012 results for willowy monardella population monitoring according to newly revised methodology.

1.1 PROJECT OVERVIEW

1.1.1 Purpose

The purpose of this project was to establish a population baseline for willowy monardella on MCAS Miramar. In addition to the Station-wide census, new mapping and plant tagging techniques were developed that will provide the means to assess changes in the population over time. Monitoring efforts will be used to establish a long-term population estimate for the species at MCAS Miramar.

1.1.2 Objectives

The census objectives were to survey all willowy monardella habitat on MCAS Miramar, use a standardized method to distinguish individual clumps of willowy monardella, and map the species using a global positioning system (GPS) with sub-foot accuracy. Monitoring was also completed at previously established monitoring plots to identify changes in the plant community, establish baseline measurements of clumps, map changes in the main drainage locations, and provide a comparison to previous monitoring data.

1.1.3 Project Location

The project took place at MCAS Miramar, which is located in San Diego County, California, approximately 13 miles north of downtown San Diego and 4 miles east of the Pacific Ocean, as shown in Figure 1. The willowy monardella census and population monitoring was completed Station-wide. MCAS Miramar contains nine watersheds representing portions of three larger San Diego County drainage systems (San Diego Natural History Museum [SDNHM] 2006). The census survey area is shown in Figure 2.

1.1.4 Site Description

The western portion of MCAS Miramar is located on a coastal mesa dissected by four major canyons and their smaller tributaries: Rose Canyon in the north, San Clemente Canyon through much of the southern and the central portions, and Elanus Canyon and Murphy Canyon in the southern portion. West Miramar is relatively flat with deeply incised canyons (MCAS Miramar 2011).

Legend

Miramar MCAS

Roads

Primary

Secondary

N

W E

S

0 0.5 1 2 Miles

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Data sources: Miramar MCAS, ESRI Topographic Map

United States Marine Corps
Miramar Marine Corps Air Station

Project Location

2012 Census and Monitoring Surveys Report

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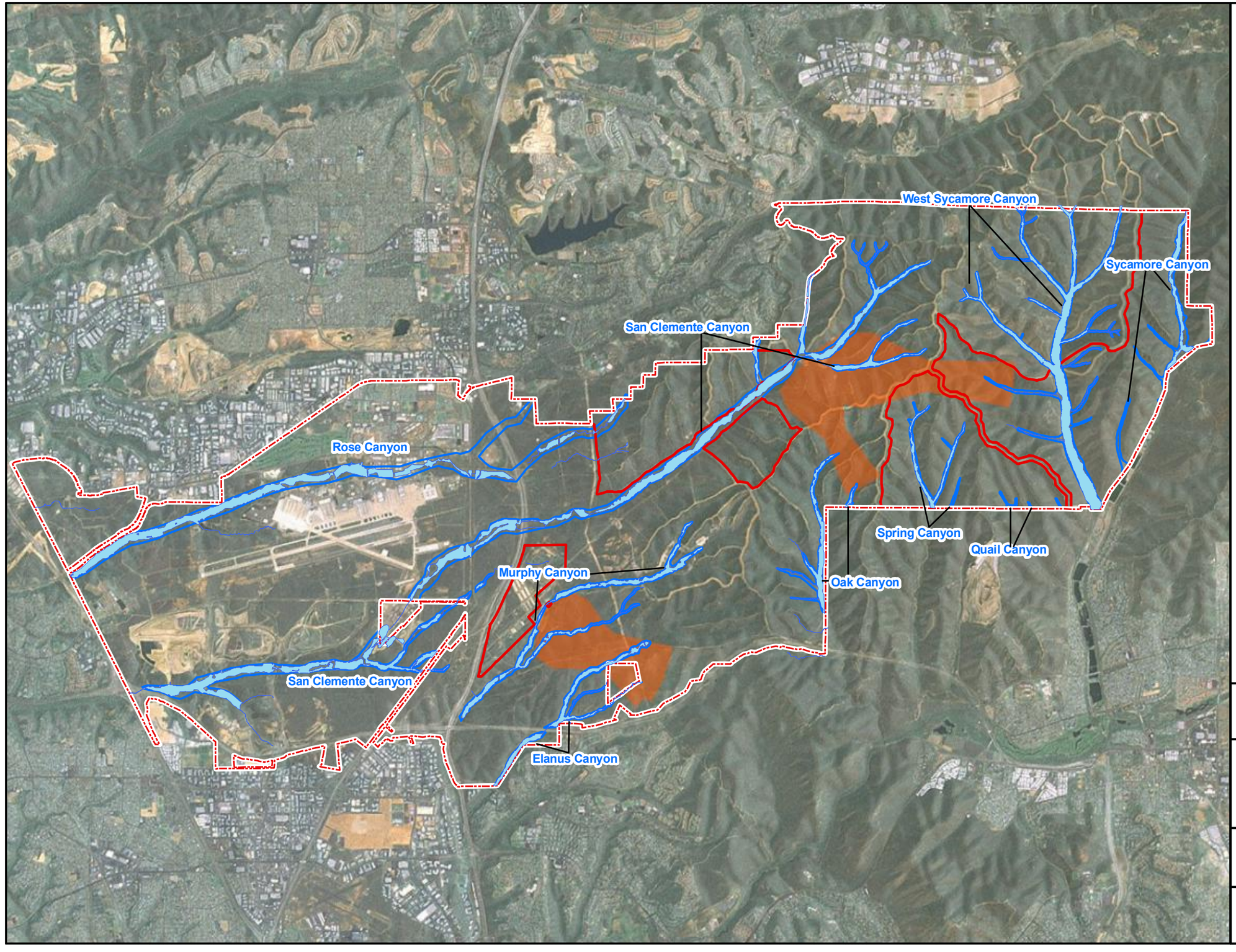
301 Mentor Drive, Suite A
Santa Barbara, CA 93111

TC NO.	DATE	DRAWN BY	MAP NO.	Figure
23330. FZN7	8/20/2012	METCALF	8666	1



Legend

- MCAS Boundary
- Training Area
- Surface Watercourse
- Surface Danger Zone
- Willowy Monardella Survey Area

N
W E
S

0 0.5 1 2 Miles

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Data sources: Miramar MCAS, ESRI Topographic Map

United States Marine Corps
Miramar Marine Corps Air Station

Willowy Monardella Census Survey Area

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The eastern portion of MCAS Miramar is made up of coastal foothills and canyons with moderate to steep slopes and cobbled bottoms (SDNHM 2006). East Miramar has portions of five watersheds: Oak Canyon, Spring Canyon, Quail Canyon, West Sycamore Canyon, and Sycamore Canyon. East Miramar contains designated areas used for military ground training and operational exercises, while the remainder of the area is undeveloped (Figure 2). Military training includes land navigation training, troop maneuvers, bivouacking/overnight camping, aircraft and personnel support exercises, tactical vehicle driver training, and weapons instruction training. East Miramar also supports the military need for encroachment and access control (MCAS Miramar 2011).

1.2 BACKGROUND

1.2.1 Species Status

Willowy monardella was first listed by the State of California as endangered in 1979, and later federally listed as endangered in 1998 (United States Fish and Wildlife Service [USFWS] 1998, USFWS 2011). The original listing pertained to the subspecies *Monardella linoides* ssp. *viminea*, which was split into two new species, willowy monardella and Jennifer's monardella (*Monardella stoneana*), following the reporting of observational differences in southern populations and a subsequent genetic investigation (USFWS 2011). Following the taxonomic split, the USFWS issued a final ruling on March 6, 2012 accepting the split of willowy monardella and retaining its federal listing (USFWS 2011). The critical habitat established for *Monardella linoides* ssp. *viminea* in 2006 was adjusted following the acceptance of the new taxonomic structure to only include habitat for willowy monardella (USFWS 2011).

1.2.2 Habitat Description

Willowy monardella primarily inhabits sandy washes and floodplains in coastal sage scrub or riparian scrub vegetation (USFWS 2008). Often the species is associated with California buckwheat (*Eriogonum fasciculatum*), California sycamore (*Plantanus racemosa*), coast live oak (*Quercus agrifolia*), California sagebrush (*Artemisia californica*), and broom baccharis (*Baccharis sarathriodes*) (USFWS 2008). On MCAS Miramar, previous surveys have found willowy monardella within primary, secondary, and tertiary drainages (SDNHM 2006).

1.2.3 Taxonomy

Willowy monardella is a perennial herbaceous or subshrub plant in the mint family (Lamiaceae) with a woody base and aromatic foliage (Code of Federal Regulations [CFR] 2011, 50 CFR 17). The stems are densely short-hairy appearing to be glaucous-green, bearing conspicuously gland-dotted linear or lance-shaped leaves, and dense, terminal heads of white, rose, or pale purple-colored, tubular-shaped flowers. Mature plants flower readily with inflorescence persisting 10 to 12 weeks, peaking between early June and mid-July. Inflorescence bracts are conspicuously gland-dotted, green to white or occasionally rose-tipped (Baldwin 2012, USFWS 2008).

Willowy monardella stands 25 to 50 centimeters (cm) in height and lacks a central stem. The subshrub grows in clumps and has a hemispherical shape with grey-green foliage (SDNHM 2006). Clumps can consist of one to four individual plants (USFWS 2011). The perennial is

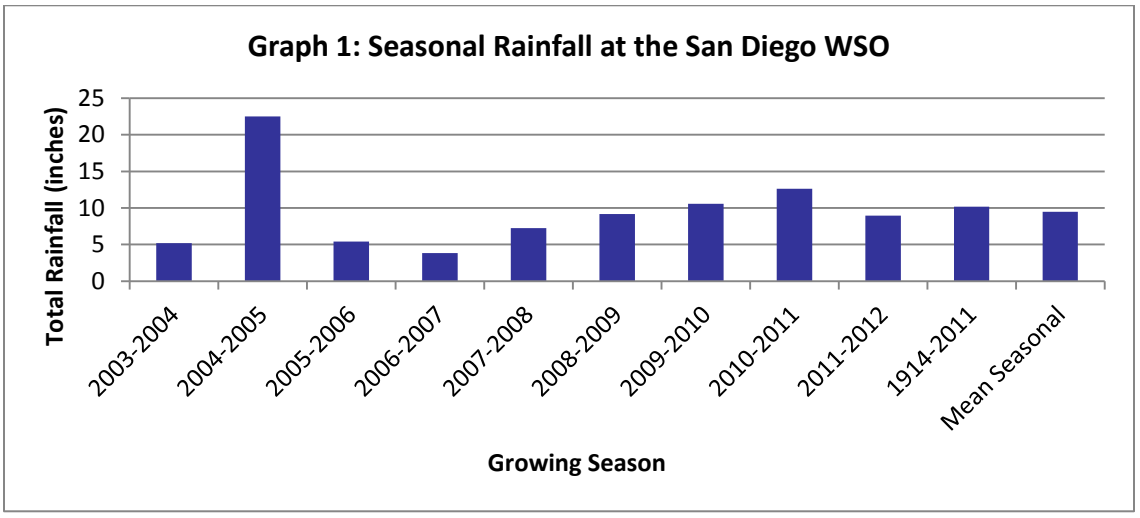
short-lived, producing a new cohort of aerial stems each year from the existing perennial root structure (USFWS 2011).

1.2.4 Rainfall History

Rainfall regimes in the region play an important role in vegetation community structure and population dynamics. The mean annual rainfall at the San Diego Weather Service Office (WSO), approximately 8 miles southwest of the Station, was 10.17 inches between 1914 and 2011 (National Oceanic and Atmospheric Administration [NOAA] National Climatic Data Center [NCDC] 2012). The average annual rainfall is measured from January 1 through December 31.

Seasonal rainfall measured from July 1 through June 30 is more ecologically significant since it coincides with the vegetative growing season for willowy monardella. Seasonal rainfall for the 2003-2004 through the 2011-2012 growing seasons was calculated and is presented in Graph 1 (NOAA NCDC 2012). Since the Cedar Fire in 2003, the mean seasonal rainfall at the San Diego WSO is 9.49 inches. Since the 2003-2004 growing season, three years had very low rainfall totals, and each year had less than 58 percent of the mean seasonal rainfall (2003-2004, 2005-2006, and 2006-2007).

Comparing the mean seasonal rainfall totals shown in Graph 1 to the mean annual rainfall since 1914 provides context compared to the historic mean. The mean seasonal average calculated since the 2003-2004 growing season is subject to short term climatic patterns which are less significant to the mean annual rainfall total since 1914. The 2004-2005 growing season received 22.49 inches of rain, which is over 220 percent of the mean annual rainfall since 1914. Since the 2007-2008 growing season the region has received at least 71 percent of the mean annual rainfall since 1914.



Graph 1. Seasonal rainfall totals measured at the San Diego WSO (July 1 to June 30), which is located approximately 8 miles southwest of the Station, are shown (NOAA NCDC 2012). Seasonal rainfall totals in 2003-2004, 2005-2006, and 2006-2007 were less than 58 percent of the mean seasonal rainfall for the 2003-2004 through the 2011-2012 growing seasons. The 1914 to 2011 data represents the mean annual rainfall (January 1 to December 31, 10.17 inches). The Mean Seasonal data represents the mean seasonal rainfall from the 2003-2004 season through the 2011-2012 season (9.49 inches).

2.0 METHODS

2.1 OVERVIEW

A review and evaluation of the previous census and monitoring efforts, techniques, and long-term objectives was performed. This process included discussions with Mr. Mike Kelly (Kelly and Associates), Mr. Andrew Sanders (University of Riverside), and Ms. Cindy Burrascano (California Native Plant Society [CNPS]). These are botanists who have been involved with willowy monardella management. Mr. John Willoughby, an expert in monitoring plant populations, was also consulted. Based on the evaluation, the methods for identifying, mapping, and tagging clumps during the census and monitoring plot surveys were revised and implemented during the surveys performed in 2012. The previous methods attempted to identify individual willowy monardella plants, which have been proven to be difficult due to underground root structures. The 2012 methods relied on a consistent mapping unit ("clumps") to monitor the population instead of attempting to identify the number of individuals. The 2012 monitoring plot surveys were performed using updated methods to collect similar vegetation and habitat data as was collected in 2003 and 2004. The new methods will provide the means to assess changes in the population over time.

As data was being collected in 2012, the methods were also reevaluated to determine if they could be adjusted to improve the data collected during future monitoring. Based on this evaluation, additional changes to the monitoring and census methods were identified. These changes will be included in the Willowy Monardella Field Protocol Manual, which is being developed and submitted under separate cover and will be implemented during future census and monitoring surveys. For example, one recommendation is to expand the monitoring to include plots within Spring Canyon and Sycamore Canyon in order to provide data for drainages that are not sampled within the current monitoring protocol. Other changes include collecting additional habitat characteristics during future monitoring efforts to identify habitat characteristics impacting willowy monardella growth rates. The recommendations section of this report provides additional details regarding these changes.

2.2 IDENTIFICATION METHODS

Willowy monardella within the survey area and monitoring plots were identified using the characteristics outlined in the second edition of the Jepson Manual and experience gained from direct observations at reference populations (Baldwin *et al.* 2012). The identifying characteristics of willowy monardella that were used during identification are:

- 1 to 50 cm in height;
- Grey-green in foliage color;
- Minty aroma;
- Hemispherical in overall subshrub shape, growth pattern in clumps of 1 to 4 plants;
- Leaves less than 4 millimeters (mm) wide, linear to narrowly lanceolate;
- Middle flower bracts 10 to 15 mm long and 5 to 9 mm wide;
- Densely short-hairy stems appearing glaucous-green
- Inflorescence bearing conspicuously gland-dotted bracts;

- Flower clusters 20 to 30 mm wide; and
- Dense, terminal heads of white to rose to pale purple-colored, tubular-shaped flowers.

Photographs of willowy monardella characteristics and growth structure are included in Appendix A.

2.3 CENSUS METHODS

2.3.1 Census Protocol

A Station-wide census for willowy monardella was performed within all appropriate habitat, including ephemeral and perennial drainages and associated flood plain areas. During the Station-wide census, the following nine watersheds were surveyed: Elanus Canyon, Murphy Canyon, Oak Canyon, Quail Canyon, Rose Canyon, San Clemente Canyon, Spring Canyon, Sycamore Canyon, and West Sycamore Canyon (Figure 2). GPS units and field maps were used to ensure that all suitable habitat within the survey area was searched. Field crews identified the boundaries of the survey area using GPS units.

Since individual plants are not reliably distinguished without exposing the roots or performing genetic testing, plants were mapped as clumps (50 CFR 17, 2011 edition). A single clump is defined as a willowy monardella plant(s) that is separated by more than 24 inches from another willowy monardella plant(s) (as recommended by Mike Kelly and Cindy Burrascano). The center point of every willowy monardella clump observed during the census was tagged using individually numbered plant tags and recorded with a GPS point. Plant tags are on small metal stakes and were installed in the ground at the center point of each clump. Care was taken not to harm the species during tag installation.

The field effort collected basic census information for every willowy monardella clump on the Station. The following census data was collected for all points:

- Location of each individual clump was recorded by GPS (points) with sub-foot accuracy;
- Plant tag number (individually numbered tag installed at each individual clump);
- Phenology stage (vegetative, budding, flowering, seeding, and dormant/dead states);
- Life stage (seedling, juvenile, mature, adult);
- Location of each individual clump within the drainage (within main drainage, inside edge of curves in meandering drainages, alluvial benches/flats, etc.); and
- Any special observations (disturbance or natural history observations).

If phenology variations were observed within a clump, the dominant trait of the clump was recorded.

The original plant phenology definitions, developed by SDNHM for the 2002 Miramar *Monardella viminea* survey, were used for this survey effort for consistency. Seedlings are defined as individuals that are less than four inches tall and lack multiple stems. Juveniles are defined as lacking multiple stems but being over four inches tall. Mature plants have 20 or fewer stems. Adult plants have more than 20 stems and are over four inches tall.

2.3.2 Plant Tag History

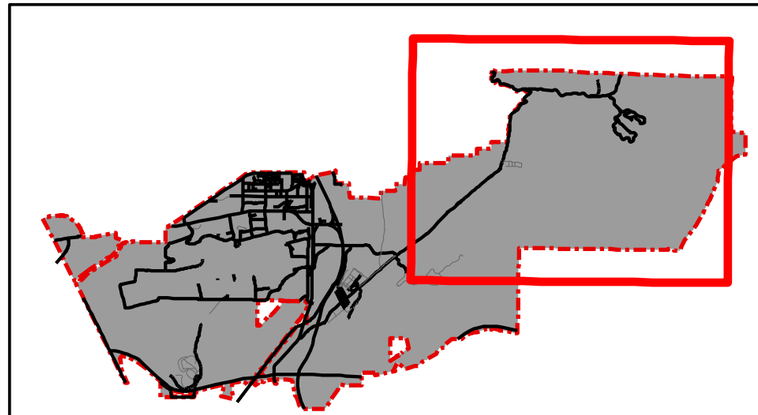
Plant tags were installed to locate willowy monardella individuals on the Station during past projects. Only a subset of willowy monardella was tagged prior to the 2012 census; not all willowy monardella individuals were tagged. Past methods for tagging clumps varied and a specific protocol was not established. Previously, tags were installed to locate individuals, not clumps. Many of the clumps identified during the 2012 census had multiple tags previously installed. In other situations, tags were installed outside of a clump. When this occurred, the existing tags were removed or adjusted so that each clump had a single tag placed in the center of the clump. A reduction in the number of tags used to identify a clump was common and should not be inferred as a reduction in population size, but rather a change in the tagging techniques.

Tags that were removed during the tagging process were often reused to mark previously untagged clumps. This would result in the shifting of tag locations from previous mapping efforts. The previous tagging efforts and shifting of tag locations made it impractical to attempt to tag clumps in numerical order within a drainage or across the Station. While some areas have groups of clumps tagged in numerical order, it should not be assumed that tags close in numerical order should be spatially close. For example, a group of clumps could have plant tags 1 through 4 and 7 through 10. It should not be assumed that plant tags 5 and 6 are in close proximity. These tags could have been removed and installed at another location or not used at all.

2.4 Monitoring Plot Methods

2.4.1 Monitoring Plot Survey

In addition to the census, 17 previously established monitoring plots were surveyed (Figure 3). Fifteen monitoring plots were established in West Sycamore Canyon by SDNHM in 2003 (SDNHM 2006). The additional two long-term monitoring plots (P and Q, as shown in Figure 3) were established in 2003 by SDNHM to assess impacts downstream from the rifle range construction in San Clemente Canyon (SDNHM 2007). First, the four corners of the monitoring plot were identified using a GPS unit and the established metal stakes. The corner locations were recorded using a sub-foot GPS unit. Each site was then surveyed and each willowy monardella clump was counted, measured, and mapped. The same 24-inch rule that defines clumps for the census was used during the survey of the monitoring plots.



Legend

- MCAS Boundary
- Training Area
- Surface Danger Zone
- Monitoring Plot Polygons
- Photo Point Locations

N
W E
S

0 0.25 0.5 1 Miles

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Data sources: Miramar MCAS, ESRI Topographic Map

United States Marine Corps
Miramar Marine Corps Air Station

Willowy Monardella Monitoring Plots

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In addition to the data collected for the census, the following data was collected for each plant within a monitoring plot:

- Clump diameter for each individual clump (measured at the widest point of each clump);
- Clump width for each individual clump (measured at the widest point perpendicular to the widest clump diameter); and
- Clump height for each individual clump (measured at the highest point of each clump).

The measurements made in 2012 used the highest point of the clump to measure height. Following the monitoring completed in 2012, it was determined that collecting the height data to the highest point of a clump increases the elliptical volume values when a small portion of the clump is significantly taller than the rest of the clump. This can make it difficult to identify growth within the clump, overestimate plant growth over time, and misrepresent clump size. As described in the recommendations in Section 5.0, when a small portion of the plant is significantly taller than the rest of the clump, the measurement should be made at the highest point shared by the majority of stems within the clump. Individual stems that are significantly taller would therefore be excluded from clump height measurements.

The following data was also collected for each monitoring plot:

- Observations of disturbances within the plot (evidence of fire, recent erosion, etc.). These observations noted disturbance to the plot as a whole and are independent of disturbances observed at individual willowy monardella clumps;
- Monitoring plot species composition (identified and listed surrounding plant species, recorded estimated percent cover of each species that has at least 5 percent cover);
- Estimated depth of drainages (the point within the drainage that represented the average depth of the reach within the monitoring plot was identified and measured in centimeters from the base of the drainage to the top of the bank); and
- The outer extent of all rocky drainages within each plot was recorded as a polygon by mapping the drainage boundary using a GPS with sub-foot accuracy. The outer extent was identified by the presence of a distinct bank or a rocky edge transitioning to vegetation growth depending on the drainage topography.

In addition to the data above, photographs were taken to document each monitoring plot and species population. Missing plot stakes were replaced and all stakes were painted with light blue spray paint. Plant tags were installed within the center point of each clump, and existing plant tags were repaired, replaced, or re-positioned for improved accuracy in future surveys.

2.4.2 Monitoring Plot Analysis

Measurements taken during the monitoring effort in 2012 were used to determine the elliptical area and elliptical volumes for each clump. These size estimates were calculated using the following equations:

Elliptical Area = π * (1/2 of the Clump Diameter) * (1/2 of the Clump Width)

Elliptical Volume = Elliptical Area * Clump Height

The 17 monitoring plots in San Clemente Canyon and West Sycamore Canyon have been surveyed during past monitoring efforts (SDNHM 2006, 2007). Vegetation monitoring began in 2003 at the 15 monitoring plots in West Sycamore Canyon established by SDNHM. Following the Cedar fire in October of 2003, the monitoring plots were resurveyed in 2004. All of the monitoring plots in West Sycamore Canyon were surveyed in 2004 except for monitoring plot E. The baseline data used for comparison for the 2012 surveys is from 2004 for all plots except monitoring plot E, where data from 2003 is used. In addition, monitoring plots P and Q did not have vegetation data collected during monitoring surveys performed during previous efforts and therefore were not included in species diversity comparisons.

A Sørensen similarity index was calculated for each monitoring plot (excluding monitoring plots P and Q) to compare the species composition from the original survey effort to the species composition observed in 2012. The Sørensen similarity index is a commonly used method to compare species composition when abundance data is not available (Chao *et al.* 2005). A Sørensen similarity index uses the total number of species in the monitoring plot during the original survey (A), the total number of species in the monitoring plot during the survey in 2012 (B), and the number of species present at both times (C). Using these three variables a Sørensen similarity index is calculated using the equation:

$$\text{Sørensen similarity index} = 2C / (A + B)$$

The Sørensen similarity index provides a value between 0 and 1. A Sørensen similarity index value for a plot with very similar species composition at both survey events will provide a value close to 1, while a monitoring plot with only a few similar species will have an index close to 0.

2.5 GPS AND GIS METHODS

During the census and monitoring plot surveys, willowy monardella clumps were mapped as center points using Trimble GPS units to record locations with sub-foot accuracy, and collect attribute information. Trimble GeoXH receivers, Series 2005 and 2008, were used; these units were loaded with Trimble TerraSync software, version 3.3. Trimble Zephyr antennas were used in conjunction with GPS receivers to increase accuracy.

The field team followed previously established best practices to ensure the collection of accurate GPS data. Horizontal accuracies were sub-foot.

Post-processing, including differential correction, was performed daily in the office using Trimble Pathfinder Office software. The Trimble TerraSync software was version 3.3; while the Trimble Pathfinder Office software was version 5.3.

The UNAVCO, San Diego, CA (p475) base station was used for differential correction. This base station meets the following criteria: 1) it was less than 25 kilometers from the data collected, 2) had an integrity index of 93 or higher, and 3) provided 95 percent or higher sub-foot differential correction accuracy.

Post-processed field GPS data was converted to GIS data using ArcGIS Desktop (ArcMap and ArcCatalog). GIS data has been provided in a personal geodatabase created using ArcGIS 9.3.1.

2.6 SCHEDULE

The field effort was completed during the willowy monardella peak flowering season. The census and monitoring plot surveys were performed between July 1 and July 17, 2012. Monitoring was coordinated with training activities at the Station and survey areas within the Surface Danger Zone were visited while the rifle and pistol ranges were inactive. A final field quality control check was performed between December 19 and December 21, 2012.

2.7 QUALITY CONTROL

All field personnel were trained on survey methods and GPS data collection methods prior to beginning field work. Each field crew member reviewed previous reports and the Final Work Plan, and was trained in the identification methods described in Section 2.2.

During December of 2012 a final field quality control check was performed to verify locations where willowy monardella was previously found but not mapped during the 2012 census. In addition, all previously mapped locations for missing plant tags were visited and searched for willowy monardella. Located plants were mapped utilizing the same methods used during the surveys completed in July 2012.

This Final Report was peer reviewed by Ms. Jen Nix, a botanist that participated in the field surveys. This Final Report was also reviewed by Ms. Amy Noddings, a technical reviewer and qualified biologist who has not contributed significantly to the writing of this report. Ms. Michelle Bates was the Functional Area Manager reviewer of this Final Report and implemented quality assurance/quality control procedures throughout the project. All Tetra Tech personnel involved in the project are listed in Appendix C.

2.8 HEALTH AND SAFETY

Prior to the commencement of the survey all field personnel reviewed the Final Health and Safety Plan. A tailgate meeting was held at the beginning of each field day to discuss the possible safety risks and the precautions outlined within the Final Health and Safety Plan to mitigate those risks. All field personnel were informed about the possibility of discovering unexploded ordnances and prior to the survey effort were trained in the associated risks and response protocol.

3.0 RESULTS

3.1 CENSUS

During the Station-wide census, 1,181 willowy monardella clumps were identified and mapped. The highest number of willowy monardella clumps was identified in San Clemente Canyon where 386 clumps were observed. West Sycamore Canyon had the second highest number of clumps with a total of 353 clumps. This canyon had the highest number of clumps in secondary and tertiary drainages. In West Sycamore Canyon, a total of 67 clumps were observed within primary drainages, 281 clumps were observed in secondary drainages, and an additional five clumps were observed in tertiary drainages. Spring Canyon had 232 clumps, and Sycamore Canyon had 198 clumps. Elanus Canyon had 11 clumps and Murphy Canyon had a single

clump. Figure 4 shows the locations of all the clumps recorded during the 2012 census. Table 1 provides the total number of clumps observed in each drainage.

Phenology was recorded at every clump mapped during the 2012 census. San Clemente Canyon had the highest number of willowy monardella individuals in the seeding stage, as 216 clumps were seeding out of the 329 clumps that were neither dead nor dormant. West Sycamore Canyon had the highest number of vegetative clumps with 106 vegetative clumps of the 353 total clumps observed. All of the clumps in Murphy Canyon and Elanus Canyon were flowering when surveyed in 2012. The clumps observed during the December field surveys were observed outside of the growing season and account for 51 of the 210 dead or dormant individuals. The number of clumps in each phenological stage is provided in Table 1.

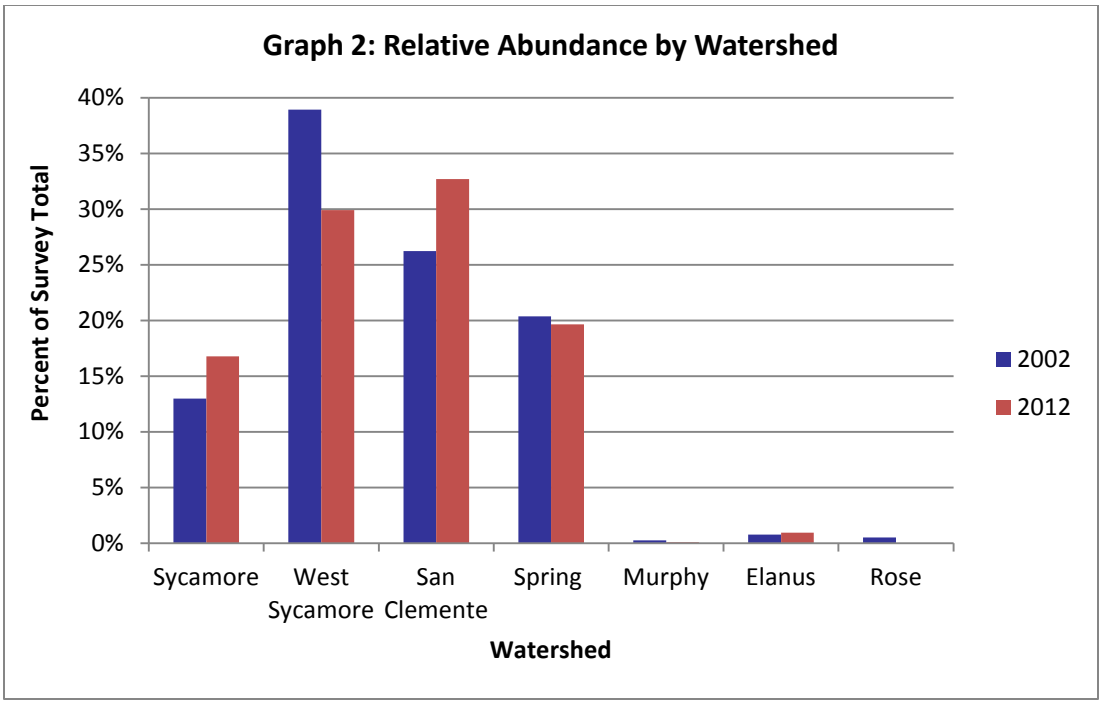
Table 1: Number of Clumps in Each Phenological Stage, 2012

Phenological Stage	Sycamore	West Sycamore	San Clemente	Spring	Murphy	Elanus	Total
Vegetative	20	106	12	42	0	0	**180**
Budding	5	17	3	8	0	0	**33**
Flowering	95	178	98	72	1	11	**455**
Seeding	37	11	216	39	0	0	**303**
Dead/Dormant	41	41	57	71	0	0	**210**
Total	**198**	**353**	**386**	**232**	**1**	**11**	**1,181**

Note: Surveys were performed between July 1 and July 17, 2012 and December 19 and 21, 2012.

No willowy monardella were observed in Rose Canyon, Oak Canyon, or Quail Canyon. Of these three canyons, Rose Canyon was the only canyon where willowy monardella had been observed in previous years. Two individuals were located in Rose Canyon during surveys performed in 2002 (SDNHM 2006).

The change in clump mapping methods makes a direct comparison to historic population data difficult. While comparing population size is not possible, the relative abundance per watershed is similar in 2012 as was measured in 2002 (SDNHM 2006). The relative abundance for 2012 was calculated using the number of clumps mapped. For comparison, the relative abundance for the 2002 surveys was calculated using the number of occurrences mapped during the 2002 census (SDNHM 2006). The relative abundance observed in each watershed is presented in Graph 2. Although different mapping techniques were used in 2002 and 2012, the relative abundance calculation can be used to compare the general presence or absence of the species within each watershed. Significant differences in willowy monardella populations within watersheds in 2002 and 2012 would be captured by the relative abundance numbers.



Graph 2: Relative abundance of willowy monardella in 2002 and 2012 (SDNHM 2006). Relative abundance in 2002 uses mapped occurrences in each canyon. The data presented for 2012 shows willowy monardella clumps. While the mapping techniques differ, the relative abundance in each watershed is similar.

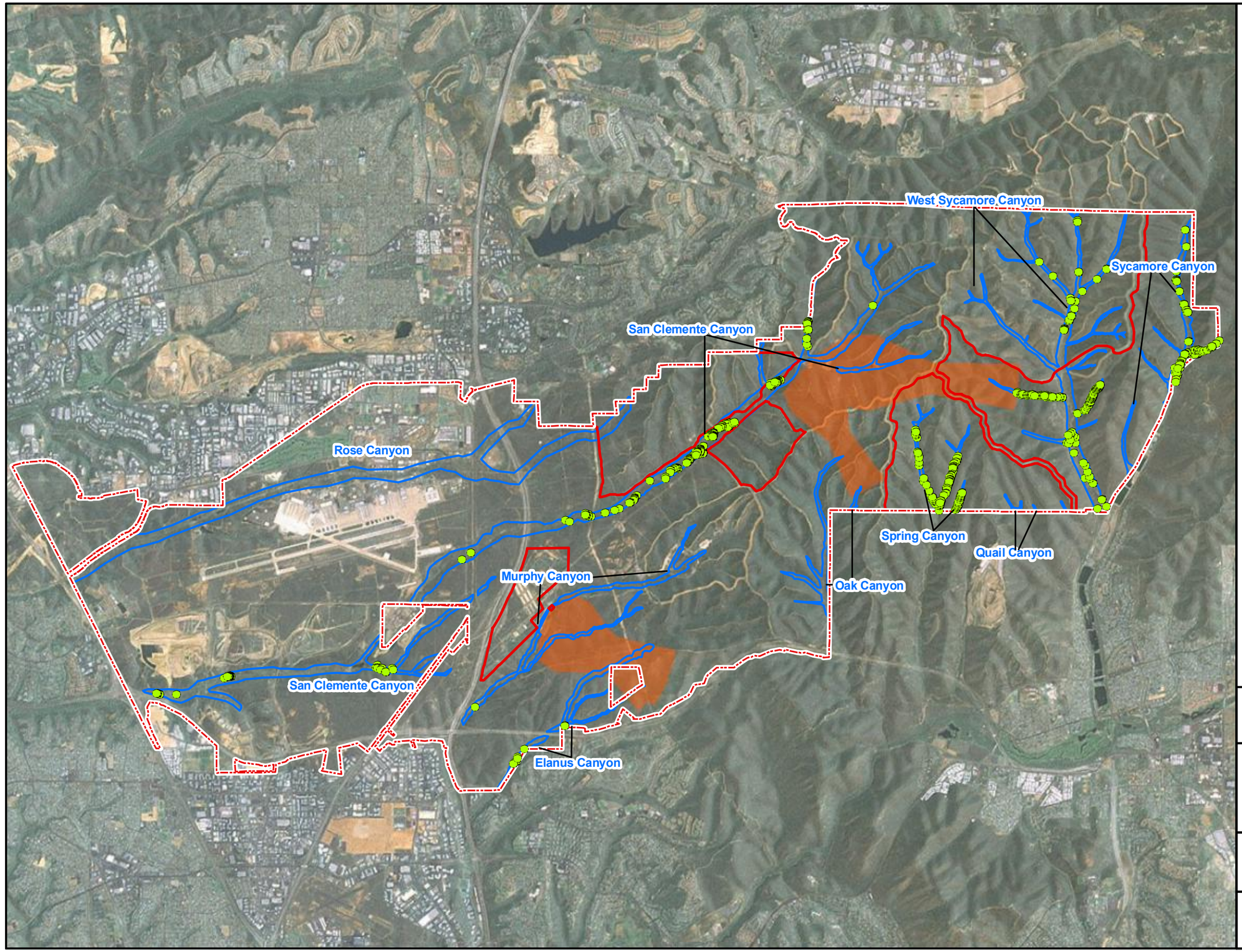
The position of each clump within the drainage was recorded and mapped during the 2012 census. Each clump was identified as being within the main drainage, along the inner edge of the drainage, or on the alluvial bench. Larger clumps were occasionally within multiple areas of the drainage and one classification would not sufficiently describe their location within the drainage. These clumps were identified as "Multiple". For example, a very large clump growing through the main drainage, over the inner edge of drainage and into the alluvial bench would be labeled as having "multiple" positions. The position of clumps in relation to the main drainage varied depending on the drainage type. Spring Canyon and West Sycamore Canyon were the only drainages where willowy monardella clumps were located within tertiary drainages. Within primary drainages, the majority of the clumps were located on the alluvial benches (79.5 percent). In secondary and tertiary drainages, clumps were more evenly distributed within the drainage and alluvial benches. In secondary drainages, 271 clumps (48.7 percent) were located on the alluvial benches and 273 clumps were within the main drainage or inner edge (49.1 percent). Table 2 provides the location of clumps within each drainage type.

Table 2: Clump Location by Drainage Type

Drainage Location	Primary Drainage	Secondary Drainage	Tertiary Drainage	Total
Alluvial Bench	492	271	3	**766**
Inner Edge	74	152	1	**227**
Main Drainage	53	121	0	**174**
Multiple*	0	12	2	**14**
Total	**619**	**556**	**6**	**1,181**

Note: *Multiple—larger clumps within multiple locations of the drainage.

Life stage was recorded at each clump mapped during the 2012 census. The willowy monardella population is heavily dominated by mature and adult clumps. Across the Station, 68 percent and 26 percent of all willow monardella clumps were classified as adult or mature clumps, respectively. There is evidence of recruitment, since four percent and two percent of the clumps mapped were identified as juvenile or seedling individuals, respectively. The number of clumps in each stage class is presented in Table 3. The distribution of clumps within each drainage is provided in Table 4.



Legend

- Willowy Monardella Recorded in 2012
- MCAS Boundary
- Training Area
- Willowy Monardella Survey Area
- Surface Danger Zone

N
W E
S

0 0.5 1 2 Miles

FOR OFFICIAL USE ONLY

Data sources: Miramar MCAS, ESRI Topographic Map

United States Marine Corps
Miramar Marine Corps Air Station

Willowy Monardella Census Results

2012 Census and Monitoring Surveys Report

TETRA TECH
301 Mentor Drive, Suite A
Santa Barbara, CA 93111

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Table 3: Number of Clumps in Each Life Stage, July 2012

Age Class	Sycamore	West Sycamore	San Clemente	Spring	Murphy	Elanus	Total
Seedling	1	15	0	7	0	0	**23**
Juvenile	7	33	4	8	0	0	**52**
Mature	56	89	87	74	0	0	**306**
Adult	134	216	295	143	1	11	**800**
Total	**198**	**353**	**386**	**232**	**1**	**11**	**1,181**

Note: Surveys were performed between July 1 and July 17, 2012 and December 19 and 21, 2012.

Table 4: Willowy Monardella Clump Location Within Each Drainage, July 2012

	Sycamore		West Sycamore			San Clemente		Spring			Murphy	Elanus	
Drainage Location	Primary	Secondary	Primary	Secondary	Tertiary	Primary	Secondary	Primary	Secondary	Tertiary	Primary	Primary	Total
Alluvial Bench	63	66	44	117	2	342	10	33	78	1	1	9	**766**
Inner Edge	13	4	11	86	1	20	9	28	53	0	0	2	**227**
Main Drainage	26	26	12	67	0	5	0	10	28	0	0	0	**174**
Multiple*	0	0	0	11	2	0	0	0	1	0	0	0	**14**
Total	**102**	**96**	**67**	**281**	**5**	**367**	**19**	**71**	**160**	**1**	**1**	**11**	**1,181**

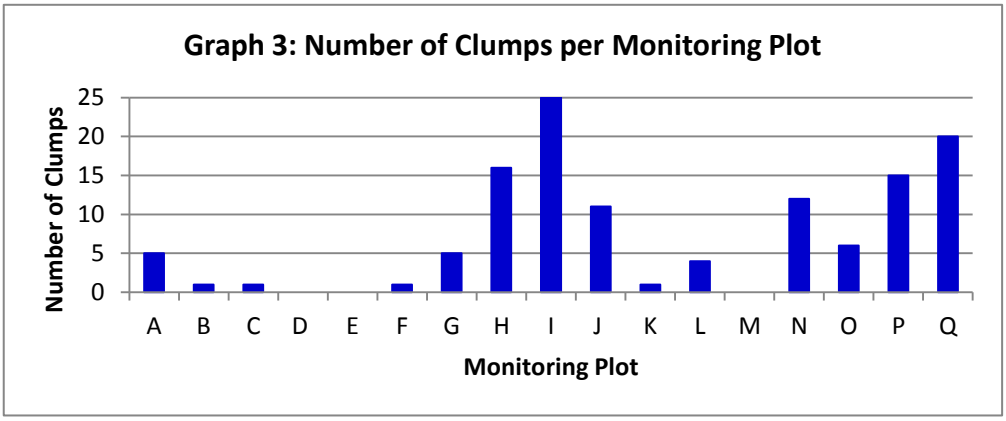
Notes:
A drainage type is only reported when at least one willowy monardella clump was located within it. For example, Murphy Canyon does not have willowy monardella within secondary drainages.
*Drainage locations described as "Multiple" include clumps that extended into multiple drainage locations and are likely to be influenced significantly from factors in both or all locations.

3.2 MONITORING PLOTS

3.2.1 Clump Monitoring

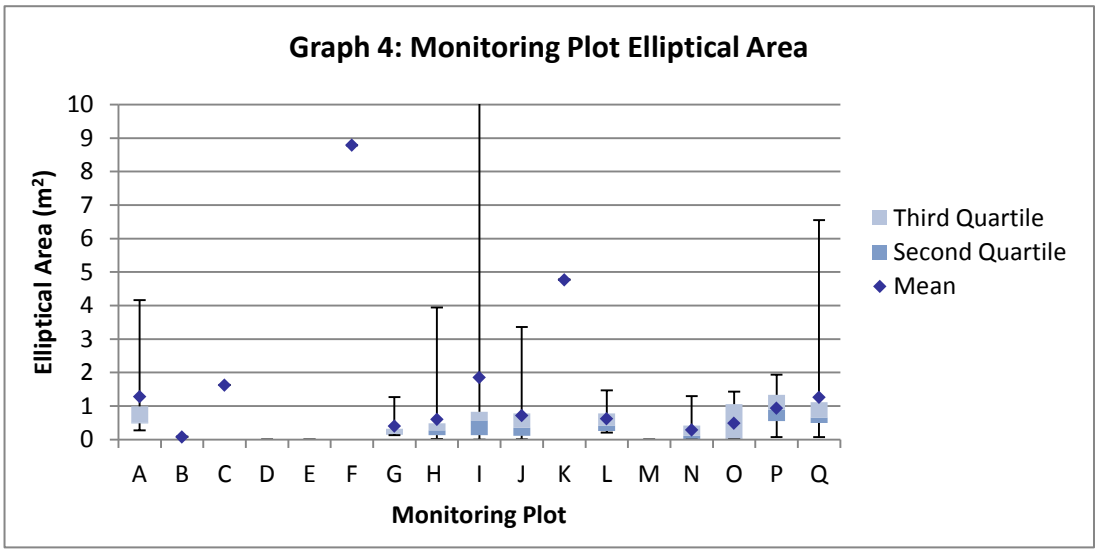
Previously established monitoring plots in West Sycamore Canyon and San Clemente Canyon were visited in 2012. There were 123 willowy monardella clumps measured and mapped within the 17 established monitoring plots. Monitoring plots A through O are located in West Sycamore Canyon and monitoring plots P and Q are in San Clemente Canyon. The number of clumps within the monitoring plots ranged from 0 to 25 (Graph 3). The mean number of clumps per plot was 7 with a median of 5 clumps per plot.

Within West Sycamore Canyon, monitoring plots ranged 0 to 25 willowy monardella clumps [mean=5.9, median=4, standard deviation (σ)=7.24]. The highest numbers of clumps within West Sycamore Canyon monitoring plots were in plots J, N, H, and I (Figure 3, Graph 3). These plots had 11, 12, 16, and 25 clumps, respectively. Three plots did not have any willowy monardella clumps (plots D, E, and M) and four plots only contained a single clump (plots B, C, F, and K). Monitoring plots P and Q in San Clemente Canyon had 15 and 20 clumps, respectively (Graph 3).

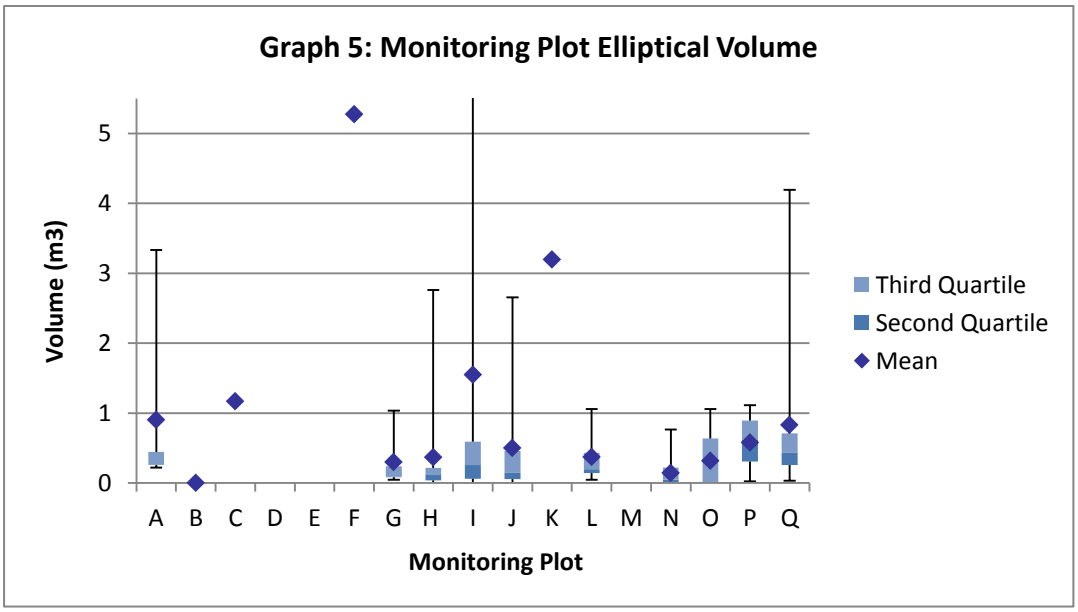


Graph 3. Total number of willowy monardella clumps observed in each monitoring plot in July 2012. Monitoring Plots A through O are within West Sycamore Canyon. Monitoring Plots P and Q are in San Clemente Canyon.

The clumps within the monitoring plots had a mean elliptical area of 11,043 square centimeters (cm^2) or 1.104 square meters (m^2) (min=0.785 cm^2, max=287,506 cm^2, σ=28,216 cm^2). The median elliptical area was 0.493 m^2. This difference between the mean and median indicates that there are a large number of smaller clumps with some very large clumps, which increase the mean to twice as large as the median. The largest clump observed had an elliptical area of 287.5 m^2 (monitoring plot I). The smallest willowy monardella clump was a seedling observed in monitoring plot N that was less than a square centimeter. The clump height was measured at the highest point within each clump and was used to estimate the clump volume. The mean clump volume for all 17 monitoring plots was 763,441 cubic centimeters (cm^3) or 0.763 cubic meters (m^3) (min=0.785 cm^3, max=28,175,587 cm^3, σ=2,613,393 cm^3). The median elliptical volume was 0.247 m^3. Graph 4 provides box plots for the elliptical area data collected at each monitoring plot. Graph 5 provides box plots for the elliptical volume data collected at each monitoring plot.



Graph 4: Elliptical area at each monitoring plot observed in July 2012. The box plots display the data range for the second and third quartiles for each monitoring plot. The line separating these is the median. The error bars represent the range for each monitoring plot. The maximum range for monitoring plot I (max=28.75 m^2) was not included to provide better representation of the data. Only one clump was observed at monitoring plots B, C, F, and K. Monitoring plots D, E, and M did not have any willowy monardella clumps. The elliptical area was calculated using the equation: π * (1/2 of the Clump Diameter) * (1/2 of the Clump Width). All values are square meters.



Graph 5: Elliptical volume at each monitoring plot observed in July 2012. The box plots display the data range for the second and third quartiles for each monitoring plot. The line separating these is the median. The error bars represent the range for each monitoring plot. The maximum range for monitoring plot I (max=28.18) was not included to provide better representation of the data. Only one clump was observed at monitoring plots B, C, F, and K. Monitoring plots D, E, and M did not have any willowy monardella clumps. The elliptical volume was calculated using the equation: Elliptical Area * Clump Height. All values are in cubic meters.

3.2.2 Vegetation Monitoring

Vegetation monitoring began in 2003 at the 15 macroplots in West Sycamore Canyon established by SDNHM. Following the Cedar fire in October of 2003, all of the monitoring plots in West Sycamore Canyon were resurveyed in 2004, excluding monitoring plot E. The baseline data used for comparison is from 2004 for all plots except monitoring plot E, where data from 2003 is used. A comparison of the 2012 vegetation community within each plot shows an overall drop in species diversity as compared to vegetation monitoring data from the baseline surveys. The mean number of combined native and non-native species in each monitoring plot dropped from 28.7 during the baseline surveys to 22.1 in 2012 (Table 5). Monitoring plot E had 13 species in 2012, the lowest number of species in all 17 monitoring plots. Monitoring plot E had 37 species in 2003 which was the highest number of species recorded in 2004 (monitoring plot E was surveyed prior to the Cedar Fire in October of 2003). The lowest number of species observed during the baseline surveys was 19 species in monitoring plot B. The most diverse plot in 2012 was monitoring plot K with 36 species, as compared to 30 species observed in 2004 (Table 5). The total number of species in each plot is provided in Table 5. A complete species list for each monitoring plot is provided in Appendix B.

Native species diversity also decreased from an average of 19.8 species per monitoring plot during the baseline surveys to 16 native species per monitoring plot in 2012 (Table 5). Monitoring plots K and Q had 28 native species each, the highest number of native species observed in 2012. Monitoring plot K had 24 native species when surveyed in 2004. Vegetation data was not collected at monitoring plots P and Q during previous monitoring efforts so a comparison for this plot is not available. Monitoring plot M had eight native species, the lowest number of native species observed in a monitoring plot in 2012. This is a decrease from 14 native species observed in 2004 (Table 5). A mean of 8.5 native species per plot were observed during the baseline surveys and again in the same plot during the 2012 monitoring. When all monitoring plots are combined, 42 percent of the native species observed during the baseline survey were also observed in the same plot in 2012. Monitoring plots G and K had the highest percentage of species observed during the baseline survey that were also observed during the 2012 survey (79 and 63 percent, respectively). The total number of native species in each plot and the number of native species found in both surveys are provided in Table 5.

The average number of non-native species dropped from 8.9 per plot during the baseline surveys to 6.1 non-native species per plot in 2012 (Table 5). Monitoring plots P and Q had 12 and 14 non-native species per plot in 2012, respectively. These represent the two largest numbers of non-native species. Vegetation data was not collected at either of these plots during surveys performed between 2003 and 2006 so there is no baseline data for these plots. Monitoring plot M had nine non-native species in 2012 which is one more non-native species compared to 2004. In 2004, monitoring plots K and N had 12 non-native species, the highest number of non-native species observed. These plots had four and eight non-native species in 2012, respectively. An average of 4.4 non-native species per plot was observed during the baseline surveys and again in the same plot during the 2012 monitoring. In monitoring plots A, D, E, I, and J, all of the non-native species observed during the baseline survey were observed in 2012. When all monitoring plots are combined 74 percent of the non-native species observed during the baseline survey were observed again in the same plot in 2012. The total number of non-native species in each plot and the number of non-native species found in both surveys are provided in Table 5.

Table 5: Species Composition Data and Comparisons: July 2012 and July 2004

Monitoring Plot	A	B	C	D	E*	F	G	H	I	J	K	L	M	N	O	P	Q	Mean
Number of Native Species, 2004	19	13	20	15	26	13	19	22	27	22	24	17	14	27	19	**	**	19.8
Number of Native Species, 2012	18	10	15	10	9	15	22	22	14	16	28	15	8	26	12	21	28	16.0
Number of Native Species Present During Baseline Survey and 2012 Survey	8	3	10	3	6	6	15	9	9	8	15	8	5	16	7	**	**	8.5
Number of Non-Native Species, 2004	10	6	10	11	11	10	7	7	10	12	6	8	12	8	6	**	**	8.9
Number of Non-Native Species, 2012	5	6	5	6	4	6	7	8	4	6	8	9	8	6	3	12	14	6.1
Number of Non-Native Species Present During Baseline Survey and 2012 Survey	5	4	4	6	4	5	5	6	4	6	3	4	6	3	1	**	**	4.4
Sørensen Similarity Index																		
Total Number of Species, Baseline Survey (A)	29	19	30	26	37	23	26	29	37	34	30	25	26	35	25	**	**	28.7
Total Number of Species, 2012 (B)	23	16	20	16	13	21	29	30	18	22	36	24	16	32	15	33	42	22.1
Number of Species Present During Baseline Survey and 2012 (C)	13	7	14	9	10	11	20	15	13	14	18	12	11	19	8	**	**	12.9
Sørensen Similarity Index	0.50	0.40	0.56	0.43	0.40	0.50	0.73	0.51	0.47	0.50	0.55	0.49	0.52	0.57	0.40	**	**	***

Notes:
*Baseline vegetation surveys were not completed for monitoring plot E in 2004. The above data comparison uses data from 2003 for plot E only.
**Baseline vegetation surveys were not performed at monitoring plots P and Q during monitoring completed between 2003 and 2006. These plots have been excluded from comparisons.
***A Sørensen similarity index is used to compare two sites; an index was not calculated for the combined monitoring plots.
The Sørensen similarity index values were calculated using the following equation: Sørensen similarity index = 2C / (A + B). This equation uses the total number of species in the monitoring plot during the baseline survey (A), the total number of species in the monitoring plot during the 2012 survey (B), and the number of species present at both times (C). The Sørensen similarity index provides a value between 0 and 1. The Sørensen similarity index will provide a value close to 1 for a site that has a very similar species composition in 2012 compared to the baseline survey. A monitoring plot with very few similar species will have an index close to 0.

Species composition has changed since the 2002 initial surveys were performed. An average of 12.9 species per plot was observed during the baseline survey and again in the same plot in 2012. To compare species composition between the baseline surveys and the surveys completed in 2012, a Sørensen similarity index was calculated for each monitoring plot. Monitoring plot G was the most similar in 2012 compared to its original species composition in 2004 (Sørensen similarity index = 0.73). Monitoring plots B, E, and O had the greatest change in species composition (Sørensen similarity index = 0.4). Similarity indexes for each plot are included in Table 5.

3.3 PHOTOGRAPH POINTS

During the 2012 monitoring surveys, photograph points were permanently established at each of the 17 monitoring plots. Photograph points were situated to include willowy monardella within the plot while providing an overall view of the general habitat. When possible the main drainage was included to allow for visual observations of changes in the drainage course over time. A metal stake was installed at each photograph point established during the 2012 surveys. Photographs from the 17 established photograph monitoring locations are provided in Appendix A.

3.4 GENERAL OBSERVATIONS

During the census and monitoring effort, areas of disturbance from human activity in proximity to willowy monardella were noted. There was very little disturbance observed other than trail use, which rarely traveled through willowy monardella areas. The exception to this observation was in Sycamore Canyon, Spring Canyon, and West Sycamore Canyon, where heavily traveled trails were in close proximity to some groups of willowy monardella clumps. In Sycamore Canyon there were multiple bike trails that were close to clumps and in one instance a bike trail was two feet from a clump. In West Sycamore Canyon there were heavily used bike trails at the southern portion of the drainage that were within ten to twenty meters of willowy monardella clumps. The access road (R-32), which extends south to north through West Sycamore Canyon, is within a few meters of a group of willowy monardella clumps in the central portion of the canyon.

Herbivory and other natural history observations were noted during the monitoring and census efforts. There were 181 plants that had signs of herbivory across the Station. There were 6 plants in San Clemente Canyon, 44 in Spring Canyon, 25 in Sycamore Canyon, and 106 in West Sycamore Canyon. In San Clemente Canyon, this represents two percent of all the clumps mapped and all were within the primary drainage. In Spring Canyon this represents 19 percent of the total number of clumps mapped and was primarily observed in the secondary drainages. In Sycamore Canyon, this represents 13 percent of all the clumps mapped and was generally observed in the primary drainage. In West Sycamore Canyon, herbivory was observed on 30 percent of the clumps mapped and was primarily observed within secondary drainages. While herbivory was noted on a large number of clumps, the clumps were usually top-foraged and still had visible vegetative growth. However, clumps that were foraged usually did not show any signs of reproduction.

Pollinators were observed on 39 clumps during the census and were primarily bee pollinators. The bees observed on willowy monardella included honey bees (*Apis mellifera*), bumble bees (*Bombus* spp.), and unidentified halictid bees (Halictidae). In addition to bee pollinators there were multiple butterflies observed visiting willowy monardella flowers and one hummingbird.

On four occasions willowy monardella clumps were observed to be covered by Argentine ants (*Linepithema humile*). The other primary observation commonly made during the census was that some clumps appeared to be very dry.

4.0 DISCUSSION

4.1 CENSUS

The census effort re-established a more quantitative baseline for measuring changes in the population over time. Due to the fact that individual willowy monardella plants cannot be determined without genetic testing or digging up the roots, using a standardized method for clump identification is the key to the long-term success of population monitoring. Establishing a baseline using a Station-wide census eliminates the need for extensive population modeling to determine population size estimates. By determining the total number of clumps on the Station, direct comparisons can be made to identify changes in population size over time. In addition to measuring the size of the population, having a baseline census on the Station will allow managers to identify areas where clumps are lost or gained following additional census surveys.

Sycamore Canyon, West Sycamore Canyon, San Clemente Canyon, and Spring Canyon have the highest willowy monardella numbers on the installation. The distribution of the species has become more restricted since the original mapping and monitoring efforts performed by SDNHM. However, the relative abundance from the 2012 data is similar to the 2002 data (Graph 2). This is evidence that reduction in population size is fairly even throughout the multiple drainages on MCAS Miramar and no specific drainage has seen a loss of willowy monardella at a greater rate than other drainages. Some locations where willowy monardella had been observed in the past no longer contained willowy monardella in 2012. This is true for Rose Canyon and small areas of West Sycamore Canyon. Three monitoring plots in West Sycamore Canyon no longer had willowy monardella (monitoring plots D, E, and M). There were also areas where willowy monardella were observed in 2012 where it had not been observed during past survey efforts. These include plants upstream from previously known locations. In 2012, willowy monardella was found upstream of previously known locations in San Clemente Canyon, West Sycamore Canyon, Sycamore Canyon, Spring Canyon, and Elanus Canyon. In addition, an individual was located during the 2012 census within Murphy Canyon where willowy monardella has not been seen for many years. The continued effort to map the species over time allow for fluctuations in the population distribution to be closely monitored.

Clumps were primarily located on alluvial benches within the primary drainages. Clumps within secondary drainages were more abundant in the main drainage or along the inner edge (Table 2). This could be a function of the limited habitat within the smaller canyons of the secondary drainages where the drainage widths are much smaller than the very wide primary drainages. Another possible explanation is that the upper drainages tend to dry faster than the main drainages limiting the water availability within the alluvial benches of the secondary drainages.

There was also more encroachment from shrub species within the secondary drainages that could be altering the available resources for willowy monardella. The primary drainages also receive higher water flows within the main drainage during rain events compared to the secondary and tertiary drainages. This difference could result in more individuals being displaced within the main drainages by water flows or erosion. Including vegetation sampling that identifies possible competition for specific clumps could help determine what habitat vegetation community factors are causing the major shift in location between secondary drainages and primary drainages.

The census can be used by managers to identify areas on the Station where willowy monardella could be vulnerable to impacts from training activities, development, or trespassing. Using a census gives a complete understanding of the spatial distribution and age structure of the species. This will help identify where recruitment is occurring and where the population is aging without recruitment. Since the census surveys all willowy monardella habitat on the Station, clumps that are not assessed within monitoring surveys will be identified during the census surveys. During the 2012 census, juveniles and seedlings were identified during the census effort in many areas outside the monitoring plots making this an important survey to determine where willowy monardella is establishing successfully on the Station. Juveniles were observed in all of the watersheds where willowy monardella were observed except for Murphy and Elanus Canyons. Seedlings were observed in West Sycamore and Spring Canyons. This is evidence of continued recruitment in addition to vegetative expansion of clumps.

A census can also provide quantitative data that can be used to support hypotheses about specific management concerns. Many clumps within the secondary drainages of West Sycamore Canyon would likely be more reproductive if they had not been foraged (Table 1, Section 3.5). Many clumps had well-developed vegetative growth and appeared to still be growing vigorously, even after being top-foraged. During dry years, forage opportunities are limited in summer months, which is when willowy monardella is flowering. During this time, willowy monardella is one of the only herbaceous plants available in the upper drainages. This likely increases the amount of herbivory on the species. During wetter years when resource availability is more abundant, herbivory is likely a smaller pressure on the species. The pressure from small herbivores is also increased due to the lack of trees in the upper drainages that provide perches for raptors. In the primary drainages large trees are more common and many raptors, such as white-tailed kite (*Elanus leucurus*) and red-tailed hawk (*Buteo jamaicensis*), were observed hunting or perched. With a longer lived perennial plant species, the impacts from this type of herbivory likely varies each year but herbivory should be monitored during all census events, especially during drier years.

4.2 MONITORING PLOTS

Willowy monardella are no longer present in three of the monitoring plots (monitoring plots D, E, and M). Vegetation communities have changed over time in these plots as depicted by the Sørensen index values in Table 5. While it is likely that non-native grass encroachment competed with individuals in monitoring plots D, E, and M, since these plots had at least 70 percent non-native grass cover (Appendix B), it is not clear if other factors attributed to the loss of willowy monardella. Monitoring plots B, C, F, and K had only one clump within each plot. With the exception of monitoring plot K, these six monitoring plots are all in the north portion of West Sycamore Canyon. These monitoring plots all had very high cover of non-native grasses

but monitoring plots H and I, which had the highest counts within West Sycamore Canyon, also had 65 and 50 percent non-native grass cover, respectively (Appendix B). Additionally, monitoring plot H was also in the northern portion of the canyon. Besides the presence of non-native grasses, none of the monitoring plots had high cover of other non-native invasive species (Appendix B).

Monitoring plot K is in the southern most portion of West Sycamore Canyon on the Station and likely has the most trespassing in the area. Multiple hiking trails were observed in the monitoring plot, which also included an access road and parking areas below power lines. While it is not clear if trespassing has impacted willowy monardella within this monitoring plot, the disturbance types in monitoring plot K differ from any other plot.

Throughout the monitoring plots, a drop in species diversity was observed since the initial surveys were performed in 2003 and 2004. This included a drop in native and non-native diversity. This is expected as non-native grasses reestablished following the Cedar Fire in October 2003. While the rate of change over this time period was fairly similar for a majority of the monitoring plots, monitoring plot G had a Sørensen index value of 0.73, which is higher than all of the other monitoring plots (range 0.40 to 0.57). Monitoring plot G had 26 species during the baseline survey performed in 2004, 19 of these were native (Table 5). Many of the perennial chaparral species observed in monitoring plot G were already established during the baseline surveys. In many of the plots these species were not observed during the initial surveys performed in 2003 and 2004. This observation likely explains the high Sørensen index value for monitoring plot G compared to other plots where the establishment of longer lived chaparral species began after the baseline surveys were completed.

The overall ratio of native versus non-native species within each plot was similar in 2012 compared to the baseline surveys. In 2003 and 2004, the mean number of native species per plot was 19.8 and the mean number of non-native species per plot was 8.9. A major limitation of the Sørensen similarity index is that it does not account for abundance of each species during the comparison of species composition. Since species abundance values were only recorded for the dominant species, the Sørensen similarity index is the best possible comparison with the available data. While the data identifies broad changes over time, it is limited at identifying direct impacts to willowy monardella. Measuring vegetation cover using a clump-based sample area will provide community structure data that is directly related to specific clumps. Following multiple monitoring surveys, the change in vegetation structure near each clump can be compared to the growth rate for the specific clump. This will identify if non-native invasive species encroachment is impacting willowy monardella growth rates.

During the 2012 monitoring effort, the largest average clump sizes were within monitoring plots F and K. Both plots only contained a single clump which is a major short coming of the current monitoring plots. Seven of the 17 monitoring plots have either a single clump or no longer have any clumps (Graph 3). Monitoring using plots with small numbers of clumps makes identifying ecological impacts to the species difficult. For example, if a non-native invasive species increased to 50 percent cover in a monitoring plot with only one willowy monardella clump, there is still a relatively good chance that the willowy monardella clump would be in an area where non-native grasses are absent. If that same clump decreased in size by 25 percent, an obvious inference from the data would be that the non-native species establishment resulted in

negative impacts to the clump. While it will be helpful to identify any disturbance in the vicinity of willowy monardella, making an inference as to the possible environmental factors that resulted in the 25 percent reduction of clump size could lead to a faulty conclusion.

The size of the monitoring plots intensifies the problem of identifying ecological impacts to willowy monardella. Their large size can lead to an underestimate of the possible impacts from a small change in vegetation community structure. If the change is isolated within a group of willowy monardella clumps, even a five percent increase could result in the loss of multiple willowy monardella clumps. To alleviate this problem, developing a sampling protocol that ties vegetation sampling to the individual clumps will allow for a better estimate of direct competition between a clump and its nearest neighbors. This will allow for quantitative monitoring of plant cover within the watersheds while identifying what species are within close proximity of willowy monardella clumps. This issue is addressed in the recommendations in Section 5.

The monitoring plots currently focus on the status and growth patterns of willowy monardella clumps within West Sycamore Canyon and directly downstream from the rifle range in San Clemente. Following multiple years of monitoring, estimates on the status of the species within these areas could be made. The ability to infer this information into other watersheds is limited, especially with the variation in the amount of available water, topographical features, and use by the public. Expanding the monitoring effort in Spring Canyon and Sycamore Canyon will increase the ability of the monitoring protocol to address these issues.

5.0 RECOMMENDATIONS

Completing a census on a regular time interval allows for an accurate understanding of the population status. The existing census and monitoring methods have been reviewed and recommendations have been identified to enhance the census and monitoring methods. As previously described, several botanical experts were consulted with regarding these recommendations, including Mr. John Willoughby. Recommendations for future census and monitoring efforts are described below.

5.1 RECOMMENDATIONS FOR CENSUS AND MONITORING EFFORTS

Phenological data, life stage data, herbivory and other natural history observations will be collected at every clump visited during the monitoring and census efforts. This will provide additional data that can be used to determine changes and possible impacts to the species over time.

A categorical assessment of the residual dry matter within close proximity of every clump will also be measured during the monitoring and census surveys. Efforts on the Station have been taken to control thatch within communities containing willowy monardella and a categorical measurement of thatch can be used to identify changes over time. This will also highlight possible causes for loss of individual clumps following multiple survey events. The residual dry matter will be assessed within a variable quadrat that is one foot wider than the clump diameter and width. Three categories will describe the types of residual dry matter observed the census. These categories are:

- No Residual Dry Matter – This describes clumps within rocky drainages without any vegetative matter in close proximity.
- Minimal Dry Matter – More than 80 percent bare ground, minimal thatch buildup, often from dried forbs. This is common along alluvial benches.
- Dense Thatch – Thatch buildup with less than 80 percent bare ground. This is common within areas with non-native grasses.

These categories will help identify encroachment of non-native grasses in areas where the monitoring plots do not exist.

5.2 RECOMMENDATIONS SPECIFICALLY FOR MONITORING EFFORTS

A key limitation of the current monitoring approach is that it does not include monitoring plots within Spring Canyon and Sycamore Canyon, two canyons known to contain high numbers of willowy monardella. Since the current monitoring approach does not include a sampling of all canyons that contain willowy monardella, statistical inferences to the population on the Station as a whole cannot be made from the existing monitoring plot data.

Sycamore Canyon has a greater abundance of tree canopy and willowy monardella growing in tree understories as compared to other portions of the Station. The existing monitoring plots do not provide any monitoring of willowy monardella within this type of habitat. Establishing three

monitoring plots within Sycamore Canyon will provide monitoring in different habitat than is currently monitored while also providing a better measure of disturbance in the area.

Spring Canyon has high densities of willowy monardella and would provide important data for comparison to the data collected in the upper reaches of West Sycamore Canyon. By adding three monitoring plots to Sycamore Canyon and three monitoring plots to Spring Canyon, the monitoring will collect data in a variety of habitats where willowy monardella is found. It will also assess what is influencing changes in the population within the multiple drainages where the species is found. There are several existing monitoring plots that had a single clump or no clumps of willowy monardella (B, D, E, F, K, and M). Monitoring Plot B contained plant number 1540, plot F contained plant number 1737, and plot K contained plant number 1535. Plots D, E, and M contained no plants. Eliminating these plots will also offset the increased level of effort needed to sample the six new plots within Sycamore Canyon and Spring Canyon. The addition of new monitoring plots within Sycamore Canyon and Spring Canyon will be situated in areas containing higher amounts of willowy monardella clumps and will better represent characteristics of the vegetation community surrounding the clumps. These changes to the monitoring plots would provide a better representation of the population status on the Station by monitoring a greater proportion of clumps while maintaining the same number of monitoring plots. Photograph locations will be established at each of the new monitoring plots.

An additional concern is the methods used to collect vegetation data within a monitoring plot. The current methods require a floristic survey to identify all of the species within each monitoring plot. While this is helpful for identifying what species are commonly found near willowy monardella, the size of the monitoring plots and variation within each monitoring plot make this a time consuming effort which does not provide a clear understanding of the interactions between other plant species and willowy monardella. To address this issue, the methods will be adjusted to only collect the dominant species within a monitoring plot. Identifying all species with greater than 10 percent cover will identify the dominant species and document changes within the monitoring plot over time. An absolute percent cover estimate of bare ground and vegetation at each clump within the monitoring plot will also be collected. These estimates will include percent cover of bare ground, native herbs, native shrubs, trees, non-native grasses, other non-natives, and willowy monardella within a variable quadrat that is adjusted based on the size of the clump. Bare ground, non-native grasses, native herbs, other non-natives, and willowy monardella will be estimated within a quadrat that extends 1 foot outside of the ellipse created by the willowy monardella diameter and width. Shrub cover will be measured within a larger area (5 feet beyond the clump diameter and width). Trees can influence clump habitat at a greater distance and will be measured within an area extending 10 feet beyond the clump diameter and width. This will establish a standardized set of concentric ellipses, centered at the central point of each clump. This will provide quantitative data for measuring each plant layer to determine the vegetation types and canopy cover that willowy monardella clumps are associated with while also measuring changes over time. If vegetation is growing into a clump and appears to be impacting the clump, the species will be noted within the natural history observations.

Currently, plant height is measured at clumps within the monitoring plots. This data is used to identify growth rates of individuals following multiple years of monitoring. The heights were measured to the highest point of the clump in 2012. Following the surveys it was determined

that this could influence the clump volume measurement, which is calculated using the plant height measurement. This could make it difficult to identify growth in clumps that are biased by a small portion of the clump that has grown taller than the rest of the clump. While most clumps have a general canopy height some clumps have a few stems that can grow much taller than the rest of the clump. To provide a more consistent height measurement of the clump, the following measurement rule will be followed.

- If the highest point of the clump is greater than 20 percent taller than 95 percent of the clump, the outlier section will not be measured. Instead, the highest point of the 95 percent of the canopy will be measured.

5.3 SUMMARY OF RECOMMENDATIONS

These recommendations have been developed to improve the census and monitoring methods. The recommendations and the goals that they address are summarized in Table 6. Implementation of these recommendations will be further described in a Field Protocol Manual that will be submitted separately.

Table 6: Goals and Recommendations

Goals	Recommendations
1. Complete a census by recording spatial data with sub-foot accuracy so that each willowy monardella clump can be identified during future surveys.	1a. Perform the Station-wide census every six years using the clump identification protocols developed and implemented during the 2012 baseline survey. This will provide an opportunity for discovery of new adults, juveniles, and seedlings that have established since the 2012 census in areas outside of the monitoring plots. The census data collected in future years will be compared to the data collected in 2012 to assess the changes in the status of the species across the Station while focusing on population structure and distribution.
	1b. Continue using sub-foot accuracy GPS units while mapping clumps during all future census and monitoring efforts.
2. Monitor the species within the monitoring plots on a regular basis.	2a. Perform the sampling within the monitoring plots every three years. Monitoring will focus on collecting data on the growth rates of individuals and specific vegetation data. This will allow managers to identify possible changes in the status of the species more regularly than the Station-wide census. This data will help identify ecological changes that could impact the species.
3. Obtain population data to assess the status on the Station.	3a. In 2012, four monitoring plots were recorded to contain a single willowy monardella clump and three monitoring plots were recorded to not contain any clumps. Replacing monitoring plots B, D, E, F, K, and M with three new monitoring plots in Spring Canyon and three new monitoring plots in Sycamore Canyon will expand the monitoring to new canyons where monitoring previously did not occur. By relocating these monitoring plots to areas where more clumps are within each monitoring plot the data collected can be associated to a larger proportion of the willowy monardella population Station-wide.
	3b. Establish photograph points at each of the new monitoring plots within Sycamore Canyon and Spring Canyon. Take photos at each photograph point every time the monitoring is completed.
	3c. Continue collecting the phenological and life stage data for every clump during the census and monitoring efforts.
4. Collect quantitative ecological data during census and monitoring that can be used to identify factors impacting the status of the species on the Station.	4a. Collect data on evidence of herbivory at every clump to identify areas where herbivory is heaviest. If needed, this data could be used to inform management efforts pertaining to herbivory control.
	4b. Measure residual dry matter during future census and monitoring. The Station has performed efforts to remove thatch from areas inhabited by willowy monardella so adding this measurement into the monitoring protocol will help identify if the amount of thatch is impacting willowy monardella growth.
	4c. The current surveys will be adjusted to only collect the dominant species within a monitoring plot. Identifying all species with greater than 10 percent cover will identify the dominant species, and identify changes within the monitoring plot. A percent cover estimate of vegetation at each clump within the monitoring plot will be collected. These estimates will include percent cover of bare ground, native herbs, native shrubs, trees, non-native grasses, other non-natives, and willowy monardella within a variable quadrat that is adjusted based on the size of the clump. The area surveyed should vary depending on type of influence each class has on willowy monardella. Bare ground, non-native grasses, native herbs, and willowy monardella will be estimated within a quadrat that extends 1 foot outside of the ellipse created by the willowy monardella diameter and width to identify encroachment. Shrub cover should be measured within a larger area (5 feet beyond the clump diameter and width). Trees can influence communities containing clumps at a greater distance and will be measured extending 10 feet beyond the clump diameter and width. Establishing a standardized set of concentric ellipses, centered at the central point of each clump. This will provide quantitative data on the vegetation types that willowy monardella are associated with while also measuring changes over time.

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APPENDIX A
MONITORING PLOT PHOTOGRAPHS

Monitoring Plot A: Photograph taken July 3, 2012. Aspect – SW (225 degrees).

Monitoring Plot B: Photograph taken July 5, 2012. Aspect – N (0 degrees).

Monitoring Plot C: Photograph taken July 10, 2012. Aspect – S (160 degrees).

Monitoring Plot D: Photograph taken July 10, 2012. Aspect – NW (320 degrees).

Monitoring Plot E: Photograph taken July 10, 2012. Aspect – SW (225 degrees).

Monitoring Plot F: Photograph taken July 5, 2012. Aspect – NW (320 degrees).

Monitoring Plot G: Photograph taken July 5, 2012. Aspect – E (90 degrees).

Monitoring Plot H: Photograph taken July 5, 2012. Aspect – W (270 degrees).

Monitoring Plot I: Photograph taken July 5, 2012. Aspect – NE (30 degrees).

Monitoring Plot J: Photograph taken July 3, 2012. Aspect – S (190 degrees).

Monitoring Plot K: Photograph taken July 2, 2012. Aspect – E (90 degrees).

Monitoring Plot L: Photograph taken July 5, 2012. Aspect – NE (40 degrees).

Monitoring Plot M: Photo graph taken July 5, 2012. Aspect – S (180 degrees).

Monitoring Plot N: Photograph taken July 6, 2012. Aspect – SW (245 degrees).

Monitoring Plot O: Photograph taken July 3, 2012. Aspect – SE (117 degrees).

Monitoring Plot P: Photograph taken July 15, 2012. Aspect – W (270 degrees).

Monitoring Photograph Q: Photograph taken July 12, 2012. Aspect – SW (225 degrees).

Common observation of herbivory on willowy monardella clumps in West Sycamore secondary drainages. Photograph taken July 3, 2012.

Willowy monardella clump with plant tag. Photograph taken July 1, 2012.

Willowy monardella clump with multiple groups of growth within 24 inches. The plant tag is placed in the middle of the clump. Photograph taken on July 1, 2012

Willowy monardella clumps along the inner edge, within the main drainage, and on the alluvial bench of a secondary drainage in West Sycamore Canyon. Photograph taken July 3, 2012.

APPENDIX B
2012 MONITORING DATA SHEETS

Site	WSYC12003A	Date:	7/3/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, Natasha Niday

Clumps	4	**Vegetative**	
Adults	4	**Blooming**	
Mature		**Flowering**	3
Juvenile		**Seeding**	1
Seedlings		**Dead/Dormant**	

Depth of Drainage (centimeters, cm) 25

Photo Aspect (degrees, deg) 225

General Observations: Two roads through the south side of the plot. Lower portion of the main drainage has *Bromus hordeaceus and B. madritensis* competing with willowy monardella.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Acmispon glaber		**Avena sp.**	10
Adenostoma fasciculatum		**Brassica nigra**	
Ambrosia psilostachya		**Bromus hordeaceus**	10
Artemisia californica		**Bromus madritensis**	10
Baccharis sarothroides		**Centaurea melitensis**	5
Croton setigerus			
Daucus pusillus			
Dudleya pulverulenta			
Epilobium canum			
Eriogonum fasciculatum	15		
Galium angustifolium			
Lathyrus vestitus			
Monardella viminea			
Pseudognaphalium canescens			
Quercus berberidifolia	10		
Rhamnus crocea	5		
Salvia apiana	5		
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003B	Date:	7/5/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, David Murray, Natasha Niday, Jennifer Nix

Clumps	1	**Vegetative**	
Adults	1	**Blooming**	
Mature		**Flowering**	
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	1

Depth of Drainage (cm) 48
Photo Aspect (deg) 0
General Observations: Plot heavily invaded by non-native grasses but drainage clear. High flow drainage. Evidence of burn on woody species. One dead monardella in drainage, plant tag 1540.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Baccharis sarothroides		**Avena sp.**	20
Cercocarpus minutiflorus		Bromus diandrus	20
Corethrogyne filaginifolia		**Bromus madritensis**	
Monardella viminea		**Centaurea melitensis**	
Prunus ilicifolia		**Erodium botrys**	5
Quercus agrifolia		Hordeum sp.	
Quercus berberidifolia		Logfia gallica	
Quercus chrysolepis			
Rhamnus crocea		**Other**	**Percent Cover**
Toxicodendron diversilobum		Drainage	10
		All Non-native grasses (NNG)	75

Bold species were also present during the 2004 surveys.

Site	WSYC12003C	Date:	7/10/2012
Drainage Mapped	Yes	Surveyors:	David Murray, Natasha Niday, Jennifer Nix

Clumps	1	**Vegetative**	
Adults	1	**Blooming**	
Mature		**Flowering**	1
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	

Depth of Drainage (cm) 50
Photo Aspect (deg) 160
General Observations: Drainage meanders through the plot. Only 1 willowy monardella found

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Artemisia californica		**Avena sp.**	20
Corethrogyne filaginifolia		**Brassica nigra**	
Deinandra fasciculata		**Bromus diandrus**	20
Eriodictyon crassifolium	5	Bromus madritensis	5
Eriogonum fasciculatum		**Centaurea melitensis**	
Galium sp.			
Heteromeles arbutifolia			
Monardella viminea		**Other**	**Percent Cover**
Prunus ilicifolia		Drainage	20
Pseudognaphalium californicum		NNG	40
Quercus berberidifolia		Bare Ground	20
Rhamnus crocea	5		
Rhus integrifolia			
Salvia apiana			
Toxicodendron diversilobum	5		

Bold species were also present during the 2004 surveys.

Site	WSYC12003D	Date:	7/10/2012
Drainage Mapped	Yes	Surveyors:	David Murray, Natasha Niday, Jennifer Nix

Clumps	0	**Vegetative**	
Adults		**Blooming**	
Mature		**Flowering**	
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	

Depth of Drainage (cm) 0

Photo Aspect (deg) 320

General Observations: Evidence of burned vegetation in larger Prunus trees. Drainage clear but not obviously deeper than alluvial bench (no distinct inner edge of main drainage)

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Artemisia californica		**Avena sp.**	
Eriogonum fasciculatum		**Bromus diandrus**	
Heteromeles arbutifolia		**Bromus hordeacous**	
Lonicera subspicata var. denudata		**Bromus madritensis**	
Malosma laurina		**Centaurea melitensis**	
Opuntia littoralis		**Erodium sp.**	
Prunus ilicifolia	5		
Quercus berberidifolia		**Other**	**Percent Cover**
Salvia apiana		Drainage	5
Toxicodendron diversilobum		NNG	70

Bold species were also present during the 2004 surveys.

Site	WSYC12003E	Date:	7/10/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller

Clumps	0	**Vegetative**	
Adults		**Blooming**	
Mature		**Flowering**	
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	

Depth of Drainage (cm) 29

Photo Aspect (deg) 225

General Observations: Dominated by non-native grasses

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Cercocarpus minutiflorus		**Avena sp.**	50
Baccharis salicifolia		**Bromus sp.**	35
Croton setigerus		**Centaurea melitensis**	
Eriogonum fasciculatum		**Erodium sp.**	
Prunus ilicifolia			
Pseudognaphalium canescens			
Quercus berberidifolia	5		
Rhamnus crocea			
Toxicodendron diversilobum	5		

Bold species were also present during the 2003 surveys.

Site	WSYC12003F	Date:	7/5/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, David Murray, Jennifer Nix, Natasha Niday

Clumps	1	**Vegetative**	
Adults	1	**Blooming**	
Mature		**Flowering**	1
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	

Depth of Drainage (cm) 56

Photo Aspect (deg) 320

General Observations: One central drainage through plot. Alluvial benches dominated by NNG. Drainage clear. Some NNG trampled but mostly upright. Trail through center of the plot, minimal disturbance. Evidence of herbivory on vegetation.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Adenostoma fasciculatum		**Avena sp.**	35
Baccharis sarothroides		**Bromus diandrus**	25
Cercocarpus minutiflorus		Bromus hordeaceus	
Chroizanthe fimbriata		**Bromus madritensis**	
Epilobium canum		**Centaurea melitensis**	
Eriogonum fasciculatum	5	**Erodium sp.**	
Malacothamnus fasciculatus			
Malosma laurina		**Other**	**Percent Cover**
Monardella viminea		NNG	80
Prunus ilicifolia		Drainage	5
Quercus berberidifolia		All Quercus sp.	5
Quercus chrysolepis			
Rhamnus crocea			
Stachys sp.			
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003G	Date:	7/5/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, David Murray, Natasha Niday, Jennifer Nix

Clumps	5	**Vegetative**	
Adults		**Blooming**	
Mature	1	**Flowering**	3
Juvenile	4	**Seeding**	
Seedlings		**Dead/Dormant**	2

Depth of Drainage (cm) 53

Photo Aspect (deg) 90

General Observations: High flow drainage, alluvial bench dominated by NNG. Similar to monitoring plot H. Road adjacent to meandering drainage. Evidence of fire on large woody species

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Acmispon glaber		**Avena sp.**	25
Artemisia californica		**Brassica nigra**	
Baccharis sarothroides		**Bromus diandrus**	10
Brickellia californica		Bromus hordeaceus	5
Cercocarpus minutiflorus	5	**Bromus madritensis**	10
Chroizanthe fimbriata		**Erodium botrys**	
Deinandra fasciculata		Logfia gallica	
Epilobium canum			
Eriogonum fasciculatum		**Other**	**Percent Cover**
Galium sp.		NNG	60
Lonicera subspicata var. denudata			
Malosma laurina			
Monardella viminea			
Opuntia sp.			
Pallaea sp.			
Phacelia distans			
Prunus ilicifolia			
Quercus agrifolia			
Quercus chrysolepis			
Rhamnus crocea			
Salvia apiana			
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003H	Date:	7/5/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, David Murray, Natasha Niday, Jennifer Nix

Clumps	16	**Vegetative**	7
Adults	15	**Blooming**	
Mature	1	**Flowering**	6
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	3

Depth of Drainage (cm) 77

Photo Aspect (deg) 270

General Observations: Overflow/high flow drainage. Road bisecting plot. Alluvial bench dominated by tall non-native grasses. No signs of erosion. Minimal disturbance. Drainage clear. Only non-native species are non-native grasses

Native Species Observed	**Percent Cover**	**Non-Native Species Observed**	**Percent Cover**
Adenostoma fasciculatum		**Avena sp.**	25
Artemisia californica		**Bromus diandrus**	15
Baccharis sarothroides		**Brassica nigra**	
Cercocarpus minutiflorus	5	Bromus hordeaceus	
Chroizanthe fimbriata		**Erodium botrys**	5
Croton setigerus		**Bromus madritensis**	15
Deinandra fasciculata		Logfia gallica	
Epilobium canum		**Festuca multiflorum**	
Eriogonum fasciculatum	5		
Ferocactus viridescens		**Other**	**Percent Cover**
Galium sp.		Total NNG	65
Malosma laurina		Drainage	10
Monardella viminea			
Opuntia sp.			
Prunus ilicifolia			
Pseudognaphalium canescens			
Quercus berberidifolia			
Quercus chrysolepis			
Rhamnus crocea	5		
Salvia apiana			
Stipa sp.			
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003I	Date:	7/3/12 and 7/6/12
Drainage Mapped	Yes	Surveyors:	David Murray, Jennifer Nix (7/3/12); Anthony DiBiase, David Murray (7/6/12)

Clumps	23	**Vegetative**	15
Adults	20	**Blooming**	1
Mature	1	**Flowering**	5
Juvenile	3	**Seeding**	
Seedlings		**Dead/Dormant**	2

Depth of Drainage (cm) 65

Photo Aspect (deg) 30

General Observations: Non-native grasses dominant on alluvial benches. One trail meanders through the plot. Drainage channel is clear. Large number of willowy monardella throughout the plot, including juveniles within the main drainage. Upper extent of willowy monardella within secondary drainage. GPS battery exhausted on first day of surveys, required second day to complete.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Acmispon glaber		**Avena sp.**	45
Adenostoma fasciculatum		**Bromus diandrus**	5
Artemisia californica	5	**Bromus hordeaceus**	
Cercocarpus minutiflorus		**Centaurea melitensis**	
Eriodictyon crassifolium	10		
Eriogonum fasciculatum	10	**Other**	**Percent Cover**
Ferocactus viridescens		Bare ground/drainage	20
Monardella viminea			
Prunus ilicifolia			
Pseudognaphalium californicum			
Rhamnus crocea			
Salvia apiana			
Salvia mellifera	5		
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003J	Date:	7/3/2012
Drainage Mapped	Yes	Surveyors:	David Murray, Jennifer Nix

Clumps	11	**Vegetative**	5
Adults	1	**Blooming**	1
Mature	9	**Flowering**	2
Juvenile		**Seeding**	3
Seedlings	1	**Dead/Dormant**	

Depth of Drainage (cm) 60

Photo Aspect (deg) 190

General Observations: Non-native grasses dominant in herbaceous understory. No signs of disturbance or erosion. Clear drainage channel. No broad-leafed invasives.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Acmispon glaber		**Avena sp.**	
Baccharis sarothroides		**Bromus diandrus**	
Cercocarpus minutiflorus		**Bromus hordeaceus**	
Corethrogyne filaginifolia		**Bromus madritensis**	40
Croton setigerus		**Centaurea melitensis**	5
Deinandra fasciculata		**Erodium botrys**	
Eriodictyon crassifolium			
Eriogonum fasciculatum	10	**Other**	**Percent Cover**
Malosma laurina		Unidentifiable grasses	15
Mimulus sp.		Drainage	10
Monardella viminea			
Pseudognaphalium sp.			
Rhamnus crocea	5		
Salvia apiana			
Salvia mellifera			
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003K	Date:	7/2/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Amy Noddings, Daniel Miller, David Murray, Natasha Niday, Jennifer Nix

Clumps	1	**Vegetative**	
Adults	1	**Blooming**	
Mature		**Flowering**	1
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	

Depth of Drainage (cm) 65

Photo Aspect (deg) 90

General Observations: Replaced three stakes. High traffic area for hikers and bikers. Major access road travels through plot, road cuts in the plot. Incised erosion banks in drainage, variety of habitat. Upland habitat and drainage habitat are very different.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Acmispon glaber		**Avena sp.**	
Ambrosia psilostachya		Bromus hordeaceus	
Artemisia californica		**Bromus madritensis**	
Baccharis salicifolia		Centaurea melitensis	
Baccharis sarothroides	5	**Hordeum murinum**	
Brickellia californica		Rumex crispus	
Chroizanthe fimbriata		Silene gallica	
Corethrogyne filaginifolia	5	Vulpia myuros	
Cuscuta californica			
Deinandra fasciculata			
Distichlis spicata			
Dudleya pulverulenta			
Epilobium canum			
Eriogonum fasciculatum	25		
Galium sp.			
Heterotheca grandiflora			
Hirschfeldia incana			
Isocoma menziesii			
Malosma laurina	5		
Monardella viminea			
Opuntia littoralis	5		
Platanus racemosa			
Pseudognaphalium biolettii			
Pseudognaphalium canescens			

Quercus agrifolia	5		
Rhamnus crocea			
Salvia apiana	5		
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003L	Date:	7/5/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, David Murray, Natasha Niday, Jennifer Nix

Clumps	4	**Vegetative**	
Adults	4	**Blooming**	
Mature		**Flowering**	3
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	1

Depth of Drainage (cm) 37

Photo Aspect (deg) 40

General Observations: Drainage clear, alluvial bench dominated by non-native grasses. Road adjacent to plot but no signs of erosion or disturbance.

Native Species Observed	**Percent Cover**	**Non-Native Species Observed**	**Percent Cover**
Adenostoma fasciculatum		**Avena sp.**	20
Artemisia californica		**Brassica nigra**	
Cercocarpus minutiflorus		**Bromus diandrus**	20
Eriogonum fasciculatum		Bromus hordeaceus	
Lonicera subspicata var. denudata		Bromus madritensis	
Lupinus sp.		Centaurea melitensis	
Malacothamnus fasciculatus		**Erodium botrys**	
Malosma laurina		Festuca perennis	
Monardella viminea		Hordeum sp.	
Prunus ilicifolia			
Quercus agrifolia		**Other**	**Percent Cover**
Quercus berberidifolia	5	All NNG	70
Rhamnus crocea		Drainage	10
Stachys bullata			
Stipa sp.			

Bold species were also present during the 2004 surveys.

Site	WSYC12003M	Date:	7/5/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, David Murray, Natasha Niday, Jennifer Nix

Clumps	0	**Vegetative**	
Adults		**Blooming**	
Mature		**Flowering**	
Juvenile		**Seeding**	
Seedlings		**Dead/Dormant**	

Depth of Drainage (cm) 33

Photo Aspect (deg) 180

General Observations: Evidence of burn on woody species. Large pieces of burned wood within the drainage. Alluvial bench dominated by non-native grasses. No signs of disturbance.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Cercocarpus minutiflorus	5	**Avena sp.**	20
Corethrogyne filaginifolia		**Bromus diandrus**	20
Eriogonum fasciculatum		**Bromus hordeaceus**	
Prunus ilicifolia		Carduus pycnocephalus	
Quercus berberidifolia		**Centaurea melitensis**	
Rhamnus crocea	5	**Erodium botrys**	
Salvia apiana		Hordeum sp.	
Toxicodendron diversilobum		**Rumex crispus**	
		Other	**Percent Cover**
		NNG Total	70
		Drainage	15

Bold species were also present during the 2004 surveys.

Site	WSYC12003N	Date:	7/3/12 and 7/6/12
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, Natasha Niday (7/3/12) Daniel Miller, Natasha Niday, Jennifer Nix (7/6/12)

Clumps	12	**Vegetative**	6
Adults	5	**Blooming**	
Mature	1	**Flowering**	5
Juvenile	3	**Seeding**	
Seedlings	3	**Dead/Dormant**	1

Depth of Drainage (cm) 35

Photo Aspect (deg) 245

General Observations: High flow drainage, drainage wide and clear through plot. Evidence of fire on older woody plants. Alluvial bench dominated by non-native grasses and Psuedognaphalium.

Native Species Observed	**Percent Cover**	**Non-Native Species Observed**	**Percent Cover**
Acmispon glaber		Avena sp.	
Adenostoma fasciculatum		Brassica nigra	
Artemisia californica		**Bromus hordeaceus**	
Calystegia macrostegia		**Bromus madritensis**	
Ceanothus tomentosus		**Centaurea melitensis**	
Cercocarpus minutiflorus		Logfia gallica	
Clematis sp.			
Deinandra fasciculata		**Other**	**Percent Cover**
Eriogonum fasciculatum		Drainage	20
Galium sp.		Total NNG	25
Hesperoyucca whipplei		Bare Ground	10
Heteromeles arbutifolia			
Lonicera subspicata var. denudata			
Malacothamnus fasciculatus			
Monardella viminea			
Opuntia sp.			
Phacelia sp.			
Prunus ilicifolia			
Pseudognaphalium californicum			
Pseudognaphalium canescens			
Quercus berberidifolia			
Rhamnus crocea			
Rhus integrifolia			
Salvia apiana			

Stachys bullata			
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	WSYC12003O	Date:	7/3/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, Natasha Niday

Clumps	6	**Vegetative**	2
Adults	2	**Blooming**	
Mature	2	**Flowering**	3
Juvenile	2	**Seeding**	
Seedlings		**Dead/Dormant**	1

Depth of Drainage (cm) 50

Photo Aspect (deg) 117

General Observations: None

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Acmispon glaber		**Brassica nigra**	
Adenostoma fasciculatum		Centaurea melitensis	
Artemisia californica		Rumex Crispus	
Baccharis sarothroides			
Ceanothus tomentosus			
Cercocarpus minutiflorus			
Eriogonum fasciculatum			
Monardella viminea			
Quercus berberidifolia			
Salvia apiana			
Salvia mellifera			
Toxicodendron diversilobum			

Bold species were also present during the 2004 surveys.

Site	SSC12003B (Plot P in 2012 figures)	Date:	7/15/2012
Drainage Mapped	Yes	Surveyors:	Daniel Miller, David Murray, Jennifer Nix

Clumps	14	**Vegetative**	
Adults	13	**Blooming**	
Mature	1	**Flowering**	2
Juvenile		**Seeding**	11
Seedlings		**Dead/Dormant**	1

Depth of Drainage (cm) 35

Photo Aspect (deg) 270

General Observations: Diverse plot. Evidence of burn on charred stumps on alluvial bench. Some non-native grasses. Main drainage has several tributaries. Some protion of plot dominated by non-native grasses. Evidence of wildlife movement through plot.

Native Species Observed	Percent Cover	Non-Native Species Observed	Percent Cover
Adenostoma fasciculatum		Avena sp.	40
Ambrosia psilostachya		Brassica nigra	
Artemisia californica		Bromus diandrus	
Deinandra fasciculata		Bromus hordeaceus	
Dudleya edulis		Bromus madritensis	
Eriogonum fasciculatum	5	Centaurea melitensis	
Galium sp.		Conyza sp.	
Heteromeles arbutifolia		Erodium botrys	
Juncus sp.		Erodium sp.	
Monardella viminea		Hirshfeldia incana	
Opuntia sp.		Rumex crispus	
Rhamnus crocea		Rumex salicifolius	
Salix gooddingii		Silybum marianum	
Salvia apiana			
Salvia mellifera		**Other**	**Percent Cover**
Sisyrinchium bellum		Drainage	20
Solanum sp.			
Stachys sp.			
Stephanomeria virgata			
Stipa sp.			
Toxicodendron diversilobum			

Site	SSC12003A (Plot Q in 2012 reports)	Date:	7/12/2012
Drainage Mapped	Yes	Surveyors:	Anthony DiBiase, Daniel Miller, David Murray, Natasha Niday, Jennifer Nix

Clumps	19	**Vegetative**	
Adults	19	**Blooming**	
Mature		**Flowering**	2
Juvenile		**Seeding**	17
Seedlings		**Dead/Dormant**	

Depth of Drainage (cm) 50

Photo Aspect (deg) 225

General Observations: Plot divers but largely dominated by non-native grasses.

Native Species Observed	**Percent Cover**	**Non-Native Species Observed**	**Percent Cover**
Acmispon glaber		Avena sp.	
Ambrosia psilostachya		Brassica nigra	
Artemisia californica		Bromus diandrus	
Baccharis sarothroides		Bromus madritensis	
Baccharis sarothroides		Centaurea melitensis	
Cercocarpus minutiflorus		Erodium sp.	
Corethrogyne filaginifolia		Hirshfelidia incana	
Corethrogyne filaginifolia		Hordeum sp.	
Croton setigerus		Lactuca serriola	
Epilobium canum		Limonium sinuatum	
Eriogonum fasciculatum		Olea europaea	
Galium sp.		Rumex crispus	
Heteromeles arbutifolia		Rumex salicifolius	
Lonicera subspicata var. denudata		Silybum marianum	
Malosma laurina			
Mimulus aurantiacus		**Other**	**Percent Cover**
Monardella viminea		Drainage	5
Opuntia sp.			
Phacelia sp.			
Prunus ilicifolia			
Pseudognaphalium canescens			
Rhamnus crocea			
Rhus integrifolia			
Salvia apiana			
Salvia mellifera			

Sisyrinchium bellum			
Stipa sp.			
Toxicodendron diversilobum			

APPENDIX C
LIST OF PROJECT PERSONNEL

Project Personnel

Personnel	Position
Brad Agius	GIS Specialist
Michelle Bates	Project Manager, Botanist
Anthony DiBiase	Botanist
Justin McCullough	Botanist
Kari Metcalf	GIS Specialist
Daniel Miller	Botanist
David Murray	Botanist
Natasha Niday	Botanist
Jennifer Nix	Botanist
Amy Noddings	Botanist