

FINAL SURVEY REPORT WILLOWY MONARDELLA (*MONARDELLA VIMINEA*) CENSUS AND MONITORING, MARINE CORPS AIR STATION MIRAMAR, SAN DIEGO, CALIFORNIA

Prepared for:



Marine Corps Air Station
Miramar
Environmental Management
Department
Natural Resources Division
Building 6022
San Diego, California 92145

Under contract with:



Naval Facilities Engineering
Command Southwest
Central Integrated Products
Team
1220 Pacific Highway
San Diego, California 92132

Prepared by:



**VERNADERO
GROUP**
INCORPORATED

2730 East Camelback Road
Suite 210
Phoenix, Arizona 85016

Contract N62473-14-D-1425
Task Order 0058

April 2018



EXECUTIVE SUMMARY

Vernadero Group Inc. (Vernadero) was contracted by Naval Facilities Engineering Command Southwest on behalf of Marine Corps Air Station (MCAS) Miramar to conduct a Stationwide census for willowy monardella (*Monardella viminea*) and monitor the species within long-term monitoring plots at MCAS Miramar in San Diego, California. We conducted willowy monardella surveys in 2017 following all of the census and monitoring methods described by the 2013 *Willowy Monardella (Monardella viminea) Field Protocol Manual* to ensure consistency with past and future willowy monardella surveys at MCAS Miramar. We surveyed and mapped all willowy monardella on MCAS Miramar, identifying adults, mature plants, juveniles, and seedlings. We used a standardized method to define and delineate clumps of willowy monardella during the census. We visited established monitoring plots and used standardized methods for measuring willowy monardella growth rates, determining clump health, and evaluating willowy monardella population expansion or contraction. We conducted census and monitoring activities at MCAS Miramar from 22 June 2017 through 8 August 2017.

A total of 972 willowy monardella clumps was found during the 2017 census; 278 clumps that had been observed and tagged during previous surveys were not found again during the 2017 census. Clumps were found in six of the nine canyons surveyed and a total of 141 living willowy monardella clumps was recorded in the 17 monitoring plots. All monitoring plots had at least one live clump. Only one seedling was observed during surveys. The overall mean and median willowy monardella clump elliptical areas were 1.40 and 0.55 square meters, respectively. The overall mean and median willowy monardella elliptical volumes were 0.79 and 0.24 cubic meters, respectively. Regression using habitat variables determined that bare ground was strongly negatively correlated with both willowy monardella clump elliptical area ($P<0.001$) and elliptical volume ($P<0.001$). There were also significant negative correlations between nonnative grass cover and willowy monardella clump elliptical area ($P<0.01$) and elliptical volume ($P<0.01$) and between nonnative herbaceous cover and willowy monardella clump elliptical area ($P<0.05$) and elliptical volume ($P<0.05$).

The results from the 2017 census and plot monitoring indicate a continuing decline in the number and health of willowy monardella clumps at MCAS Miramar. The cause of the decline in willowy monardella clumps and reproduction is unknown; however, stress to plants from the long-term drought conditions that occurred for the five years prior to the 2017 surveys accompanied by large scouring events in the stream channels from large rainfall events in the 2016 and 2017 growing seasons could have caused mortality in adult willowy monardella plants, reduced the production of viable seeds during drought conditions, and displaced all viable seed produced when drought conditions were relieved by above-average precipitation in 2016 and 2017.

FORMAT PAGE

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	Marine Corps Air Station Miramar	1
1.2	Scope	1
1.3	Species Information	1
1.4	Precipitation Information	7
2.0	METHODS.....	9
2.1	Willowy Monardella Census.....	9
2.2	Willowy Monardella Monitoring	10
2.3	Data Analysis and Reporting	15
2.4	Geographic Information System.....	16
2.5	Access and Safety Coordination	17
3.0	RESULTS.....	19
3.1	Willowy Monardella Census.....	19
3.2	Willowy Monardella Plot Monitoring	31
4.0	OBSERVED TEMPORAL TRENDS	39
4.1	Census Temporal Observations.....	39
4.2	Monitoring Temporal Observations	39
5.0	DISCUSSION	53
6.0	MANAGEMENT RECOMMENDATIONS.....	57
6.1	Scour and Bank Erosion	57
6.2	Herbivory	57
6.3	Nectaring	58
6.4	Nonnative Grasses	58
6.5	Soils and Substrate.....	58
6.6	Population Viability Analysis	59
7.0	REFERENCES	61

LIST OF FIGURES

Figure 1-1. Location of MCAS Miramar	3
Figure 1-2. Willowy Monardella Census Locations	5
Figure 2-1. Location of Willowy Monardella Monitoring Plots at MCAS Miramar.....	13
Figure 3-1. Willowy Monardella Clumps in Elanus Canyon.....	21
Figure 3-2. Willowy Monardella Clumps in Murphy Canyon.....	22
Figure 3-3. Willowy Monardella Clumps in the Eastern Portion of San Clemente Canyon.....	23
Figure 3-4. Willowy Monardella Clumps in the Western Portion of San Clemente Canyon.....	24
Figure 3-5. Willowy Monardella Clumps in Spring Canyon	25
Figure 3-6. Willowy Monardella Clumps in Sycamore Canyon	26
Figure 3-7. Willowy Monardella Clumps in the Northern Portion of West Sycamore Canyon.....	27
Figure 3-8. Willowy Monardella Clumps in the Southern Portion of West Sycamore Canyon	28
Figure 3-9. Life Stage of Willowy Monardella Clumps by Canyon	29
Figure 3-10. Phenology Stage of Willowy Monardella Clumps by Canyon.....	30
Figure 3-11. Location in Drainage of Willowy Monardella Clumps by Canyon	31
Figure 4-1. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in Elanus Canyon.....	41
Figure 4-2. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in Murphy Canyon.....	42
Figure 4-3. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Eastern Portion of San Clemente Canyon	43
Figure 4-4. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Western Portion of San Clemente Canyon	44
Figure 4-5. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in Spring Canyon	45
Figure 4-6. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in Sycamore Canyon.....	46
Figure 4-7. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Northern Portion of West Sycamore Canyon.....	47
Figure 4-8. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Southern Portion of West Sycamore Canyon	48

LIST OF TABLES

Table 1-1. Annual Precipitation from 2012 – 2017 near the Study Area	7
Table 2-1. Multiple Regression Variables	16
Table 3-1. Number of Willowy Monardella Clumps by Canyon	29
Table 3-2. Mean Height, Length, and Width of Willowy Monardella Clumps by Canyon	30
Table 3-3. Number of Willowy Monardella Clumps by Monitoring Plot.....	32
Table 3-4. Mean and Median Elliptical Areas of Willowy Monardella Clumps by Monitoring Plot.....	32
Table 3-5. Mean and Median Elliptical Volumes of Willowy Monardella Clumps by Monitoring Plot.....	33
Table 3-6. Drainage Depth, Soil Types, and Disturbances in Willowy Monardella Monitoring Plots	34
Table 3-7. Multiple Regression Results for Elliptical Area	35
Table 3-8. Multiple Regression Results for Elliptical Volume	36
Table 4-1. Willowy Monardella Growth Rates 2012 – 2017*.....	49

LIST OF APPENDICES

Appendix A. Monitoring Plot Photographs	A-1
Appendix B. Monitoring Plot Data Sheets.....	B-1

FORMAT PAGE

LIST OF ACRONYMS AND ABBREVIATIONS

cm	Centimeter
GIS	Geographic Information System
GPS	Global Positioning System
ID	Identification
MCAS	Marine Corps Air Station
mm	Millimeter
N/A	Not Available
R	Program R, Statistical and Graphic Software
RDM	Residual Dry Matter
USFWS	U.S. Fish and Wildlife Service
Vernadero	Vernadero Group Inc.

FORMAT PAGE

1.0 INTRODUCTION

Vernadero Group Inc. (Vernadero) was contracted by Naval Facilities Engineering Command Southwest on behalf of Marine Corps Air Station (MCAS) Miramar to conduct a Stationwide census for willowy monardella (*Monardella viminea*) and monitor the species within long-term monitoring plots at MCAS Miramar in San Diego, California. Willowy monardella surveys were conducted in 2017 to support natural resources planning and management activities by MCAS Miramar.

1.1 Marine Corps Air Station Miramar

MCAS Miramar is in San Diego County, approximately 13 miles north of downtown San Diego and 4 miles east of the Pacific Ocean (Figure 1-1). Suitable habitat for willowy monardella occurs in drainage basins at MCAS Miramar. This includes portions of nine canyons: Rose, San Clemente, Elanus, Murphy, Oak, Spring, Quail, West Sycamore, and Sycamore. These drainage areas where suitable habitat is present compose the census area for willowy monardella on the Station (Figure 1-2).

1.2 Scope

Vernadero conducted a Stationwide census for willowy monardella during its flowering period in 2017. The census followed the methods described by the *Willowy Monardella (Monardella viminea) Field Protocol Manual* (MCAS Miramar 2013a; Field Protocol Manual). In addition to the Stationwide census, Vernadero supported the long-term monitoring of willowy monardella at MCAS Miramar by collecting data in previously established monitoring plots following the methods described in the Field Protocol Manual (MCAS Miramar 2013a). Lastly, Vernadero compared the results of the 2017 census and monitoring to the willowy monardella census and monitoring data collected in 2012.

1.3 Species Information

Willowy monardella is a subshrub in the Lamiaceae (mint) family. It has erect stems, 25 to 50 centimeters (cm) in length, densely short-haired and appearing glaucous-green. Leaves are 20 to 40 millimeters (mm) in length, 2 to 4 mm wide, linear to narrowly lanceolate, minutely puberulent, and glaucous in appearance. There is typically one flower cluster per main stem, which is 20 to 30 mm wide with bracts that are 10 to 15 mm long and 5 to 9 mm wide. On rare occasions, there can be two to three flower clusters on a main stem. Flower corollas are white to rose in color. Willowy monardella flowers from June through August and is typically found in rocky washes with cobbles at elevations below 1,200 feet (Jepson eFlora 2017).

Willowy monardella is federally and state listed as endangered and has a California Native Plant Society ranking as 1B.1 (rare or endangered in California and elsewhere; severely endangered in California). There is a total of 28 known element occurrences of willowy monardella, with 20 presumed extant, 7 possibly extirpated, and 1 presumed extirpated (California Native Plant Society 2017). All records of willowy monardella are from San Diego County, California.

Willow monardella is found in association with sandy washes, benches, and floodplains of perennial streams and requires ephemeral watersheds with regular flooding regimes that periodically scour riparian vegetation (USFWS 2008). Incidental observations noted that where willow monardella was present within a sandy wash, bench, or floodplain, a layer of cobble was visible (due to a hydrological cut) approximately 6 inches below the soil surface. The U.S. Fish and Wildlife Service (USFWS) indicates the narrow habitat conditions for willow monardella are sustained “by natural processes and conditions of perennial streams and threatened by those factors that disrupt those processes and conditions” (USFWS 2008). The following have been causal mechanisms in the reduction of willow monardella populations (USFWS 2008):

- Grazing/trampling
- Urban and residential development
- Various recreational activities
- Altered hydrological regimes
- Road construction
- Soil removal
- Sand and gravel mining
- Trash dumping
- Erosion
- Invasive plant species
- Fire
- Drought
- Reduction in gene flow

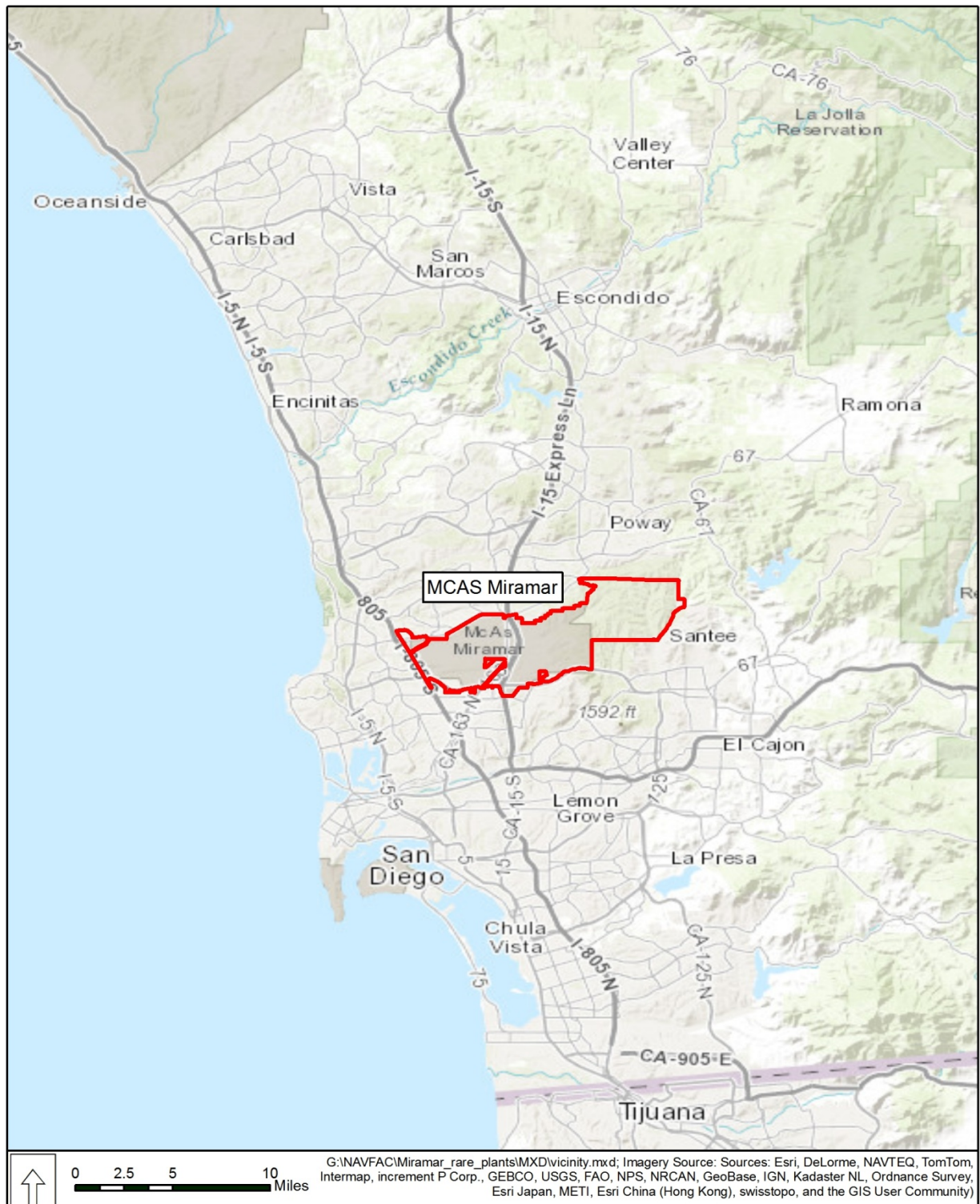


Figure 1-1. Location of MCAS Miramar

FORMAT PAGE

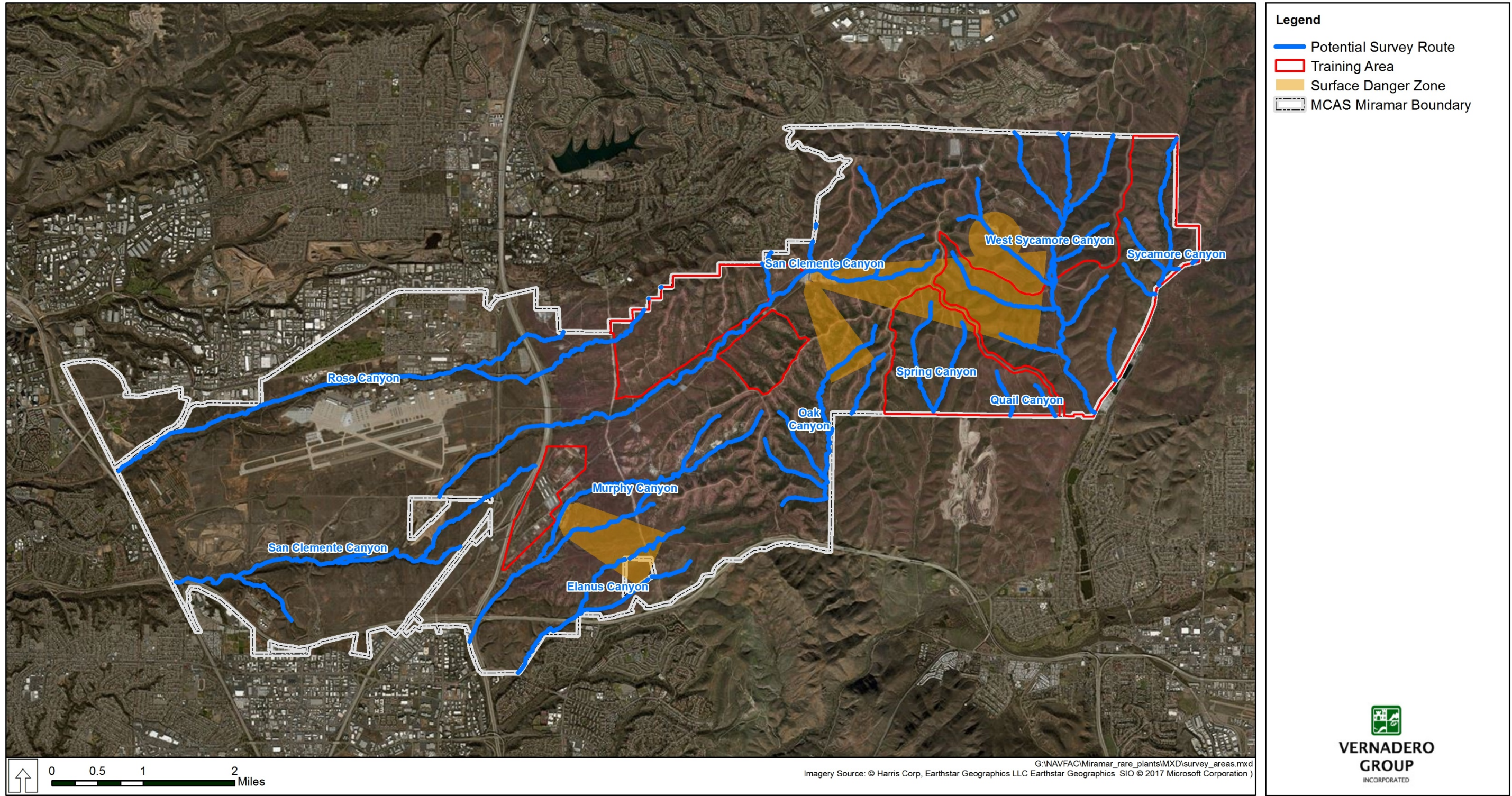


Figure 1-2. Willowy Monardella Census Locations

FORMAT PAGE

1.4 Precipitation Information

Precipitation in San Diego County is annually variable and its spatial distribution is influenced by many factors, including distance from the Pacific Ocean and topography. Because rainfall is critical for the growth of plant species and can lead to physical changes in stream channels due to scouring and biological changes such as the composition of plant species, it is useful to understand annual precipitation rates specific to the locations where willow monardella is growing (USFWS 2008). Precipitation data from growing season 2012 through growing season 2017 were therefore gathered from four weather stations (Western Regional Climate Center 2017; National Weather Service San Diego Region 2018; National Oceanographic and Atmospheric Administration National Centers for Environmental Information 2018) proximate to MCAS Miramar, including the MCAS Miramar (NKX) weather station (Table 1-1). The average rainfall over this period was 10.30 inches at the MCAS Miramar (NKX) weather station, 7.72 inches at the Camp Elliott weather station, 9.07 inches at the San Miguel weather station, and 10.70 inches at the Santee weather station at the Santee Airport. (Note that the records were not complete for this time period at the Camp Elliott weather station, as indicated in Table 1-1). The 2016-2017 growing season had the highest amount of precipitation, approximately double the average annual precipitation during the growing seasons from 2011 through 2015.

Table 1-1. Annual Precipitation from 2012 – 2017 near the Study Area

Growing Season (1 July – 30 June)	MCAS Miramar- NKX (inches)	Camp Elliott (inches)	San Miguel (inches)	Santee (Inches)
2011 – 2012	9.87	8.75	9.20	9.94
2012 – 2013	6.82	7.64	7.34	8.33
2013 – 2014	4.63	3.46	4.75	5.48
2014 – 2015*	8.30	6.58	5.19	8.26
2015 – 2016*	14.59	12.17	11.20	11.11
2016 – 2017	17.59	N/A	16.71	20.9
Mean	10.30	7.72	9.07	10.7

Sources: Western Regional Climate Center 2017; National Weather Service San Diego Region 2018; National Oceanographic and Atmospheric Administration National Centers for Environmental Information 2018

MCAS – Marine Corps Air Station; **N/A** – not available

* Both of these growing seasons straddle an anomalous summer during which four extratropical storms provided rainfall throughout San Diego County. For example, a total of 4.3 inches was recorded from 8 May through 30 September 2015 at Gillespie Field.

FORMAT PAGE

2.0 METHODS

Vernadero followed all of the census and monitoring methods described by the Field Protocol Manual (MCAS Miramar 2013a) to ensure consistency with past and future willowy monardella surveys at MCAS Miramar. We surveyed and mapped all willowy monardella on MCAS Miramar identifying adults, mature plants, juveniles, and seedlings. We used a standardized method to define and delineate clumps of willowy monardella during the census. We visited established monitoring plots and used standardized methods to measure willowy monardella growth rates, determine clump health, and evaluate willowy monardella population expansion or contraction.

We conducted census and monitoring activities at MCAS Miramar from 22 June 2017 through 8 August 2017. Surveyors included Dr. Ed Kentner, Mr. Keir Morse, Ms. Nicole Kimball, Mr. Andrew Borchert, and Dr. Eric Webb. Surveyors were all well-trained in the identification of willowy monardella and visited flowering willowy monardella prior to the start of surveys to ensure they understood the identifying characteristics.

2.1 Willowy Monardella Census

Vernadero conducted a 100-percent coverage survey within all suitable habitat in Rose, San Clemente, Elanus, Murphy, Oak, Spring, Quail, West Sycamore, and Sycamore Canyons on the Station. We examined ephemeral drainages, perennial drainages, and their associated floodplains for willowy monardella (see Figure 1-2). The identification and mapping of clumps were done according to the methods described in the Field Protocol Manual (MCAS Miramar 2013a). We identified a single clump as a willowy monardella plant(s) separated by more than 24 inches from another willowy monardella clump(s). We determined the separation between plants (living or dry) by measuring between the two closest points of vegetation. We mapped and marked all seedlings regardless of the distance between the seedlings. Surveyors visited the locations of all previously identified willowy monardella plants in an attempt to locate all of those willowy monardella clumps.

We identified all willowy monardella clumps with a plant tag following the methods described in the Field Protocol Manual (MCAS Miramar 2013a). Willowy monardella clumps mapped during previous surveys had a tag number, and the surveyors verified that the tags still existed and found them if necessary. Where plant tags were missing and a clump was observed, surveyors installed a number tag and associated this tag number with the previous tag record. Surveyors placed a new plant tag on all newly identified plants, and the plant tag number was recorded. Surveyors searched for all previously noted plant tags and recorded the status of each plant tag even if a tag and its associated clump could not be found. All plant tag locations were mapped with a global positioning system (GPS) with subfoot accuracy (Section 2.4).

The willowy monardella census collected the following information at every clump as described in the Field Protocol Manual (MCAS Miramar 2013a):

- Location (center point) of each clump with subfoot accuracy
- Plant tag number

- Plant tag numbers associated with clump expansion, splitting, or lost tags
- Phenology stage (vegetative, budding, flowering, fruiting, seeding, dormant/dead)
- Life stage (seeding, juvenile, mature, adult)
- Location of each clump within the drainage (in, at the edge, on a bench, or a combination)
- Drainage type (primary, secondary, tertiary)
- Residual dry matter (none, minimal, and dense thatch)
- Special observations such as disturbance or natural history

For life-stage data collection, surveyors defined seedlings as individuals that were less than 4 inches tall and lacked multiple stems, juveniles as lacking multiple stems but being more than 4 inches tall, mature as clumps with 20 or fewer stems, and adult as clumps with more than 20 stems.

2.2 Willowy Monardella Monitoring

Seventeen monitoring plots were established in 2002 and 2003, and those monitoring plots were labeled A through Q. However, due to the lack of willowy monardella clumps in some of the monitoring plots during the 2012 monitoring event, six originally established monitoring plots were eliminated (B, D, E, F, K, and M) and six new monitoring plots were added (R, S, T, U, V, and W).

We conducted habitat and clump-size monitoring at the 17 preestablished long-term monitoring plots labeled A, C, G, H, I, J, L, N, O, P, Q, R, S, T, U, V, and W (Figure 2-1). We identified each clump in the long-term monitoring plots and collected the following data on clumps as described by the methods in the Field Protocol Manual (MCAS Miramar 2013a):

- Individual clump diameter measured at the widest point of each clump
- Individual clump width measured at the widest point perpendicular to the clump's diameter
- Individual clump height measured at the highest average point
- Relative cover within variable-sized concentric, elliptical quadrats over the center point of the clump for willowy monardella, bare ground, nonnative and native grasses, unidentifiable grasses, native herbs, nonnative herbs, shrubs, and trees.

We also collected the following habitat data at each monitoring plot as described by the methods in the Field Protocol Manual (MCAS Miramar 2013a):

- Observations of disturbances (e.g., fire, erosion)
- Dominant plant species and percent plant cover (recorded for all plant species with greater than 10 percent relative cover)
- Estimated average depth of the drainage associated with the monitoring plot
- Mapping of the outer extent of all rocky drainages within each plot

Photograph locations were previously established at each of the monitoring plots. We collected digital photographs at each of the preestablished photograph locations. While collecting new photographs, we referenced the photographs collected in 2012 to ensure the direction and field of view matched the previous photographs to the extent practicable.

We checked the rebar stakes marking the four corners of the each plot and replaced the stakes if needed. We also collected a GPS point at all four corners of each monitoring plot during the monitoring event. We painted all replacement monitoring plot stakes blue and repainted previously installed stakes blue as needed.

FORMAT PAGE

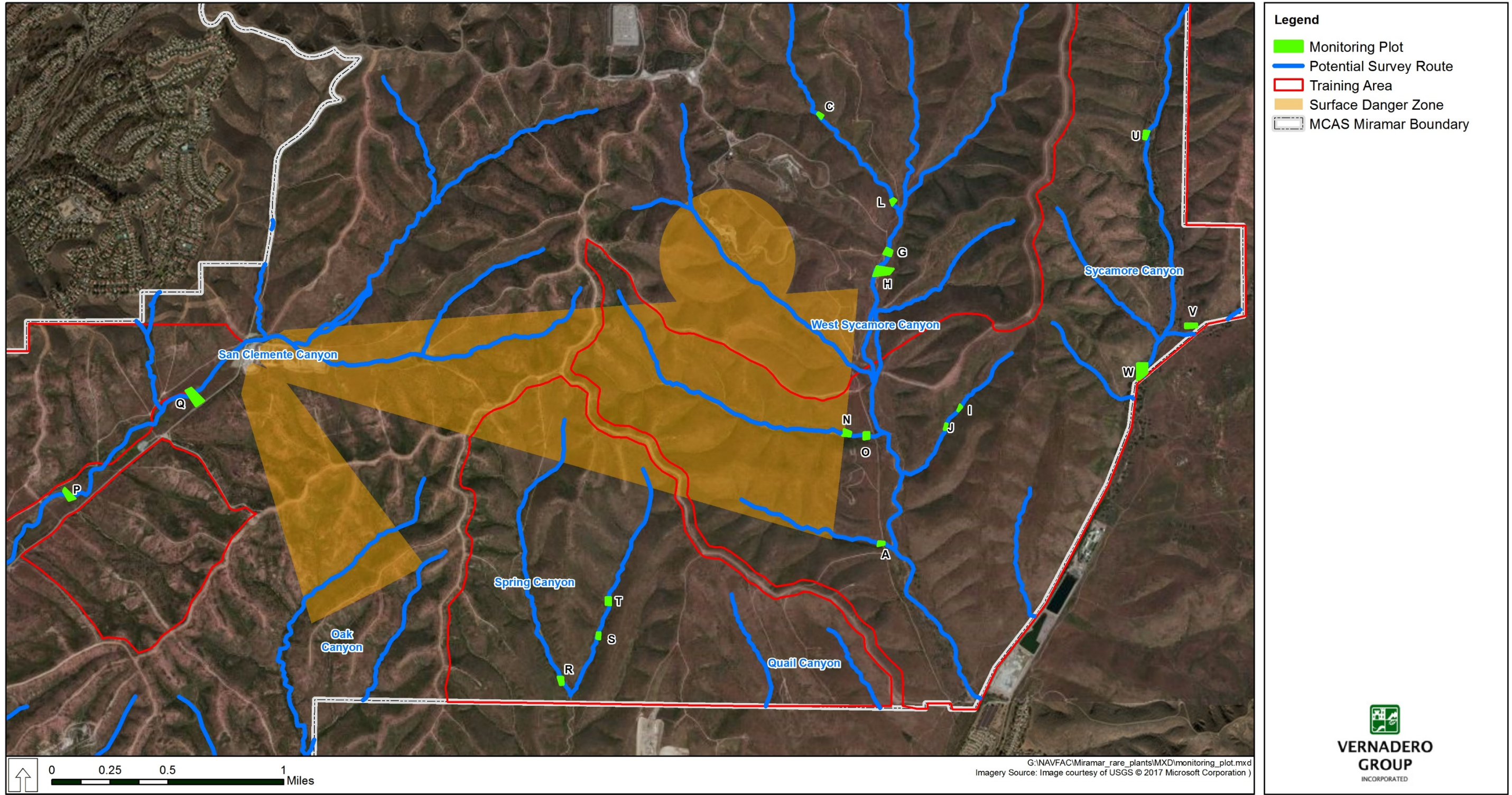


Figure 2-1. Location of Willowy Monardella Monitoring Plots at MCAS Miramar

FORMAT PAGE

2.3 Data Analysis and Reporting

Vernadero analyzed all data collected from the census and monitoring fieldwork according to the methods provided in the Field Protocol Manual (MCAS Miramar 2013a). For the census data, clumps were evaluated according to their distribution, phenology and life stages, changes in life stages between survey events, position of clumps relative to drainage areas, and additional observations (MCAS Miramar 2013a). For the analysis of monitoring plot data, changes in elliptical area, volume, and growth rate were calculated for all clumps. Elliptical area (in units of square cm) was calculated using the following formula from the Field Protocol Manual:

$$\text{Elliptical Area} = \pi * \left(\frac{1}{2} \text{ of the Clump Diameter}\right) * \left(\frac{1}{2} \text{ of the Clump Width}\right)$$

Elliptical volume (in units of cubic centimeters) was then calculated using the following formula from the Field Protocol Manual:

$$\text{Elliptical Volume} = \text{Elliptical Area} * \text{Clump Height}$$

Growth rate was determined by evaluating the change in elliptical area and elliptical volume for willowy monardella clumps in monitoring plots between monitoring events. Clump growth rate was calculated according to the methods provided in the Field Protocol Manual (MCAS Miramar 2013a) using the following formula for each willowy monardella clump that was monitored in both 2012 and 2017:

$$\text{Clump Growth Rate} = \left(\frac{\text{Time 2 Elliptical Area or Elliptical Volume}}{\text{Time 1 Elliptical Area or Elliptical Volume}}\right) - 1$$

The result is a positive or negative rate of growth for each willowy monardella clump.

Habitat features associated with willowy monardella clumps were analyzed in R (a program for statistical computing) using a multiple regression that compared elliptical area and elliptical volume with habitat variables such as plant cover, herbivory, disturbance, and residual dry matter (MCAS Miramar 2013a). The general form for the multiple regression equation as described in the Field Monitoring Protocol is as follows:

$$Y' = A + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k$$

Where:

Y' = predicted value of the dependent variable

A = Y intercept (the value of Y when all the X values are 0)

$X's$ = the various independent variable(s) (of which there are k)

$\beta's$ = the coefficients assigned to each of the independent variables during regression

The habitat characteristics collected as part of the willowy monardella monitoring were included as independent variables in the multiple regression (Table 2-1).

Table 2-1. Multiple Regression Variables

Variable	Independent Variable	Scale	Codes for Regression
X_1	Herbivory	Yes or No	1 = Yes, 0 = No
X_2	Percent cover nonnative grasses	1 to 100 percent to closest 5 percent	As continuous variable
X_3	Percent cover native herbs	1 to 100 percent to closest 5 percent	As continuous variable
X_4	Percent cover nonnative herbs	1 to 100 percent to closest 5 percent	As continuous variable
X_5	Percent cover shrub species	1 to 100 percent to closest 5 percent	As continuous variable
X_6	Percent cover tree canopy	1 to 100 percent to closest 5 percent	As continuous variable
X_7	Percent cover bare ground	1 to 100 percent to closest 5 percent	As continuous variable
X_8	Drainage type	Primary, secondary, or tertiary	1 = primary, 2 = secondary, 3 = tertiary
X_9 and X_{10}	RDM	Level 1 = no RDM Level 2 = minimal RDM Level 3 = dense thatch	As dummy variables by adding two separate dichotomous independent variables: $B_9 = 1$ if RDM level is 1, 0 otherwise; $B_{10} = 1$ if RDM level 2, 0 otherwise. (Only two dummy variables are required because if both B_8 and B_9 are 0, then the RDM level must be 3.)

Source: MCAS Miramar 2013a
RDM – residual dry matter

Photographs taken during the current monitoring and previous monitoring efforts were visually compared for noticeable changes in plant growth form and structure.

2.4 Geographic Information System

All GPS data were collected using EOS Positioning System's Arrow 200® Global Navigation Satellite System Real-Time Kinematic subfoot-accurate units. The Arrow 200® RTK units were connected via Bluetooth® with Android® and iOS® mobile phones or tablets. The locations of census-area boundaries, willowy monardella clumps, plant tag locations, monitoring plot corners, and other observed resources of interest were collected in ArcGIS Collector. For all fieldwork, geographic information system (GIS) data were collected using data dictionaries provided by MCAS Miramar. All data collected were compatible with Spatial Data Standards for

Facilities Infrastructure and Environment version 3.0 and contained complete metadata based on MCAS Miramar's metadata requirements.

2.5 Access and Safety Coordination

All range safety was coordinated through Mr. A. J. Ward, MCAS Miramar Range Control. Mr. Ward was notified when the field team required access to the far eastern part of MCAS Miramar. Additional coordination was required for various access points, and Vernadero interacted with the Padre Dam Municipal Water District and Ms. JoEllen Kassebaum, MCAS Miramar, for those access requirements.

FORMAT PAGE

3.0 RESULTS

3.1 Willowy Monardella Census

A total of 972 willowy monardella clumps was found during the 2017 census (Figures 3-1 through 3-8); 278 clumps that had been observed and tagged during previous surveys were not found again during the 2017 census. Clumps were found in six of the nine canyons surveyed. Oak, Quail, and Rose Canyons were surveyed but no willowy monardella clumps were observed (Table 3-1). Of the canyons where willowy monardella was observed, San Clemente Canyon had the most clumps and Murphy Canyon contained the fewest clumps.

FORMAT PAGE



Figure 3-1. Willowy Monardella Clumps in Elanus Canyon

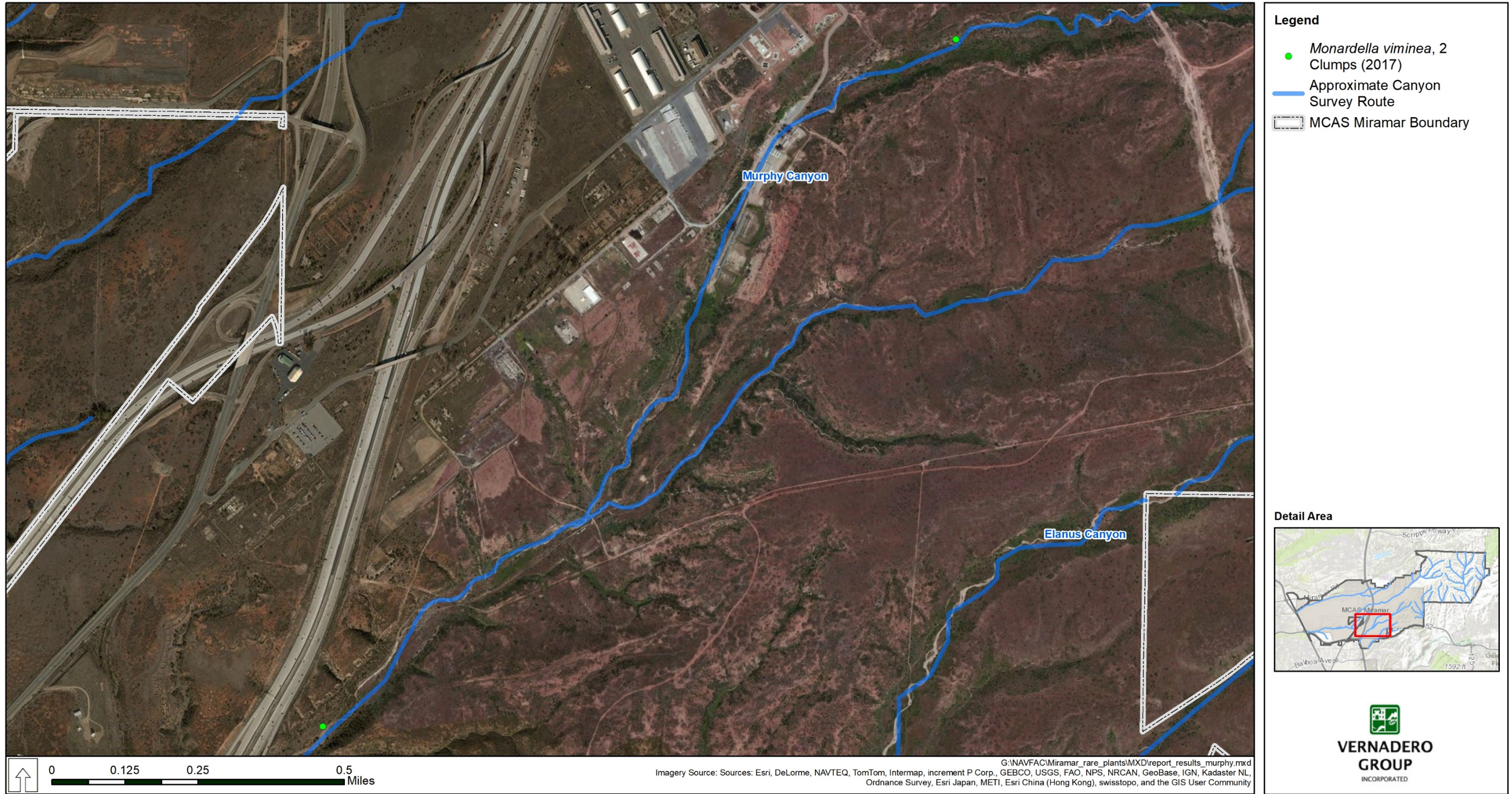


Figure 3-2. Willowy Monardella Clumps in Murphy Canyon

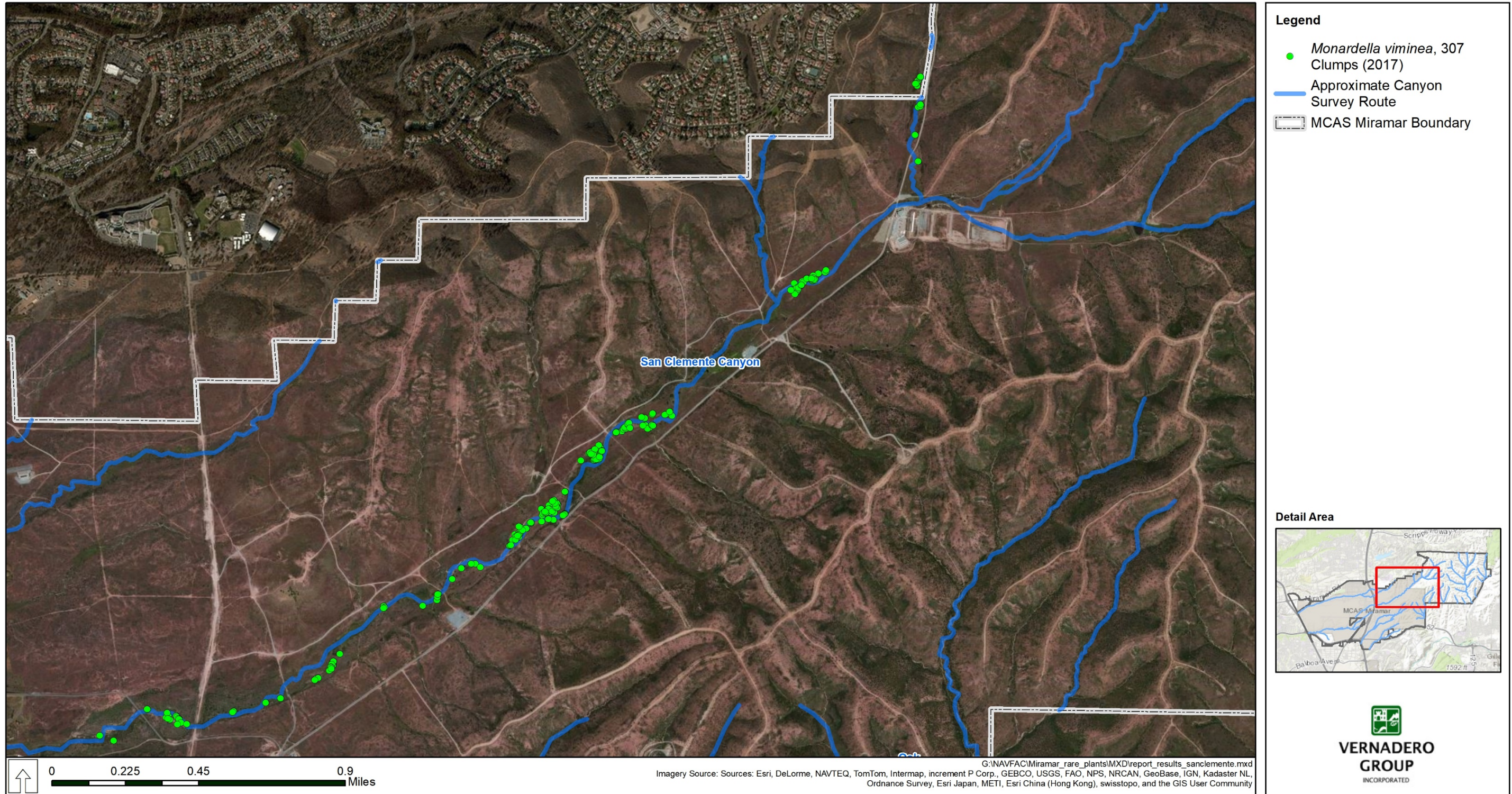


Figure 3-3. Willowy Monardella Clumps in the Eastern Portion of San Clemente Canyon

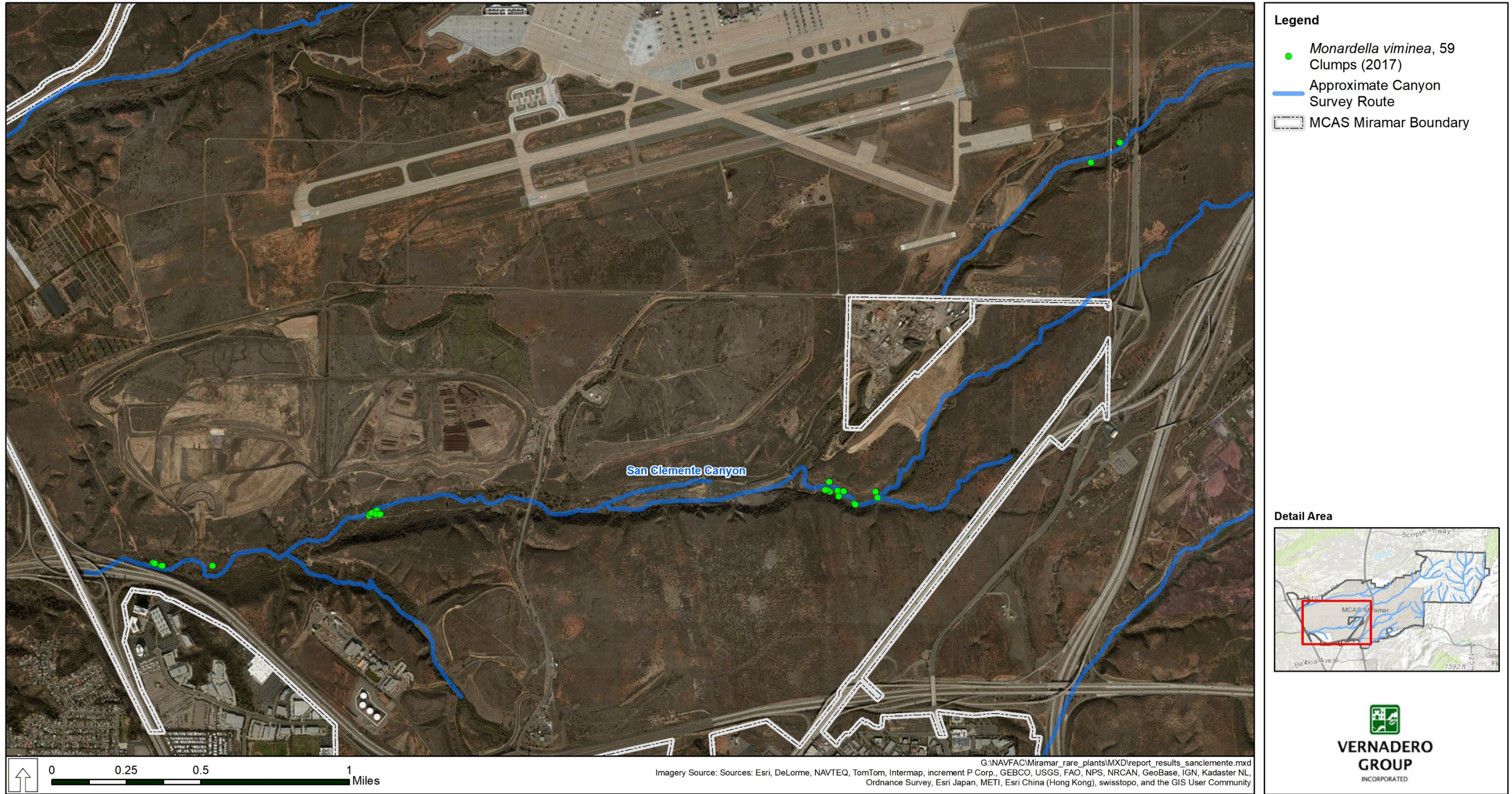


Figure 3-4. Willowy Monardella Clumps in the Western Portion of San Clemente Canyon

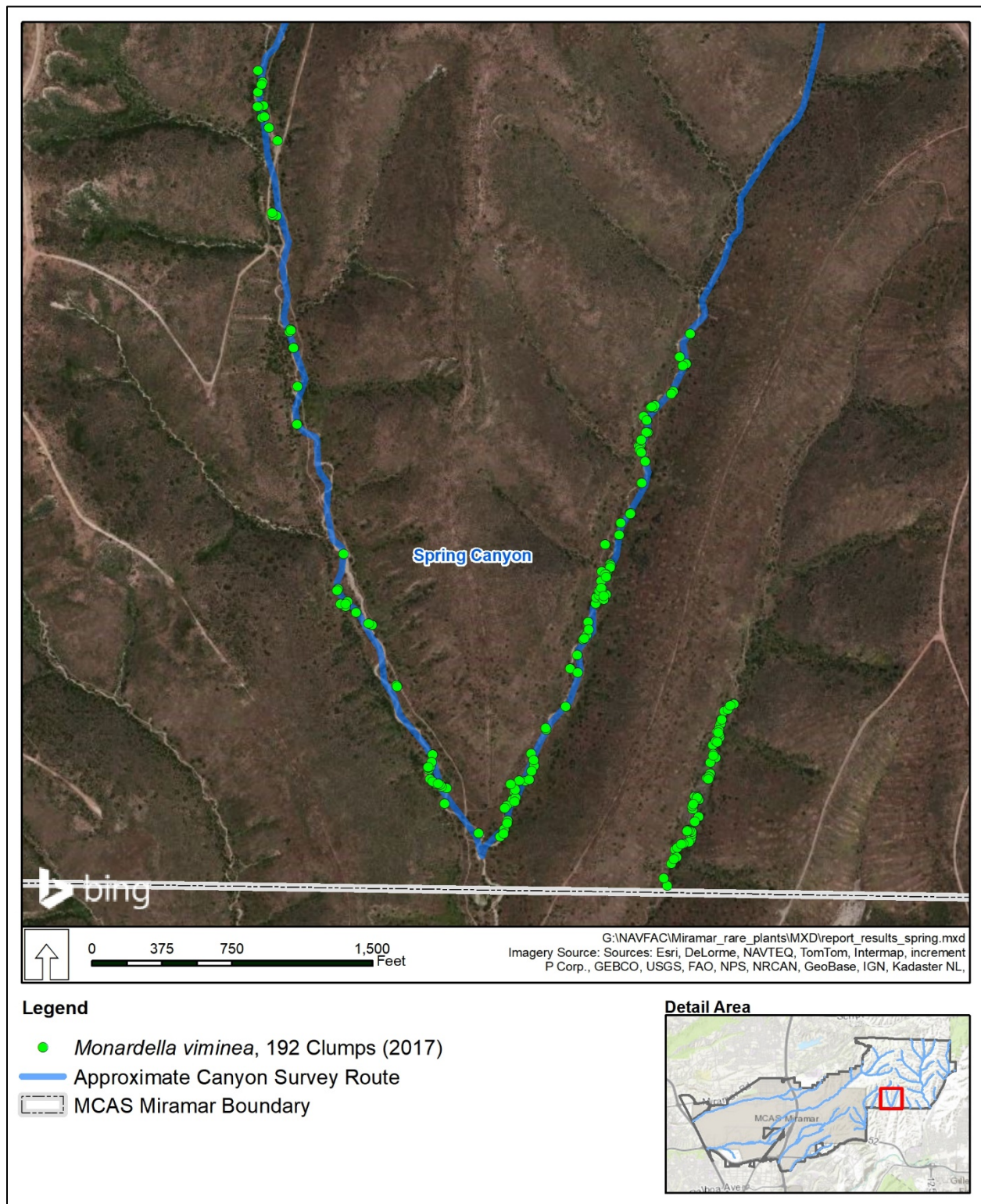


Figure 3-5. Willowy Monardella Clumps in Spring Canyon

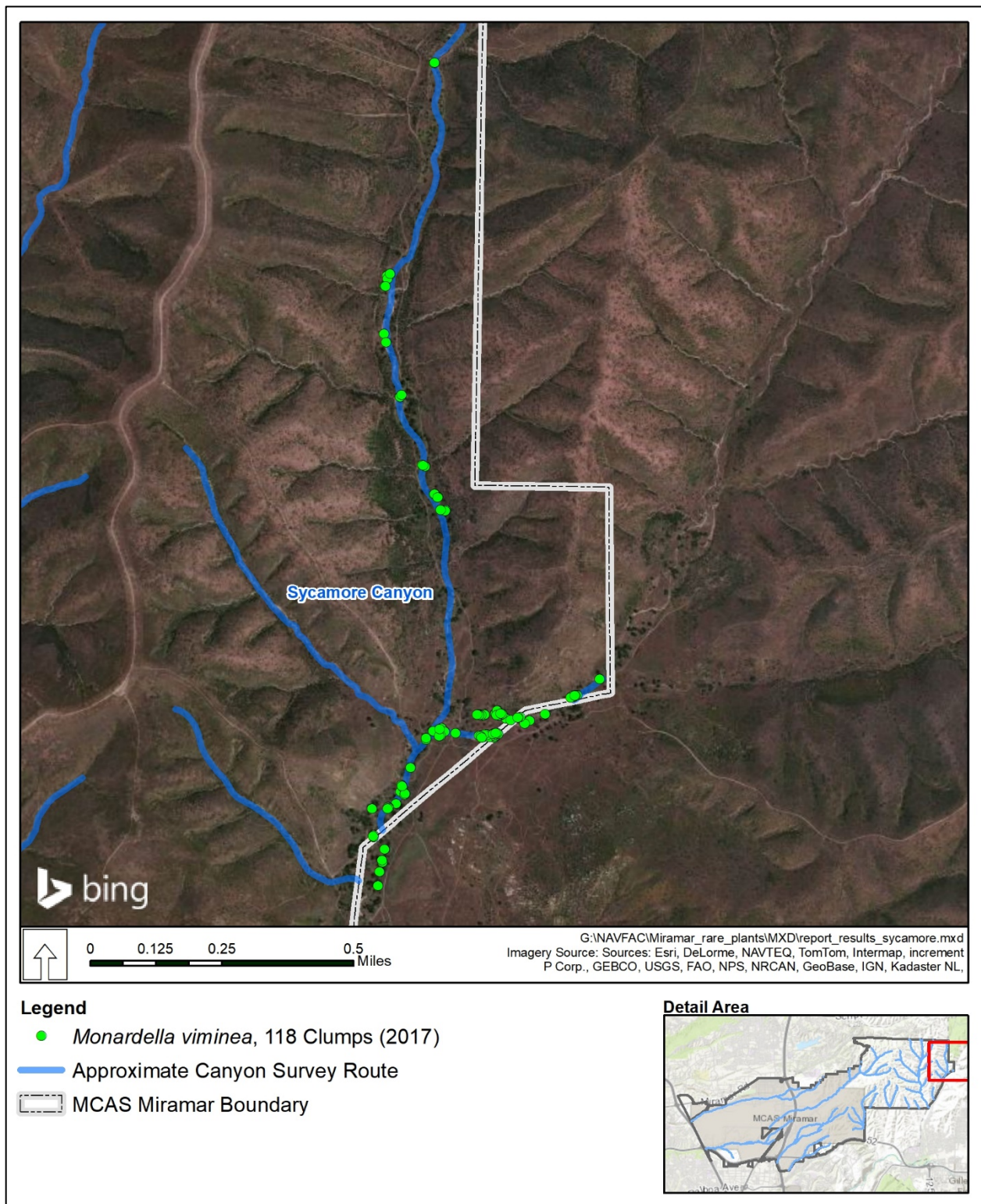
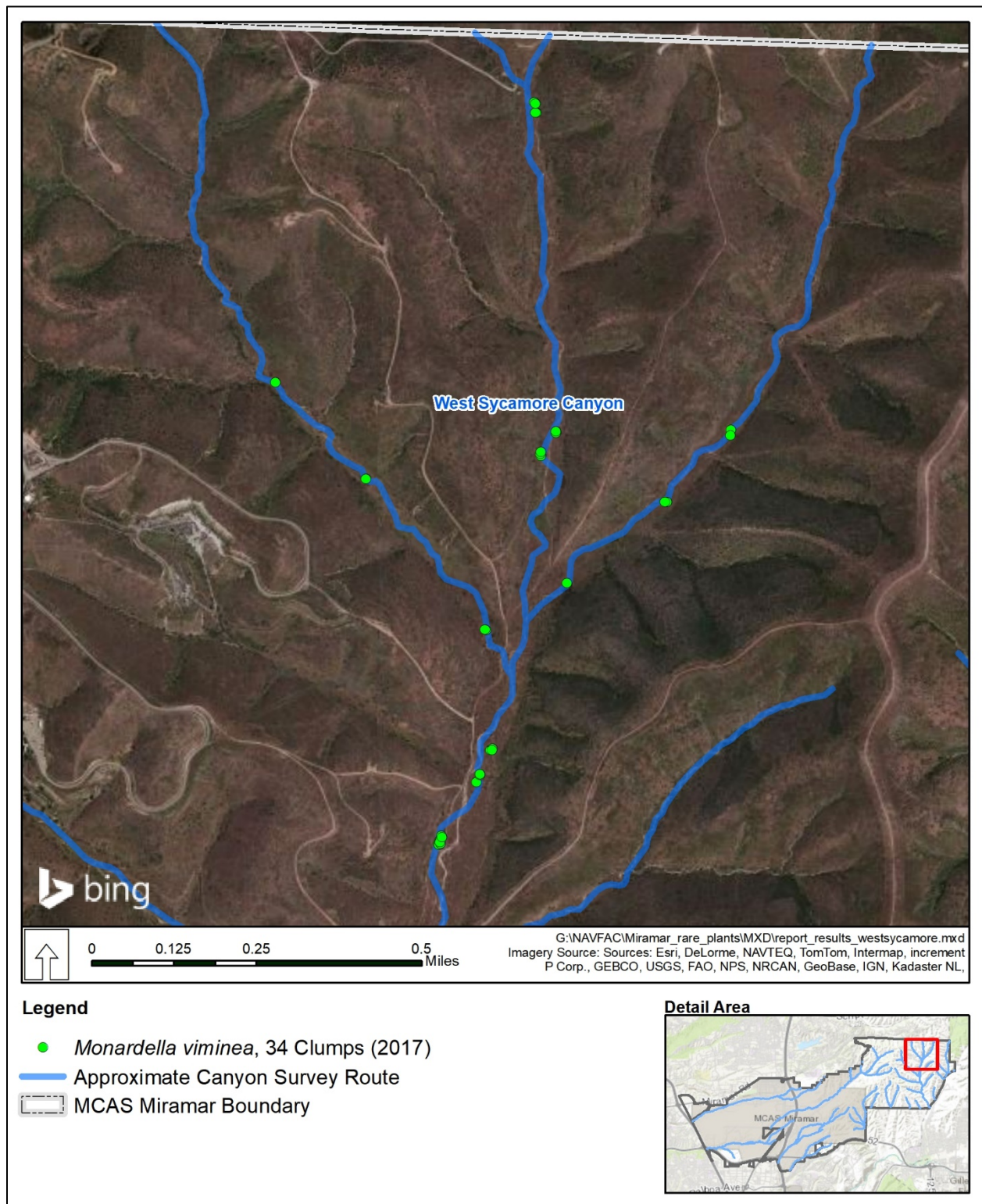


Figure 3-6. Willowy Monardella Clumps in Sycamore Canyon



**Figure 3-7. Willowy Monardella Clumps in the Northern Portion
of West Sycamore Canyon**

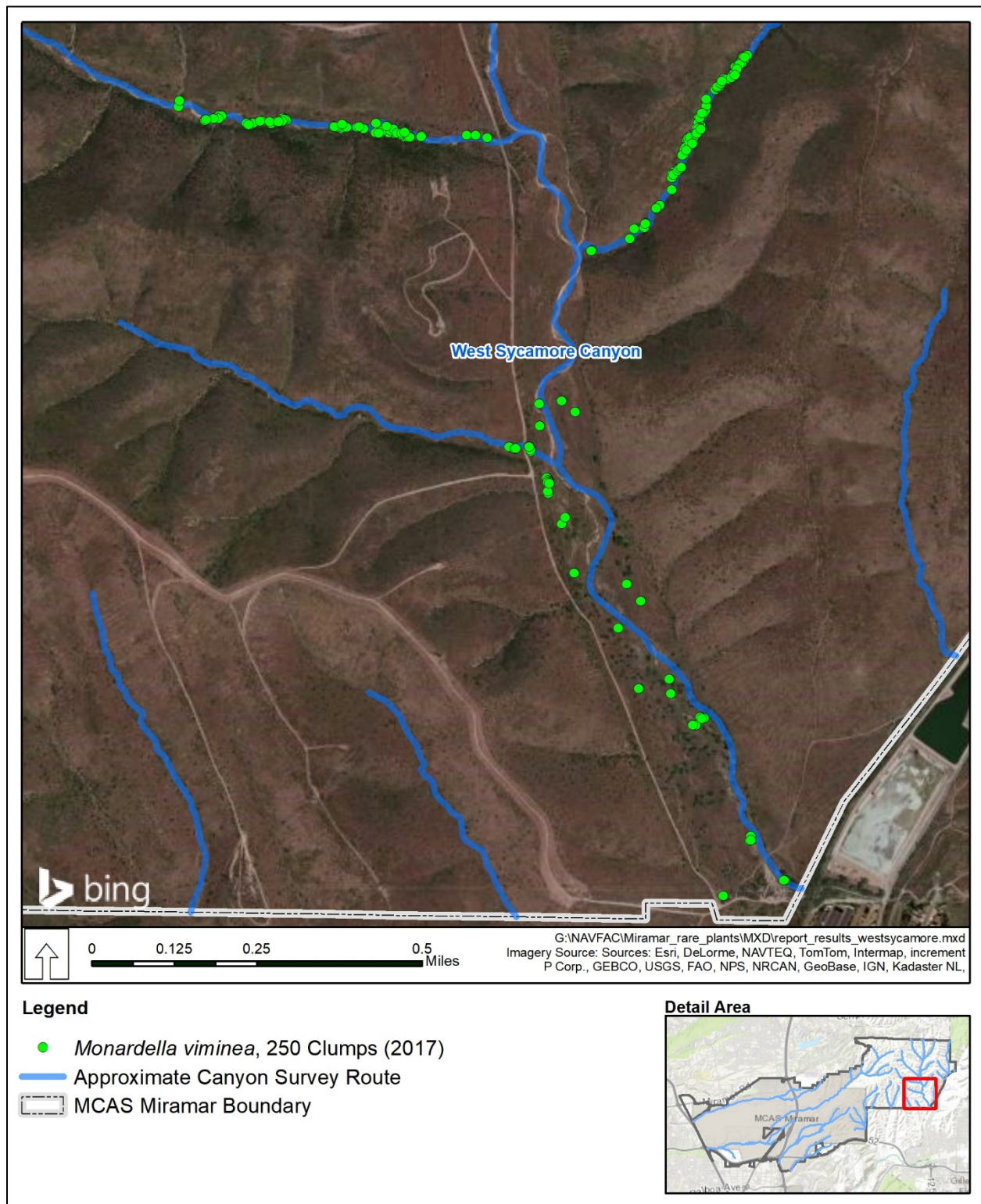


Figure 3-8. Willowy Monardella Clumps in the Southern Portion of West Sycamore Canyon

Table 3-1. Number of Willowy Monardella Clumps by Canyon

Canyon	Number of Willowy Monardella Clumps	Previously Mapped but Not Relocated
Elanus	10	1
Murphy	2	0
San Clemente	366	41
Spring	192	56
Sycamore	118	86
West Sycamore	284	94
Oak	0	0
Quail	0	0
Rose	0	0
Total	972	278

Nearly all of the willowy monardella clumps observed during the 2017 surveys were either adults (903 clumps) or mature plants (45 clumps). Only three clumps categorized as juvenile plants and one clump that was a seedling were observed (Figure 3-9). The remaining 20 willowy monardella clumps observed were either recorded as dead or dormant, or life-stage data were not collected. Over half of all clumps (551 clumps) found during the 2017 census were in the flowering stage (Figure 3-10). Most of the clumps not flowering were either in the seeding (227 clumps) or vegetative phase (120 clumps). A total of 32 clumps was in the budding stage, 4 clumps were in the fruiting stage, and 35 clumps were dead or dormant. Phenology-stage data were not collected for three willowy monardella clumps.

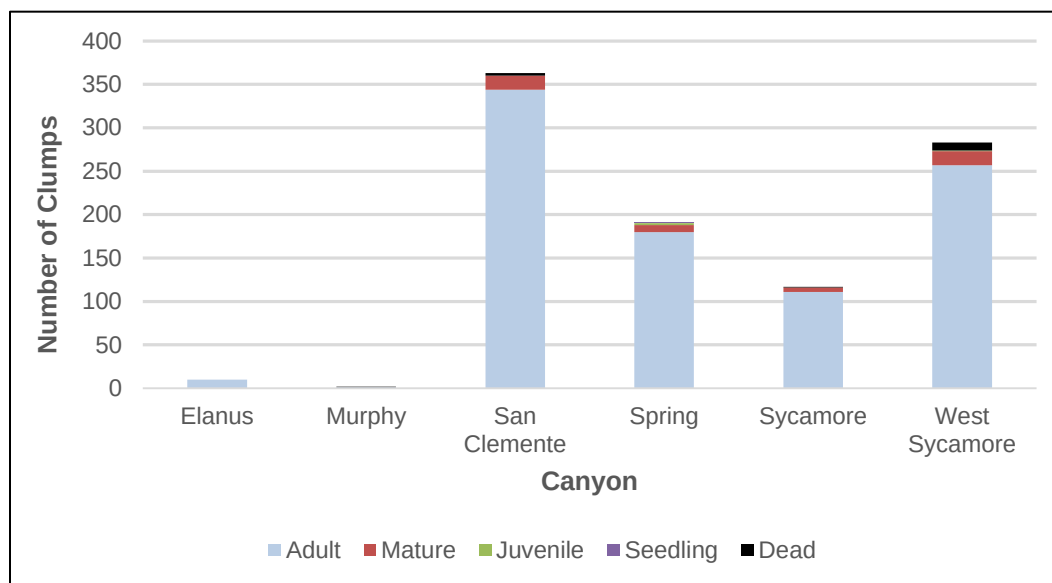


Figure 3-9. Life Stage of Willowy Monardella Clumps by Canyon

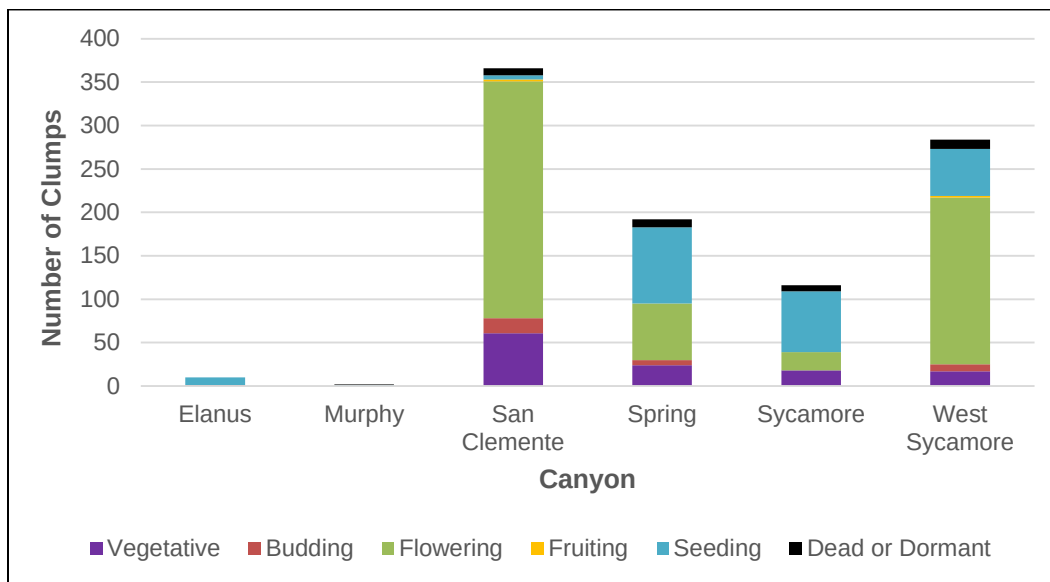


Figure 3-10. Phenology Stage of Willowy Monardella Clumps by Canyon

Although the Field Monitoring Protocol (MCAS Miramar 2013a) methods only require the measurement of clump size for willowy monardella clumps occurring in monitoring plots, we elected to collect these data for all willowy monardella clumps observed during the 2017 census. The mean height of willowy monardella clumps was relatively consistent across all canyons, with an overall average clump height of 48 cm. The tallest clump was 92 cm in height, a total of 11 clumps was taller than 80 cm in height, and 30 clumps were less than 20 cm in height. There was more variation in mean length and width of clumps than mean height between canyons, with the largest mean clump size occurring in Sycamore and West Sycamore canyons (Table 3-2). Two clumps were over 1,000 cm in length (1,050 cm and 1,200 cm), and seven clumps were less than 10 cm in length. Three clumps were more than 400 cm wide and 16 clumps were less than 10 cm wide.

Table 3-2. Mean Height, Length, and Width of Willowy Monardella Clumps by Canyon

Canyon	Mean Height (cm)	Mean Length (cm)	Mean Width (cm)
Elanus (n=10)	45	129	94
Murphy (n=1)	28	123	56
San Clemente (n=362)	45	120	82
Spring (n=186)	46	142	91
Sycamore (n=112)	45	144	100
West Sycamore (n=273)	53	151	98
Overall Mean (n=943)	48	136	90

Canyon	Mean Height (cm)	Mean Length (cm)	Mean Width (cm)
Minimum*	6	4	4
Maximum	92	1,200	490

cm - centimeter

* The minimum for the height, length, and width of willow monardella clumps consists of a single plant, which was the only seedling observed.

We recorded the geomorphological location of willow monardella clumps along drainage channels (Figure 3-11). Most clumps were found in alluvial benches or flats (690 clumps) along drainage channels.

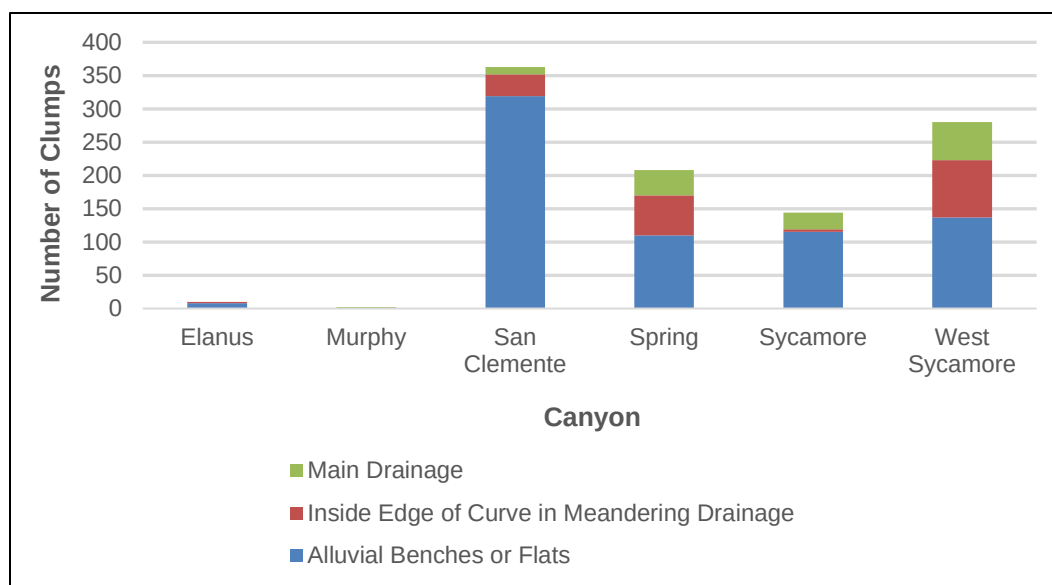


Figure 3-11. Location in Drainage of Willowy Monardella Clumps by Canyon

3.2 Willowy Monardella Plot Monitoring

A total of 141 living willow monardella clumps was recorded in the 17 monitoring plots. All monitoring plots had at least one live clump; Monitoring Plots I, P, Q, S, and V contained more than 10 living clumps. Monitoring Plot I in West Sycamore Canyon contained the most clumps of any of the monitoring plots (Table 3-3). Each of the four canyons where monitoring plots are located had at least one monitoring plot with more than 10 clumps.

Table 3-3. Number of Willowy Monardella Clumps by Monitoring Plot

Monitoring Plot	Number of Willowy Monardella Clumps*	Drainage Location	Survey Date
A	2	West Sycamore Canyon	3 July 2017
C	1	West Sycamore Canyon	12 July 2017
G	3	West Sycamore Canyon	12 July 2017
H	8	West Sycamore Canyon	12 July 2017
I	21	West Sycamore Canyon	4 July 2017
J	9	West Sycamore Canyon	4 July 2017
L	2	West Sycamore Canyon	12 July 2017
N	2	West Sycamore Canyon	2 July 2017
O	1	West Sycamore Canyon	2 July 2017
P	11	San Clemente Canyon	30 June 2017
Q	18	San Clemente Canyon	1 July 2017
R	8	Spring Canyon	5 July 2017
S	13	Spring Canyon	30 July 2017
T	7	Spring Canyon	30 July 2017
U	7	Sycamore Canyon	18 July 2017
V	19	Sycamore Canyon	15 July 2017
W	9	Sycamore Canyon	14 July 2017

* The total includes only living clumps. One dead clump was observed in each of Monitoring Plots H, I, P, Q, S, and V, and two dead clumps were observed in Monitoring Plot U.

The mean and median elliptical areas and volumes were determined for each monitoring plot. Monitoring Plots G, R, and U had the smallest mean and median elliptical areas. Monitoring Plot V had the highest mean and median elliptical areas for plots containing more than two clumps. The overall mean and median elliptical areas were 1.40 and 0.55 square meters, respectively (Table 3-4).

Table 3-4. Mean and Median Elliptical Areas of Willowy Monardella Clumps by Monitoring Plot

Monitoring Plot	Mean Elliptical Area (square meters)	Median Elliptical Area (square meters)	Standard Deviation (square meters)
A (n=2)	2.39	2.39	1.44
C (n=1)	2.41	2.41	0.00
G (n=3)	0.40	0.31	0.15
H (n=8)	1.00	0.37	1.50
I (n=21)	2.61	0.86	6.40
J (n=9)	1.06	0.70	0.86

Monitoring Plot	Mean Elliptical Area (square meters)	Median Elliptical Area (square meters)	Standard Deviation (square meters)
L (n=2)	0.77	0.77	0.29
N (n=2)	1.28	1.28	1.21
O (n=1)	0.62	0.62	0.00
P (n=11)	0.53	0.57	0.26
Q (n=18)	0.90	0.41	1.22
R (n=3)	0.42	0.08	0.61
S (n=13)	0.59	0.40	0.57
T (n=7)	1.65	0.41	2.01
U (n=7)	0.48	0.24	0.57
V (n=19)	2.91	0.98	4.53
W (n=9)	0.94	0.29	1.12
Overall (n=141)	1.40	0.55	3.17

Monitoring Plots G, R, S, and U had the lowest mean elliptical volumes, and Monitoring Plots R, S, U, and W had the lowest median elliptical volumes. Monitoring Plots I and V had the largest mean elliptical volumes, and Monitoring Plots N and V had the largest median elliptical volumes for those monitoring plots with more than two clumps. The overall mean and median elliptical volumes of willowy monardella in monitoring plots were 0.79 and 0.24 cubic meters, respectively (Table 3-5).

Table 3-5. Mean and Median Elliptical Volumes of Willowy Monardella Clumps by Monitoring Plot

Monitoring Plot	Mean Elliptical Volume (cubic meters)	Median Elliptical Volume (cubic meters)	Standard Deviation (cubic meters)
A (n=2)	1.53	1.53	0.93
C (n=1)	1.54	2.41	0.00
G (n=3)	0.19	0.17	0.08
H (n=8)	0.63	0.18	0.97
I (n=21)	1.57	0.40	3.96
J (n=9)	0.63	0.44	0.65
L (n=2)	0.34	0.34	0.15
N (n=2)	0.70	0.70	0.68
O (n=1)	0.21	0.21	0.00
P (n=11)	0.24	0.22	0.12
Q (n=18)	0.53	0.16	0.85
R (n=3)	0.21	0.02	0.32

Monitoring Plot	Mean Elliptical Volume (cubic meters)	Median Elliptical Volume (cubic meters)	Standard Deviation (cubic meters)
S (n=13)	0.21	0.08	0.22
T (n=7)	0.97	0.23	1.25
U (n=7)	0.16	0.09	0.19
V (n=19)	1.68	0.50	2.73
W (n=9)	0.46	0.09	0.63
Overall (n=141)	0.79	0.24	1.95

Some level of disturbance was present at all but four of the monitoring plots. The most common disturbances were bike trails within monitoring plots and scour from flooding (Table 3-6). The average drainage depth at the monitoring plots was 31 centimeters (Table 3-6). Only four soil types were recorded in the 17 monitoring plots, with Redding cobbly loam being the most common type (Table 3-6). The dominant plant species cover consisted mostly of nonnative plant species for all monitoring plots except A, I, S, U, and V (Table 3-6).

Table 3-6. Drainage Depth, Soil Types, and Disturbances in Willowy Monardella Monitoring Plots

Monitoring Plot	Drainage Depth (cm)	Soil Type	Native (Nonnative) Dominant Plant Species Percent Cover	Disturbance Notes
A	19	SvE, RfF	55 (10)	Road located through the plot. Drainage goes through a culvert. Some erosion was present on the edge of the culvert.
C	26	RfF, SvE	20 (60)	None.
G	50	SvE, RfF	20 (65)	Road located in the west edge of plot, away from the willowy monardella clumps.
H	32	SvE, RfF	0 (90)	Road located adjacent to plants. Some banks had collapsed on the wash, but willowy monardella clumps were far from the wash.
I	32	RfF	40 (30)	Minor evidence of flooding in the rocky drainage.
J	22	RfF	10 (70)	Minor browsing of plants. Some piles of broken heads under plants.
L	13	SvE, RfF	10 (70)	None.
N	30	SvE, RfF	10 (70)	Flooding was evident. Many plants had presumably washed away.
O	30	SvE, RfF	12 (60)	None.

Monitoring Plot	Drainage Depth (cm)	Soil Type	Native (Nonnative) Dominant Plant Species Percent Cover	Disturbance Notes
P	39	VbB	30 (50)	Evidence of flooding 1 foot above the mapped drainage.
Q	45	VbB	10 (70)	Some evidence of flooding.
R	35	RfF	30 (40)	Some browsing observed. Many heads were on the ground, which was also seen in <i>Ambrosia psilostachya</i> .
S	25	SvE, RfF	50 (15)	A minimally used bike trail was located in the plot.
T	25	SvE, RfF	30 (50)	A minimally used bike trail passed through the plot.
U	0	SvE, RfF	60 (20)	None.
V	0	SvE	55 (35)	A bike trail crossed through the plot.
W	45	SvE, DaE	40 (45)	Bike trails were located through the plot. Evidence of flooding was present in and adjacent to the main channel.

SvE – stony land; **RfF** – Redding cobbly loam, dissected, 15 to 50 percent slopes; **VbB** – Visalia gravelly sandy loam, 2 to 5 percent slopes; **DaE** – Diablo clay, 15 to 30 percent slopes

The overall average relative cover of plants associated with willowy monardella clumps was 21 percent, and the average bare-ground relative cover was 57 percent. The relative cover of grasses and forbs were 11 percent and 5 percent, respectively; all grasses and nearly all forbs identified in the quadrats at the willowy monardella clumps were nonnative. The averages for tree and shrub cover were 2 percent and 15 percent, respectively.

A multiple regression analysis was completed using the data collected on the habitat features associated with willowy monardella clumps in monitoring plots. The multiple regression analysis used the clump elliptical area (Table 3-7) and clump elliptical volume (Table 3-8) as the dependent variable and the habitat measurements as independent variables.

Table 3-7. Multiple Regression Results for Elliptical Area

Habitat Feature	Estimate	Standard Error	t Value	Probability (> t)
Intercept	6.57557	2.20805	2.978	0.003467 **
Herbivory	-0.20639	0.69108	-0.299	0.765689
Nonnative Grasses	-0.08020	0.02800	-2.864	0.004887 **
Native Herbs	-0.08951	0.09477	-0.945	0.346676
Nonnative Herbs	-0.10050	0.04100	-2.451	0.015569 *
Shrub Cover	-0.01295	0.02044	-0.634	0.527368

Habitat Feature	Estimate	Standard Error	t Value	Probability (> t)
Tree Cover	0.01751	0.04284	0.409	0.683464
Bare Ground	-0.06923	0.01891	-3.662	0.000364 ***
Drainage Type	0.93118	0.65118	1.430	0.155137
RDM	-1.63298	1.40594	-1.161	0.247589
RDM.1	-1.32828	0.99896	-1.330	0.185975

RDM – residual dry matter

Significant codes: *** = <0.001, ** = <0.01, * = <0.05

Table 3-8. Multiple Regression Results for Elliptical Volume

Habitat Feature	Estimate	Standard Error	t Value	Probability (> t)
Intercept	4.019878	1.355694	2.965	0.003605 **
Herbivory	-0.202150	0.424306	-0.476	0.634578
Nonnative Grasses	-0.048795	0.017193	-2.838	0.005274 **
Native Herbs	-0.058310	0.058188	-1.002	0.318174
Nonnative Herbs	-0.064041	0.025173	-2.544	0.012136 *
Shrub Cover	-0.006401	0.012547	-0.510	0.610812
Tree Cover	0.009288	0.026306	0.353	0.724591
Bare Ground	-0.043743	0.011609	-3.768	0.000249 ***
Drainage Type	0.573091	0.399811	1.433	0.154162
RDM	-0.909681	0.863220	-1.054	0.293934
RDM.1	-0.800802	0.613339	-1.306	0.193998

RDM – residual dry matter

Significant codes: *** = <0.001, ** = <0.01, * = <0.05

Definitions

Intercept: the expected mean value of Y when all X = 0; Estimate: the additional effect of adding a variable to the model, if the effects of all other variables in the model are already accounted for; Standard Error: the standard deviation of the sampling distribution of a statistic such as the mean; t value: test statistic representing the difference between the mean of two groups while taking into account any variation; Probability: the likelihood that the t-statistic or a sample mean will be less than or equal to a specified value

The multiple regression analysis is used to predict the unknown value of a variable from the known values of multiple variables. In the case of this analysis, we are asking whether we can predict the value of clump elliptical area or clump elliptical volume based on the value of the habitat features. The t value is the test statistic, and the probability of being greater than the t value (greater than the test statistic) determines the significance of the relationship. If the probability (P) is less than 0.05, we determine that the relationship is not random, and therefore is a significant relationship between the elliptical area or elliptical volume and the habitat feature. If the t value is negative then the relationship is negative (e.g., more nonnative grasses

is significantly related to a smaller elliptical area for clumps), and if the t value is positive, then the relationship between the elliptical area or elliptical volume of the habitat feature is positive (there were no significant positive relationships from the results of this regression).

Bare ground was strongly negatively correlated with both willowy monardella clump elliptical area ($P < 0.001$) and elliptical volume ($P < 0.001$). This indicates that the higher the percentage of bare ground at a willowy monardella clump, the smaller the clump size. There were also significant negative correlations between nonnative grass cover and willowy monardella clump elliptical area ($P < 0.01$) and between elliptical volume ($P < 0.01$), and nonnative herbaceous (i.e., nonwoody plant) cover and willowy monardella clump elliptical area ($P < 0.05$) and elliptical volume ($P < 0.05$). This indicates that willowy monardella plant size is smaller at locations with higher nonnative grass and herbaceous plant cover. The regression analysis did not find any other significant relationships between habitat measurements and willowy monardella clump elliptical area or elliptical volume.

FORMAT PAGE

4.0 OBSERVED TEMPORAL TRENDS

4.1 Census Temporal Observations

Vernadero biologists surveyed all nine canyons with suitable habitat for willowy monardella at MCAS Miramar. Substantially fewer willowy monardella clumps were found during the 2017 census than in the 2012 census. During these surveys, biologists had the locations of willowy monardella clumps from the 2012 census loaded in ArcGIS Collector (with subfoot accuracy). Using subfoot-accurate GPS units, we were able to return to the location of previously surveyed clumps. In many cases, tags were found but clumps had disappeared. Often we noted field indicators that channel erosion or scour might have removed a willowy monardella clump. A total of 278 clumps was not relocated during the 2017 census. The status of 6 of those 278 clumps is unknown. In the case of those six clumps, surveyors were unable to determine if a clump was new or if it was associated with a previously mapped 2012 point. This occurred for a variety of reasons, including inaccurately located 2012 points for willowy monardella clumps, a nearby clump missing a tag, or a clump not being in the 2012 data set. Given that we actively searched for each of these previously identified clumps and were not able to locate them, it indicates that these clumps have disappeared from MCAS Miramar over the past five years.

There were no discernable patterns in (1) the locations where willowy monardella clumps observed in 2012 were relocated during the 2017 census, (2) the distribution of newly observed clumps in the 2017 census, and (3) those clumps that were observed in 2012 but were lost between 2012 and 2017 at MCAS Miramar (Figures 4-1 through 4-8). The only consistent notation from surveyors in regard to clumps that could not be relocated was that severe scour and channel-bank erosion were evident. Further, although there is suitable habitat for willowy monardella in Oak, Quail, and Rose Canyons, willowy monardella was not identified in these three canyons in the 2012 census or the 2017 census.

4.2 Monitoring Temporal Observations

Clump growth rate is useful to determine if willowy monardella clumps are growing or reducing in size through time (Table 4-1). Only 58 willowy monardella clumps within eight monitoring plots were measured in both 2012 and 2017, and the average growth rate was 4.71 for the elliptical area and 10.86 for the elliptical volume. However, a few willowy monardella clumps had a very large growth rate relative to the clumps that reduced in size between 2012 and 2017. These outliers with large growth rates potentially skewed the large average growth rate observed between 2012 and 2017. For example, one outlier, willowy monardella clump 1733 in Monitoring Plot J, skewed the average growth rate for both elliptical area and elliptical volume substantially, as its size increased between 2012 and 2017 from a height of 21 centimeters, a length of 6 centimeters, and a width of 4 centimeters to a height of 50 centimeters, a length of 82 centimeters, and a width of 75 centimeters. Therefore, with these outliers, the average growth rate statistic does not necessarily describe whether the majority of willowy monardella plants is increasing or decreasing in size through time.

The mean growth rates for elliptical volume and elliptical area were in agreement for each monitoring plot, except for Monitoring Plot Q. This indicates that where plants were increasing or decreasing in size, there was a corresponding change in plant height with plant length and width. Although the mean growth rate for elliptical area was negative and the mean growth rate for elliptical volume was positive for Monitoring Plot Q, these growth rates were so close to zero that effectively, on the average, there was no substantial growth of willowy monardella clumps in Monitoring Plot Q.

Median growth rate provides a descriptive statistic indicating whether more or fewer clumps increased or decreased in size between 2012 and 2017. A positive median growth rate indicates more clumps became larger than smaller, and a negative median growth rate indicates that more clumps became smaller than larger. The median growth rates for elliptical area and elliptical volume were -0.18 and -0.20, respectively. This indicates that more willowy monardella clumps reduced in size than increased in size (33 of 58 for elliptical area and 36 of 58 for elliptical volume) between 2012 and 2017.



Figure 4-1. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in Elanus Canyon

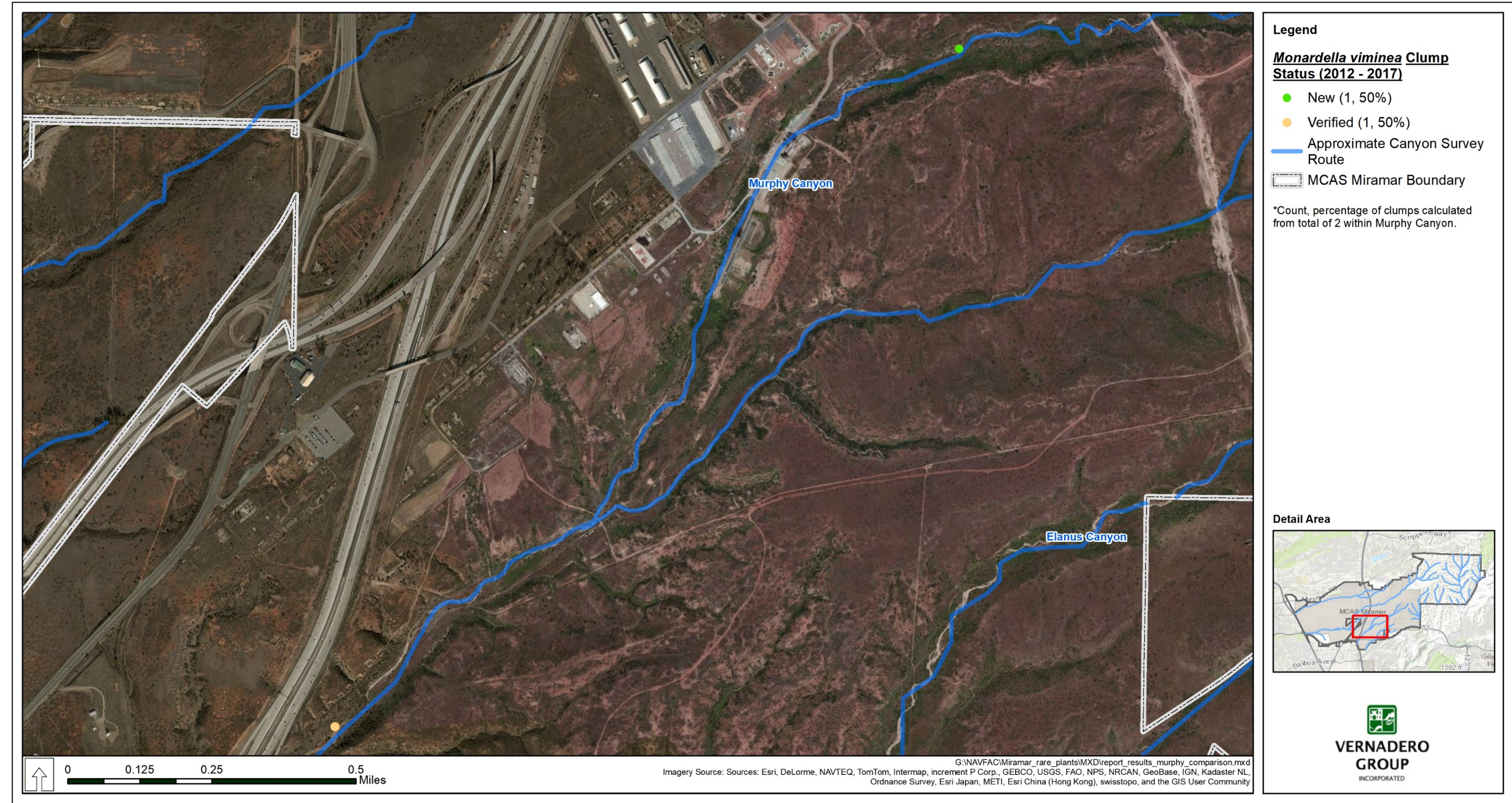


Figure 4-2. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in Murphy Canyon

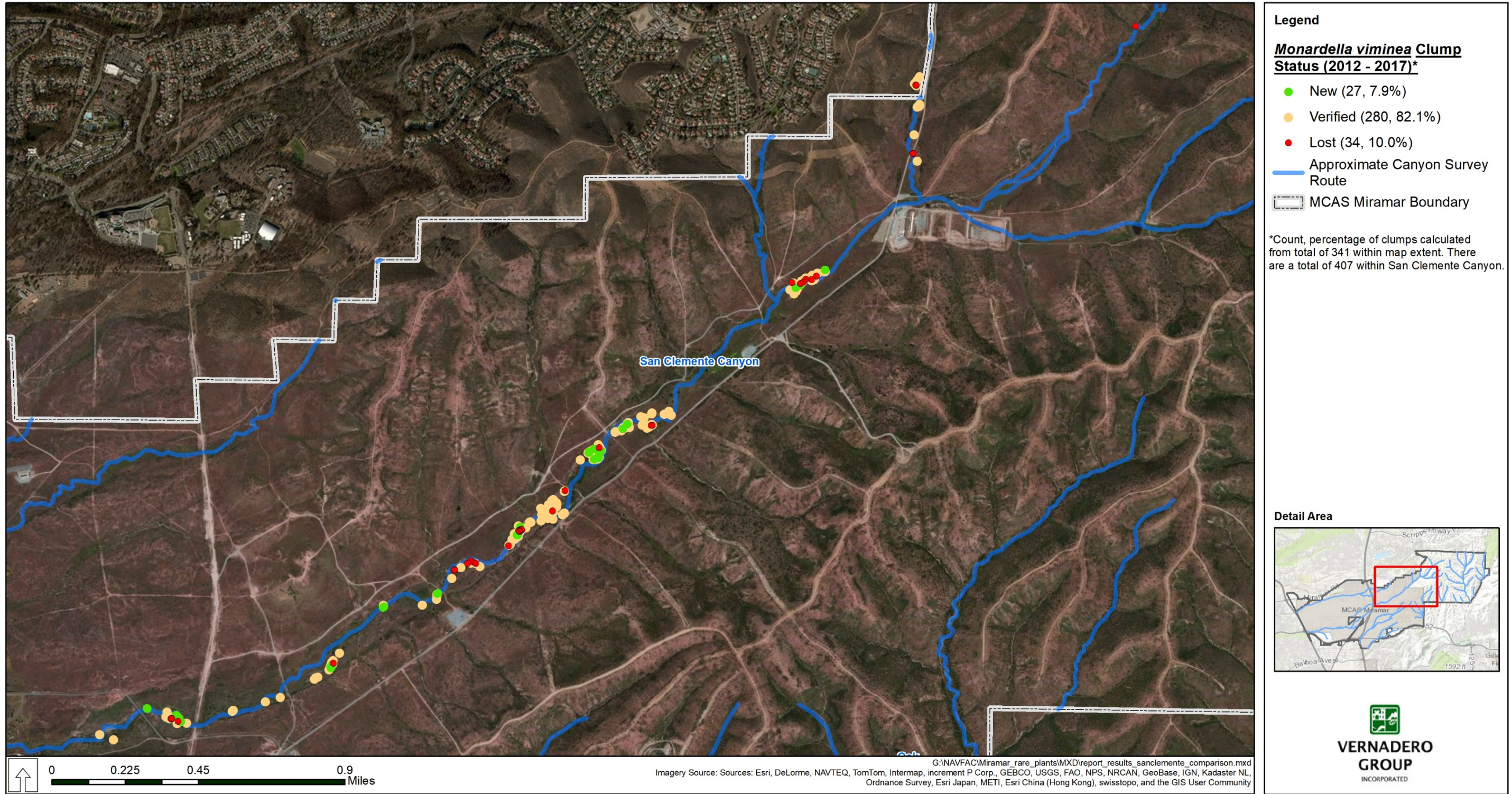


Figure 4-3. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Eastern Portion of San Clemente Canyon



Figure 4-4. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Western Portion of San Clemente Canyon

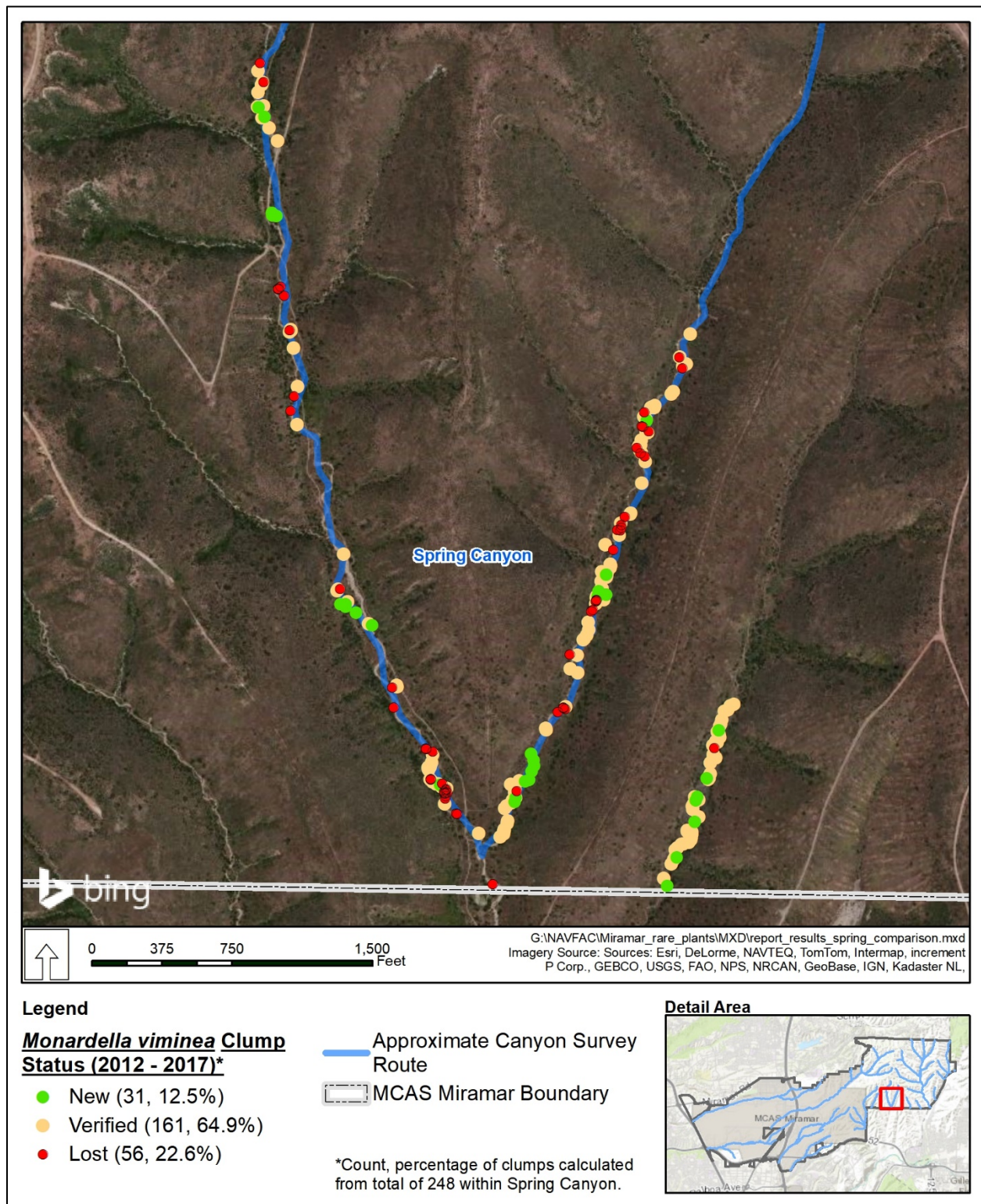
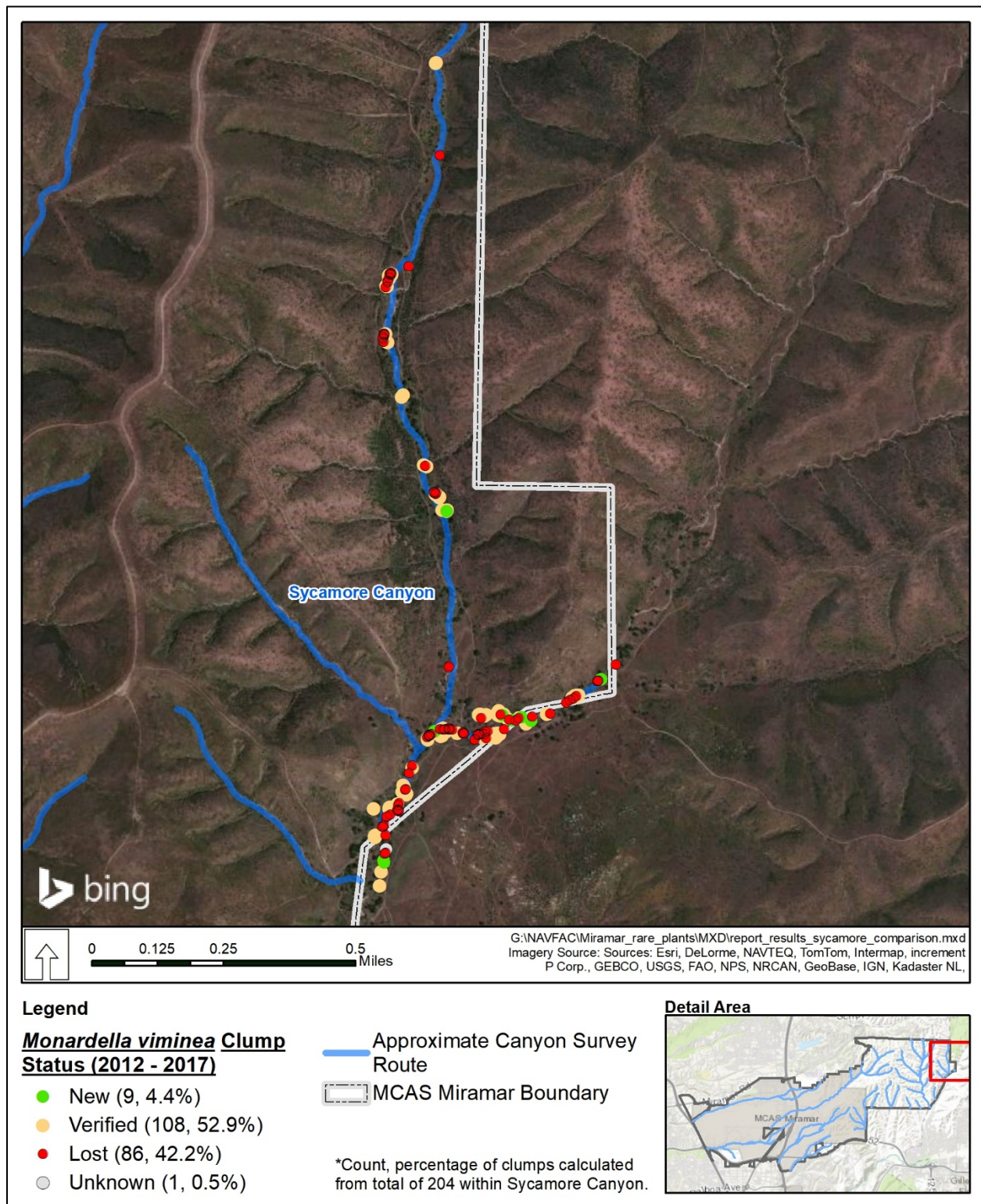


Figure 4-5. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in Spring Canyon



**Figure 4-6. Comparison between 2012 and 2017 Surveys
of Willowy Monardella Clumps Observed in Sycamore Canyon**

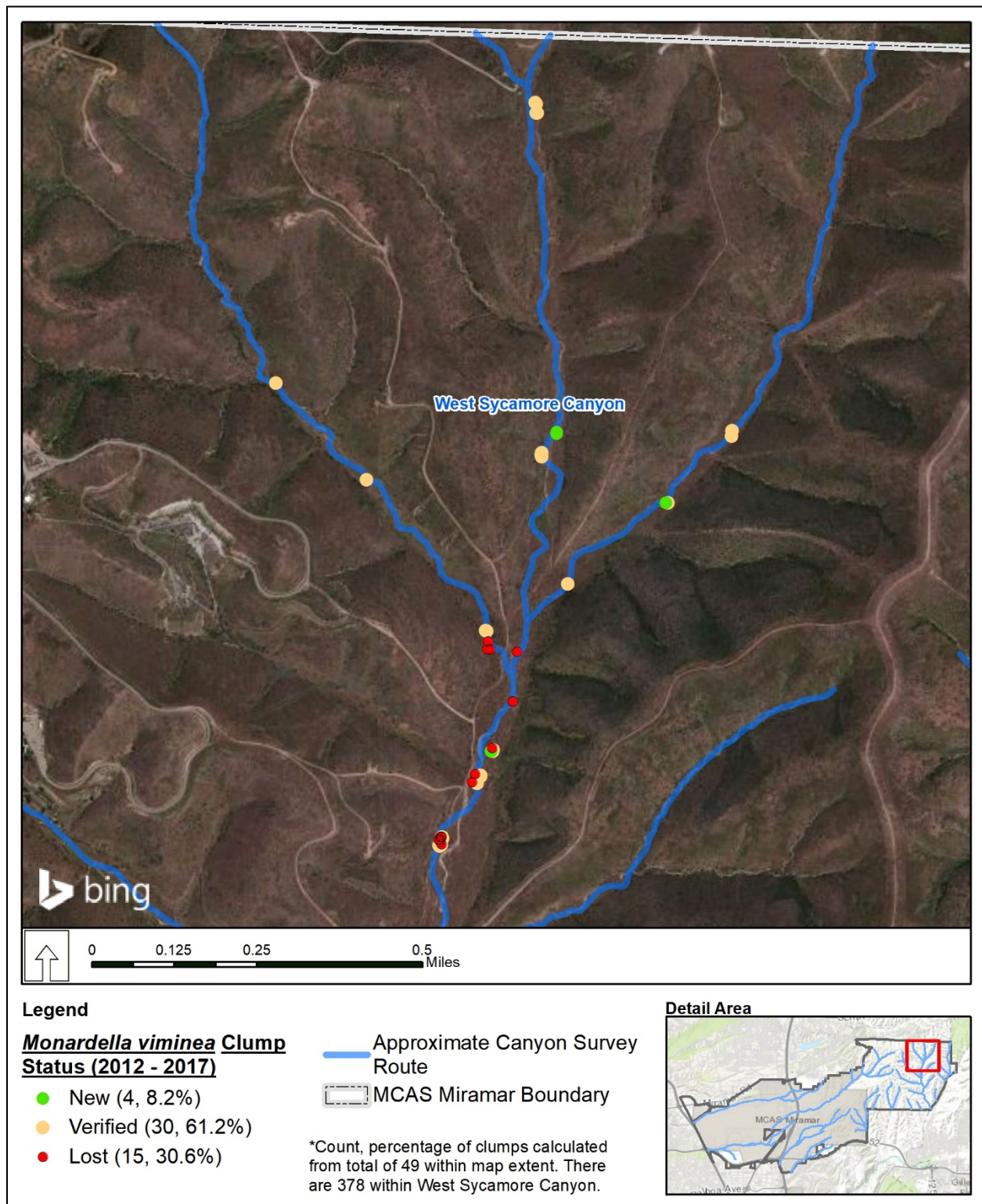


Figure 4-7. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Northern Portion of West Sycamore Canyon

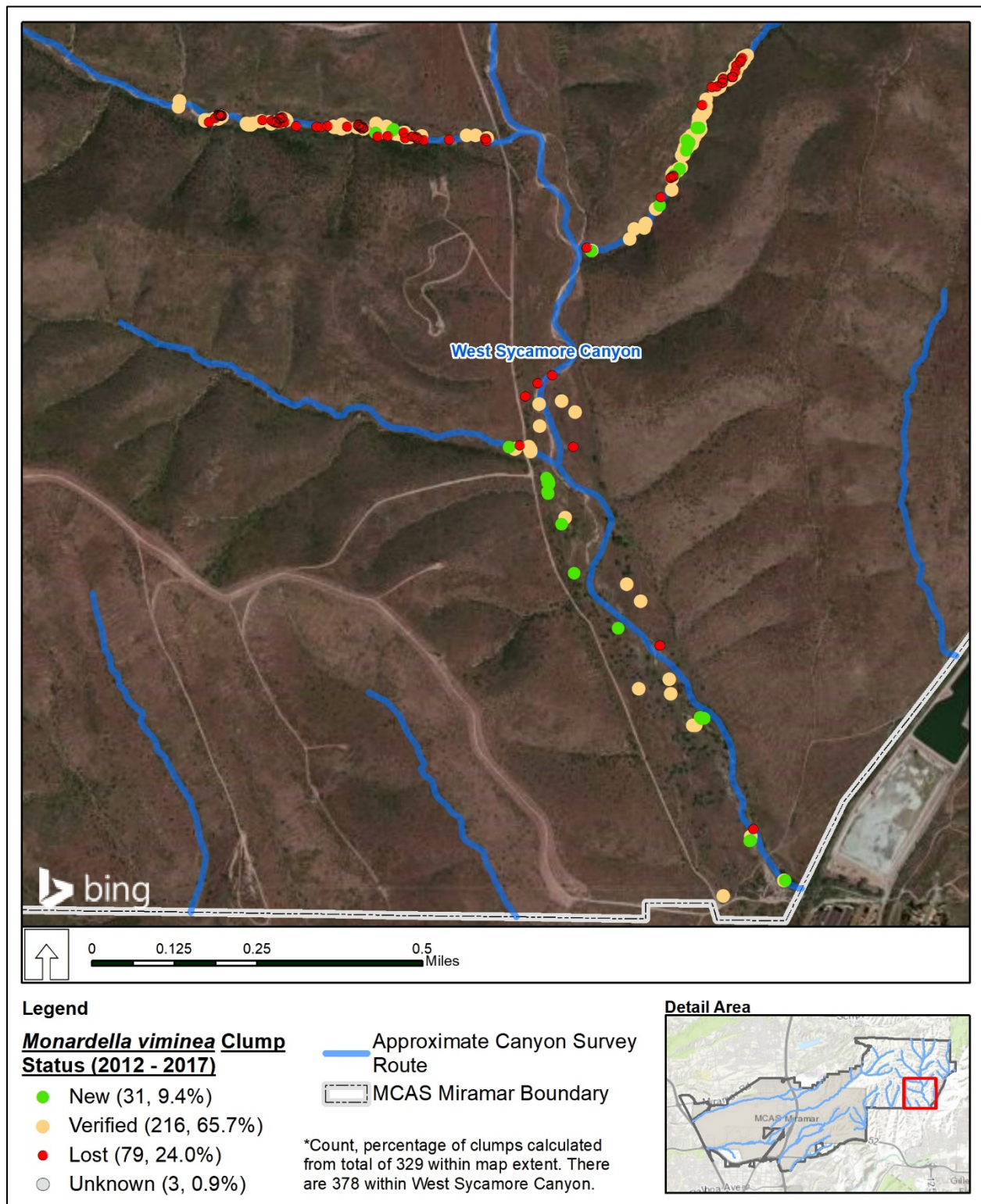


Figure 4-8. Comparison between 2012 and 2017 Surveys of Willowy Monardella Clumps Observed in the Southern Portion of West Sycamore Canyon

Table 4-1. Willowy Monardella Growth Rates 2012 – 2017*

Clump ID	Elliptical Area Growth Rate**	Elliptical Volume Growth Rate**
Monitoring Plot C		
375	0.48	0.32
Monitoring Plot G		
1770	1.44	2.41
Monitoring Plot H		
1521	0.07	-0.12
1524	0.21	0.21
1530	-0.94	-0.97
1761	-0.86	-0.85
1772	-0.17	0.06
1774	1.50	1.04
1778	-0.68	-0.85
1780	-0.26	0.27
Mean Plot H	-0.14	-0.15
Monitoring Plot I		
1230	0.63	2.21
1231	4.49	7.53
1232	-0.60	-0.69
1233	-0.20	-0.02
1236	-0.99	-1.00
1237	1.67	1.54
1246	-0.22	0.34
1250	7.23	7.67
1252	1.10	1.27
1253	-0.58	-0.79
1256	-0.33	-0.27
1257	0.65	0.71
1268	0.03	-0.36
1273	-0.05	-0.22
1286	2.37	1.20
1293	1.07	0.93
Mean Plot I	1.02	1.25
Monitoring Plot J		
1173	-0.33	-0.44
1174	0.36	0.14

Clump ID	Elliptical Area Growth Rate**	Elliptical Volume Growth Rate**
1176	3.25	3.52
1179	1.61	3.21
1182	-0.12	-0.17
1733	255.25	609.12
Mean Plot J	45.34	102.56
Monitoring Plot N		
1299	1.24	1.72
Monitoring Plot P		
905	-0.26	-0.51
919	-0.62	-0.80
920	-0.67	-0.69
921	-0.56	-0.70
924	-0.27	-0.46
925	-0.55	-0.66
927	-0.87	-0.93
931	-0.31	-0.51
932	-0.46	-0.65
934	0.32	0.22
935	-0.23	-0.40
Mean Plot P	-0.41	-0.55
Monitoring Plot Q		
852	-0.90	-0.94
855	1.28	1.28
856	-0.78	-0.81
857	-0.51	-0.67
859	-0.05	-0.43
861	0.79	0.65
865	-0.37	-0.40
866	-0.74	-0.82
867	-0.24	-0.47
872	0.87	0.57
873	1.46	1.25
874	-0.93	-0.95
876	0.19	-0.09

Clump ID	Elliptical Area Growth Rate**	Elliptical Volume Growth Rate**
879	-0.91	-0.95
Mean Plot Q	-0.06	0.60

ID – identification

* Only 58 willowy monardella clumps in eight monitoring plots were monitored in both 2012 and 2017 allowing for a growth rate calculation.

** Growth rates for elliptical area and elliptical volume generate a normalized relationship between clumps; however, these growth rates lack units (i.e., they are not converted to percentages of change). The growth rate formula used is provided in Section 2.3 (page 15) of this report and follows the requirements provided in Section 4.2.2 of the Field Protocol Manual (MCAS Miramar 2013a).

A component of the long-term monitoring of willowy monardella includes the collection of photographs at fixed locations at the monitoring plots (Appendix A). The most discernable pattern observed during the review of the photographs at the monitoring plots was the increase in nonnative grasses and other herbaceous (i.e., nonwoody) plants within the monitoring plots from 2012 to 2017. Data sheets from monitoring plot data collection in 2017 are provided in Appendix B.

FORMAT PAGE

5.0 DISCUSSION

Surveys in 2002 did not identify occurrences of willowy monardella as clumps and used a different method for conducting a Stationwide census; however, the 2002 surveys estimated that there were 3,379 individuals at MCAS Miramar. Willowy monardella is in decline at MCAS Miramar, from 3,379 individuals in 2002, to 1,181 clumps in 2012, and finally 972 clumps in 2017 (MCAS Miramar 2004; MCAS Miramar 2013b). Further, there was no indication of substantial recent plant recruitment as surveyors found only three juvenile plants and one seedling during the 2017 census and monitoring efforts. A total of 104 clumps was labeled as new in 2017, most of which were adult or mature plants, which indicates that some plant recruitment has been occurring since 2012. However, it is not known how many of these clumps are truly new versus clumps that had lost a tag or were not located accurately due to GPS location errors from the 2012 surveys.

No willowy monardella clumps were observed in Oak, Quail, or Rose Canyons in 2017, and no willowy monardella clumps were observed in these three canyons during the 2012 census. Of these three canyons, Rose Canyon is the only canyon where willowy monardella has been observed previously; the plants consisted of only two clumps found during the 2002 surveys (MCAS Miramar 2013b).

The negative correlation between willowy monardella clumps and nonnative plant species (i.e., where nonnative plant cover is high there are fewer willowy monardella clumps) indicates that nonnative plants may be outcompeting willowy monardella for resources. Competition from invasive plant species and nonnative grasses have been indicated in previous studies as a cause for the decline of willowy monardella populations; this was noted in the 2012 study as a possible cause for the loss of willowy monardella in Monitoring Plots D, E, and M; and is further supported by this study (USFWS 2008; MCAS Miramar 2011; MCAS Miramar 2013b).

The negative correlation between willowy monardella clump size and bare ground (i.e., where few to no plants grow, there are fewer willowy monardella clumps) suggests that willowy monardella has associations with some native plant species and does not typically grow well in areas without other plants present. This may be related to channel scouring in that willowy monardella clumps are most successful where scouring is limited and does not remove all native plant species. However, some scouring and erosion are needed to reduce competition between willowy monardella and woody riparian plant species and nonnative grasses as well as to support the growth of willowy monardella, as indicated by previous studies (USFWS 2008; MCAS Miramar 2011). Conversely, too much scouring and erosion in stream channels has been cited as a likely cause for reduced growth and severe damage to willowy monardella clumps (USFWS 2008; MCAS Miramar 2011). The results of this census and monitoring effort, along with results from past studies, indicate that too little as well as too much erosion and scouring in stream channels lead to reduced willowy monardella growth. Willowy monardella clump monitoring showed the median growth rate for willowy monardella clumps between 2012 and 2017 was negative, indicating that more willowy monardella clumps became smaller than grew larger. This could be a result of too little scouring during the drought years of 2013 through 2015 and too much scouring during high precipitation events in 2016 and 2017.

A total of 14.59 inches of precipitation was recorded at the MCAS Miramar weather station from 1 July 2015 through 30 June 2016 and 17.59 inches recorded from 1 July 2016 through 30 June 2017. Precipitation in January 2016 was especially high, with 6.0 inches of precipitation recorded and a single extreme precipitation event of 2.02 inches. This followed three years of below-average rainfall from 2012 through 2015. Surveyors noted 103 willowy monardella clump locations with substantial channel and bank scour. Surveyors described missing willowy monardella clumps where neither tags nor remnant clumps could be found and piles of flooding debris on and around existing willowy monardella clumps. It is likely that these high rainfall rates over the steeply sloping landscape of MCAS Miramar caused increased streamflow velocities within channels in the narrow canyons where many willowy monardella clumps grow, causing channel scour and bank erosion, potentially displacing and burying clumps.

Herbivory was evident, and surveyors noted evidence of herbivory at 97 willowy monardella clumps. Most herbivory occurred on a portion of the plants' stems, but some herbivory caused damage or removal of flower heads. Where herbivory was noted, flowering parts and stems were sometimes found on the ground beneath clumps where stems had been grazed. During surveys, mule deer (*Odocoileus hemionus*) were often seen (as individuals or in groups of two and three) in the canyons during the willowy monardella census. Given that mule deer were frequently seen by surveyors and the types of damage to willowy monardella that were noted, herbivory by mule deer is likely a common cause of dry-season damage. Browsing by rabbits may have also occurred, as rabbit scat was noted near some plants with recent herbivory damage. Insect damage to willowy monardella was only noted at three clumps. Herbivory has been noted as a possible cause of willowy monardella population decline (USFWS 2008). In the 2012 census, it was noted that 181 clumps had signs of herbivory, the clumps were usually top-forged with visible vegetative growth, and forged clumps did not show any signs of reproduction (MCAS Miramar 2013b). Alternatively, MCAS Miramar (2011) noted that very little herbivory occurred early in the year and most herbivory occurred in mid- to late-summer rather than in the spring. Further, it was noted that many plants likely recover from this intense late-season herbivory. However, the 2017 census found damage to flower heads, with numerous stems and leaves browsed and flower heads left on the ground beneath clumps. Therefore, herbivory that damages flower heads has the ability to reduce seed production and consequently lead to a decline in plant recruitment.

Even though surveyors recorded seeing plant pollinators on flowering willowy monardella, there is little evidence that willowy monardella is successfully reproducing at MCAS Miramar. Only three juveniles and one seedling were recorded during the 2017 surveys. Further, there has been a large decline in the number of clumps recorded Stationwide during the census, and more clumps have reduced in size than have increased in size, indicating that many willowy monardella clumps are experiencing growth stress and may therefore not be allocating resources to reproduction.

The definitive cause of the decline in willowy monardella reproduction is unknown. Although no studies on the seed production relative to precipitation rates have been done on willowy monardella, in many plants drought stress can lead to the production of fewer seeds as well as

smaller, less viable seeds (Yaklich 1984; Fougereaux et al. 1997; Kosinski 2007). However, stress to plants from the long-term drought conditions from 2011 through 2015, accompanied by large scouring events in the stream channels in the 2015-2016 and 2016-2017 growing seasons, could very well have reduced the production of viable seeds during the drought and displaced most viable seeds produced when drought conditions were relieved by above-average precipitation. MCAS Miramar (2011) recommended maintaining a small willowy monardella seed collection to protect against stochastic events such as those that occurred from 2011 through 2017. Based on the results of the 2017 census and monitoring, that remains a reasonable approach to protecting the population from devastation due to drought, flood, fire, or their combination.

Overall, the census data collected in 2017 and the comparison of willowy monardella monitoring between 2012 and 2017 indicate that a combination of disturbance and stressors could be the cause of the decline of willowy monardella. Disturbance of willowy monardella from scour and erosion in channels and herbivory are direct physical causes of plant mortality (especially seedlings) and have all been indicated by previous studies and anecdotal evidence as causes of the plant's decline regionally (USFWS 2008; MCAS Miramar 2011). Stress associated with prolonged drought and increased competition from nonnative grasses and herbs could slowly reduce the growth rate of mature and adult willowy monardella and reduce the germination rate from viable seeds.

FORMAT PAGE

6.0 MANAGEMENT RECOMMENDATIONS

In the 2017 surveys, we collected the length, width, and height for all willow monardella clumps, not just those that occurred in monitoring plots as required by the Field Monitoring Protocol (MCAS Miramar 2013a). We recommend that these data continue to be collected for all clumps in the future to better track the growth patterns of the remaining willow monardella. The level of effort to collect these data is not great, but the collection of these data would be highly valuable in the long term, allowing the health of all clumps that can be relocated in future surveys to be tracked through their growth rates.

6.1 Scour and Bank Erosion

There are no management opportunities to provide support to willow monardella during extended periods of drought. However, because scour and bank erosion during high stream-flow events following large storms are burying or displacing willow monardella clumps, management of stream-channel hydrology could protect existing willow monardella clumps and suitable habitat needed for seedling recruitment. MCAS Miramar (2011) recommended implementing erosion control reduction measures in channels (e.g., A-Jacks); there is no indication that these were installed in the channels on the Station following the MCAS Miramar (2011) recommendation. However, the results from the 2017 census and monitoring, which noted substantial channel erosion and loss of willow monardella clumps, support that recommendation.

6.2 Herbivory

Building and installing herbivory exclusion devices around seedlings to prevent browsing was recommended by MCAS Miramar (2011). We also recommend that MCAS Miramar consider opportunities to reduce herbivory of willow monardella clumps. Herbivory late in the growing season may be eliminating seedlings and reducing seed production by damaging flowering heads. Herbivory exclusion devices would need to be installed around seedlings and clumps to reduce or eliminate herbivory by deer and rabbits. We recommend that any use of herbivory exclusion devices begin with an experiment that is paired within canyons and uses a split-plot design to determine if herbivory exclusion devices provide higher vigor and recruitment in willow monardella. In this experiment, wildlife cameras should also be placed near the protected and unprotected plants to provide a better understanding of which animals are causing plant damage and how those animals affect the plants (e.g., insects removing the flower heads).

Further, it is important to understand the magnitude of the effect of herbivory on willow monardella populations. Timing of herbivory may be important, but the method of herbivory may be just as critical. For example, flower heads were observed at the base of the plants in 2017, but it is not clear why this growth pattern is occurring. It is possible an insect removes a section of plant material to make other portions of the plant more palatable. Focused invertebrate studies or invertebrate-plant relationship studies could provide data to better manage the willow monardella populations.

6.3 Nectaring

Learning more about the relationship between invertebrates and nectaring is important to understanding willowy monardella distribution and growth patterns, as a decline in suitable pollinators could negatively impact willowy monardella populations. For example, in 2017 we noted more nectaring activity between approximately 0900 and 1500 hours. Willowy monardella may excrete more nectar at certain times of the day or at certain ambient temperatures. Alternatively, this nectaring activity could be solely related to the timing of invertebrate activity. As mentioned in Section 6.2, focused invertebrate-plant relationship studies could provide data on nectaring activity, allowing for better management of willowy monardella to increase fertilization rates.

We also observed that Argentine ants (*Linepithema humile*) were “farming” aphids (Family Aphididae). This was a rare sighting, as almost all the willowy monardella clumps showed no evidence of this activity. However, studies related to invertebrate-plant relationships would ascertain whether this activity is impacting willowy monardella growth rates.

Lastly, in 2017 we noted an Anna’s hummingbird (*Calypte anna*) attempting to nectar from a nearby willowy monardella plant. Studies describing nectaring animals could also be important to understanding how frequent pollination occurs from vertebrate behavior relative to invertebrate behavior.

6.4 Nonnative Grasses

Controlling the growth of nonnative grasses proximate to willowy monardella clumps was recommended by MCAS Miramar (2011). MCAS Miramar (2011) also determined that clumps that were free from dense growth of nonnative grasses tended to be larger and bushier than plants that were in competition with nonnative grasses. The 2017 monitoring demonstrated that nonnative grasses and herbs negatively impacted the growth rate of willowy monardella. We therefore recommend that weed management be implemented for all willowy monardella clumps at MCAS Miramar.

6.5 Soils and Substrate

The relationship between willowy monardella and soils is also important to understanding recruitment and plant distribution. A negative correlation was noted in 2017 between willowy monardella’s robustness (i.e., elliptical area and volume) and bare ground. It is possible that bare soils adjacent to clumps become too hot to support willowy monardella, as the clumps are more exposed there than in areas with some plant cover. Additionally, water may not be retained as well in completely exposed soils. Therefore, studies of the edaphic characteristics of willowy monardella clumps could help identify the reason some canyons no longer have willowy monardella or why plant recruitment does not occur more readily.

In 2017 surveyors noted that willowy monardella appeared to be present in sandy/loamy soils. However, upon observing cut banks from scour events, we noted there was a layer of cobble within 6 inches of the surface. Cobble seems to be an important factor in the growth of willowy

monardella. Therefore, conducting studies to determine at what distance the plant grows in relation to cobble and how that affects its growth could help with management of the plant species at the Station.

Another anecdotal observation was that there seemed to be fewer willowy monardella plants farther away from the creek bed. Although this typical distribution of willowy monardella is known (USFWS 2008), the suitable habitat for willowy monardella on the Station would be better defined by understanding the range of distance from a creek channel and if that distance is related to the size of the channel and the substrate proximate to the channel.

6.6 Population Viability Analysis

A population viability analysis uses specifically collected data along with models to determine the risk of the extinction of a population over a specific period of time and under certain circumstances. We recommend annual seedling, juvenile, and mature willowy monardella clump counts to identify uneven recruitment events and to inform a population viability analysis. Collecting these same data every five years as currently recommended by the Field Protocol Manual (MCAS Miramar 2013a) does not allow positive outcomes or a catastrophic failure to be predicted for the willowy monardella populations on MCAS Miramar.

FORMAT PAGE

7.0 REFERENCES

- California Native Plant Society. 2017.** Inventory of rare and endangered plants of California. Online edition, v8-03 0.39. <<http://www.rareplants.cnps.org>>. Accessed 8 December 2017.
- Fougereaux, J. A., T. Dore, F. Ladonne, and A. Fleury. 1997.** Water stress during reproductive stages affects seed quality and yield of pea. *Crop Science* 37:1247-1252.
- Jepson eFlora. 2017.** The Jepson herbarium. University of California, Berkeley. <<http://ucjeps.berkeley.edu/eflora>>. Accessed 8 December 2017.
- Kosinski, I. 2007.** Long-term viability in seed size and seedling establishment of *Maianthemum bifolium*. *Plant Ecology* 194:149-156.
- Marine Corps Air Station (MCAS) Miramar. 2004.** Willowy monardella (*Monardella viminea*) surveys. San Diego, California.
- Marine Corps Air Station (MCAS) Miramar. 2011.** Draft monitoring report, willowy monardella (*Monardella viminea*) habitat enhancement 2011 at Marine Corps Air Station Miramar, San Diego, California. July 2011. Prepared by AMEC Earth and Environmental Inc.
- Marine Corps Air Station (MCAS) Miramar. 2013a.** Willowy monardella (*Monardella viminea*) field protocol manual. San Diego, California.
- Marine Corps Air Station (MCAS) Miramar. 2013b.** Willowy monardella (*Monardella viminea*) census and monitoring surveys. San Diego, California.
- National Oceanographic and Atmospheric Administration National Centers for Environmental Information. 2018.** Climate data online: data set directory. <<https://www.ncdc.noaa.gov/cdo-web/datasets#GSOM>>. Accessed 12 March 2018.
- National Weather Service, San Diego Region, California. 2018.** National Weather Service Forecast Office observed weather data for the Santee Airport. <<http://w2.weather.gov/climate/index.php?wfo=sgx>>. Accessed 19 January 2018.
- United States Fish and Wildlife Service. 2008.** *Monardella linoides* subsp. *viminea* (willowy monardella) 5-year review summary and evaluation. Carlsbad Fish and Wildlife Office.
- Western Regional Climate Center. 2017.** RAWs USA climate archive. <<https://raws.dri.edu/index.html>>. Accessed 20 December 2017.
- Yaklick, R. W. 1984.** Moisture stress and soybean seed quality. *Journal of Seed Technology*. 9:60-67.

FORMAT PAGE

Appendix A. Monitoring Plot Photographs

FORMAT PAGE

MONITORING PLOT A



Figure A-1. Photograph Taken on 3 July 2017



Figure A-2. Photograph Taken on 15 July 2015



Figure A-3. Photograph Taken on 3 July 2012 (Tetra Tech 2013)

MONITORING PLOT C



Figure A-4. Photograph Taken on 12 July 2017



Figure A-5. Photograph Taken on 16 July 2015



Figure A-6. Photograph Taken on 10 July 2012 (Tetra Tech 2013)

MONITORING PLOT G



Figure A-7. Photograph Taken on 12 July 2017



Figure A-8. Photograph Taken on 16 July 2015



Figure A-9. Photograph Taken on 5 July 2012 (Tetra Tech 2013)

MONITORING PLOT H

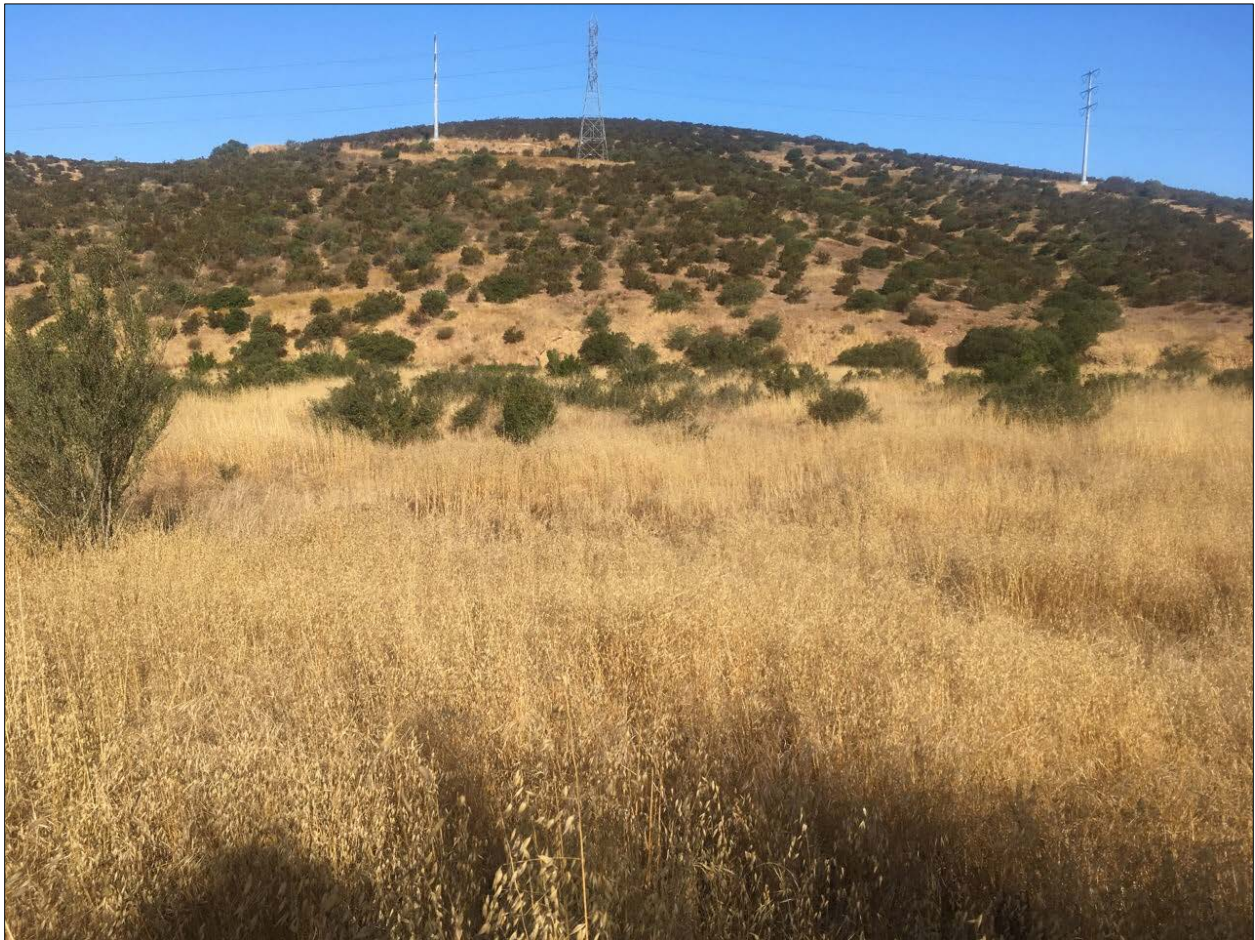


Figure A-10. Photograph Taken on 12 July 2017



Figure A-11. Photograph Taken on 15 July 2015



Figure A-12. Photograph Taken on 5 July 2012 (Tetra Tech 2013)

MONITORING PLOT I



Figure A-13. Photograph Taken on 4 July 2017



Figure A-14. Photograph Taken on 17 July 2015



Figure A-15. Photograph Taken on 5 July 2012 (Tetra Tech 2013)

MONITORING PLOT J



Figure A-16. Photograph Taken on 4 July 2017



Figure A-17. Photograph Taken on 17 July 2015



Figure A-18. Photograph Taken on 3 July 2012 (Tetra Tech 2013)

MONITORING PLOT L



Figure A-19. Photograph Taken on 12 July 2017



Figure A-20. Photograph Taken on 16 July 2015



Figure A-21. Photograph Taken on 5 July 2012 (Tetra Tech 2013)

MONITORING PLOT N



Figure A-22. Photograph Taken on 2 July 2017



Figure A-23. Photograph Taken on 15 July 2015



Figure A-24. Photograph Taken on 6 July 2012 (Tetra Tech 2013)

MONITORING PLOT O



Figure A-25. Photograph Taken on 2 July 2017



Figure A-26. Photograph Taken on 15 July 2015



Figure A-27. Photograph Taken on 3 July 2012 (Tetra Tech 2013)

MONITORING PLOT P



Figure A-28. Photograph Taken on 30 June 2017



Figure A-29. Photograph Taken on 14 July 2015



Figure A-30. Photograph Taken on 15 July 2012 (Tetra Tech 2013)

MONITORING PLOT Q



Figure A-31. Photograph Taken on 1 July 2017



Figure A-32. Photograph Taken on 14 July 2015



Figure A-33. Photograph Taken on 12 July 2012 (Tetra Tech 2013)

MONITORING PLOT R



Figure A-34. Photograph Taken on 5 July 2017



**Figure A-35. Monitoring Plot R – Aspect – SE (120 Degrees)
Photograph Taken on 17 July 2015**

MONITORING PLOT S

No photograph of Monitoring Plot S was taken in 2017.



**Figure A-36. Monitoring Plot S – Aspect – S (200 Degrees)
Photograph Taken on 17 July 2015**

MONITORING PLOT T



Figure A-37. Photograph Taken on 30 July 2017



**Figure A-38. Monitoring Plot T – Aspect – S (160 Degrees)
Photograph Taken on 17 July 2015**

MONITORING PLOT U



Figure A-39. Photograph Taken on 18 July 2017



**Figure A-40. Monitoring Plot U – Aspect – S (175 Degrees)
Photograph Taken on 20 July 2015**

MONITORING PLOT V



Figure A-41. Photograph Taken on 15 July 2017



**Figure A-42. Monitoring Plot V – Aspect – S (170 Degrees)
Photograph Taken on 20 July 2015**

MONITORING PLOT W



Figure A-43. Photograph Taken on 14 July 2017



**Figure A-44. Monitoring Plot W – Aspect – S (170 Degrees)
Photograph Taken on 21 July 2015**

FORMAT PAGE

Appendix B. Monitoring Plot Data Sheets

FORMAT PAGE

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	A
Date	July 2, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	19
Photo Point ID	3028862E
Photo Filename	14.jpg
Photo Aspect	SW

Demographic Data			
Life Stage		Phenology	
Number of Clumps	2	Number of Vegetative Individuals	0
Number of Adults	2	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	2
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations	
	Road through plot. Drainage goes through culvert. Some erosion on edge of culvert.

General Observations	

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	C
Date	July 12, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	26
Photo Point ID	C947C84F
Photo Filename	34.jpg
Photo Aspect	S

Demographic Data			
Life Stage		Phenology	
Number of Clumps	1	Number of Vegetative Individuals	0
Number of Adults	1	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	0
Number of Juvenile Individuals	0	Number of Seeding Individuals	1
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations	

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	G
Date	July 12, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	50
Photo Point ID	0689371B
Photo Filename	33.jpg
Photo Aspect	E

Demographic Data			
Life Stage		Phenology	
Number of Clumps	3	Number of Vegetative Individuals	0
Number of Adults	3	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	0
Number of Juvenile Individuals	0	Number of Seeding Individuals	3
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Road in west edge of plot, away from plants.

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	H
Date	July 12, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	32
Photo Point ID	8D3C7E03
Photo Filename	32.jpg
Photo Aspect	W

Demographic Data			
Life Stage		Phenology	
Number of Clumps	8	Number of Vegetative Individuals	1
Number of Adults	7	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	1
Number of Juvenile Individuals	0	Number of Seeding Individuals	6
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Road adjacent to plants. Some banks collapsed on wash, but plants far from wash.

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	I
Date	July 3, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	32
Photo Point ID	1CBE6F12
Photo Filename	19.jpg
Photo Aspect	NE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	20	Number of Vegetative Individuals	1
Number of Adults	19	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	13
Number of Juvenile Individuals	0	Number of Seeding Individuals	6
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Minor evidence of flooding in rocky drainage

General Observations	
	Bumblebee bees resting on inflorescences in early morning. Possibly spent night there.

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	J
Date	July 3, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	22
Photo Point ID	625DB58B
Photo Filename	16.jpg
Photo Aspect	SW

Demographic Data			
Life Stage		Phenology	
Number of Clumps	9	Number of Vegetative Individuals	0
Number of Adults	9	Number of Budding Individuals	1
Number of Mature Individuals	0	Number of Flowering Individuals	5
Number of Juvenile Individuals	0	Number of Seeding Individuals	3
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Minor browsing of plants. Some piles of broken head under plants. See photo point

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	L
Date	July 12, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	13
Photo Point ID	2008BBC1
Photo Filename	35.jpg
Photo Aspect	NE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	2	Number of Vegetative Individuals	2
Number of Adults	2	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	2
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	

	Disturbance Observations

General Observations	

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	N
Date	July 1, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	30
Photo Point ID	31CCEB92
Photo Filename	11.jpg
Photo Aspect	SW

Demographic Data			
Life Stage		Phenology	
Number of Clumps	2	Number of Vegetative Individuals	0
Number of Adults	2	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	2
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Flooding evident. Many plants presumably washed away

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	O
Date	July 1, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	30
Photo Point ID	EB3CF3C6
Photo Filename	10.jpg
Photo Aspect	SE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	1	Number of Vegetative Individuals	0
Number of Adults	1	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	1
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations	

General Observations
Some plants possibly mapped in previous boundaries are not within current boundaries

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	P
Date	June 30, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	39
Photo Point ID	BCCE44B7
Photo Filename	08.jpg
Photo Aspect	W

Demographic Data			
Life Stage		Phenology	
Number of Clumps	12	Number of Vegetative Individuals	2
Number of Adults	12	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	9
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	1

Disturbance Observations
Evidence of flooding 1ft above mapped drainage

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	Q
Date	June 30, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	45
Photo Point ID	D25907B1
Photo Filename	09.jpg
Photo Aspect	SW

Demographic Data			
Life Stage		Phenology	
Number of Clumps	19	Number of Vegetative Individuals	4
Number of Adults	19	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	12
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	2
		Number of Dead/Dormant	1

Disturbance Observations
Some evidence of flooding

General Observations
Dense grass in much of plot, metal debris in creek,

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	R
Date	July 4, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	35
Photo Point ID	728958B8
Photo Filename	21.jpg
Photo Aspect	SE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	8	Number of Vegetative Individuals	4
Number of Adults	5	Number of Budding Individuals	4
Number of Mature Individuals	1	Number of Flowering Individuals	0
Number of Juvenile Individuals	2	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Some browsing. Many heads on ground. Also seen in <i>Abrosia psilostachya</i>

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	S
Date	July 29, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	25
Photo Point ID	
Photo Filename	
Photo Aspect	

Demographic Data			
Life Stage		Phenology	
Number of Clumps	14	Number of Vegetative Individuals	8
Number of Adults	13	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	0
Number of Juvenile Individuals	0	Number of Seeding Individuals	5
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	2

Disturbance Observations	
	Minimally used bike trail through plot

General Observations	
	Plot follows pattern of other newer plots in not being consistent with earlier plot design

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	T
Date	July 29, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	25
Photo Point ID	9C7BC2C9
Photo Filename	58.jpg
Photo Aspect	S

Demographic Data			
Life Stage		Phenology	
Number of Clumps	7	Number of Vegetative Individuals	0
Number of Adults	7	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	0
Number of Juvenile Individuals	0	Number of Seeding Individuals	7
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Minimal use bike trail through plot

General Observations

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	U
Date	July 17, 2017
Surveyors	KM
Drainage Mapped	No
Depth of Drainage (centimeters)	0
Photo Point ID	8EC5C0BA
Photo Filename	52.jpg
Photo Aspect	S

Demographic Data			
Life Stage		Phenology	
Number of Clumps	9	Number of Vegetative Individuals	7
Number of Adults	9	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	0
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	2

Disturbance Observations	

General Observations
ge outside of plot. Plot layout atypical of early plots. Msny plants small and sickly looking. Many previous plants dead or not

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	V
Date	July 14, 2017
Surveyors	KM
Drainage Mapped	No
Depth of Drainage (centimeters)	0
Photo Point ID	44541F63
Photo Filename	48.jpg
Photo Aspect	SE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	19	Number of Vegetative Individuals	0
Number of Adults	19	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	0
Number of Juvenile Individuals	0	Number of Seeding Individuals	19
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	

Disturbance Observations	
	Bike trail through plot.

General Observations
rainage, only heavily vegetated overflow channel on bench. plot not consistent with early plots as doesn't include full flood

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	W
Date	July 13, 2017
Surveyors	KM
Drainage Mapped	Yes
Depth of Drainage (centimeters)	45
Photo Point ID	E6D467F2
Photo Filename	46.jpg
Photo Aspect	NE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	9	Number of Vegetative Individuals	2
Number of Adults	8	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	2
Number of Juvenile Individuals	0	Number of Seeding Individuals	5
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	0

Disturbance Observations
Bike trails through plot. Evidence of flooding in and adjacent to main channel.

General Observations
Plot setup doesn't match original plots. Southern corner rebar missing. Both were adjacent to bike trails.

[illegible]

[illegible]