

FINAL SURVEY REPORT 2020 WILLOWY MONARDELLA (*MONARDELLA VIMINEA*) CENSUS AND MONITORING, MARINE CORPS AIR STATION MIRAMAR, SAN DIEGO, CALIFORNIA

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EXECUTIVE SUMMARY

Vernadero Group Inc. (Vernadero) was contracted by Naval Facilities Engineering Systems 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 2020 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 25 June 2020 through 29 July 2020.

A total of 824 living willowy monardella clumps was found during the 2020 census; 376 clumps that had been observed and tagged during previous surveys were not found again during the 2020 census. No seedlings and only three juvenile clumps were observed during surveys. Clumps were found in six of the nine canyons surveyed, and 125 living willowy monardella clumps were recorded in the 17 monitoring plots. All monitoring plots had at least one live clump. The overall mean and median willowy monardella clump elliptical areas in monitoring plots were 2.14 and 0.84 square meters, respectively. The overall mean and median willowy monardella elliptical volumes were 1.24 and 0.45 cubic meters, respectively. Regression using habitat variables showed no correlation with elliptical area or elliptical volume.

The results from the 2020 census and plot monitoring indicate a continuing decline in the number of willowy monardella clumps at MCAS Miramar. However, the elliptical area and volume of willowy monardella clumps in monitoring plots increased since 2017. Only one seedling was observed in the 2017 survey and no seedlings were observed in the 2020 survey. The cause of the decline in the number of willowy monardella clumps and reproduction is unknown. However, recruitment could be limited by nonnative invasive plants such as Mediterranean grasses that create thatch that could inhibit seed establishment or germination of seeds.

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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
RDM	Residual Dry Matter
RTK	Real-Time Kinematic
USFWS	United States Fish and Wildlife Service
Vernadero	Vernadero Group Inc.

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1.0 INTRODUCTION

Vernadero Group Inc. (Vernadero) was contracted by Naval Facilities Engineering Systems 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 2020 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 2020. 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 2020 census and monitoring to the willowy monardella census and monitoring data collected in 2012 and 2017.

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 30 known element occurrences of willowy monardella, with 23 presumed extant, 6 possibly extirpated, and 1 presumed extirpated (California Native Plant Society 2020). 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 (U.S. Fish and Wildlife Service [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 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

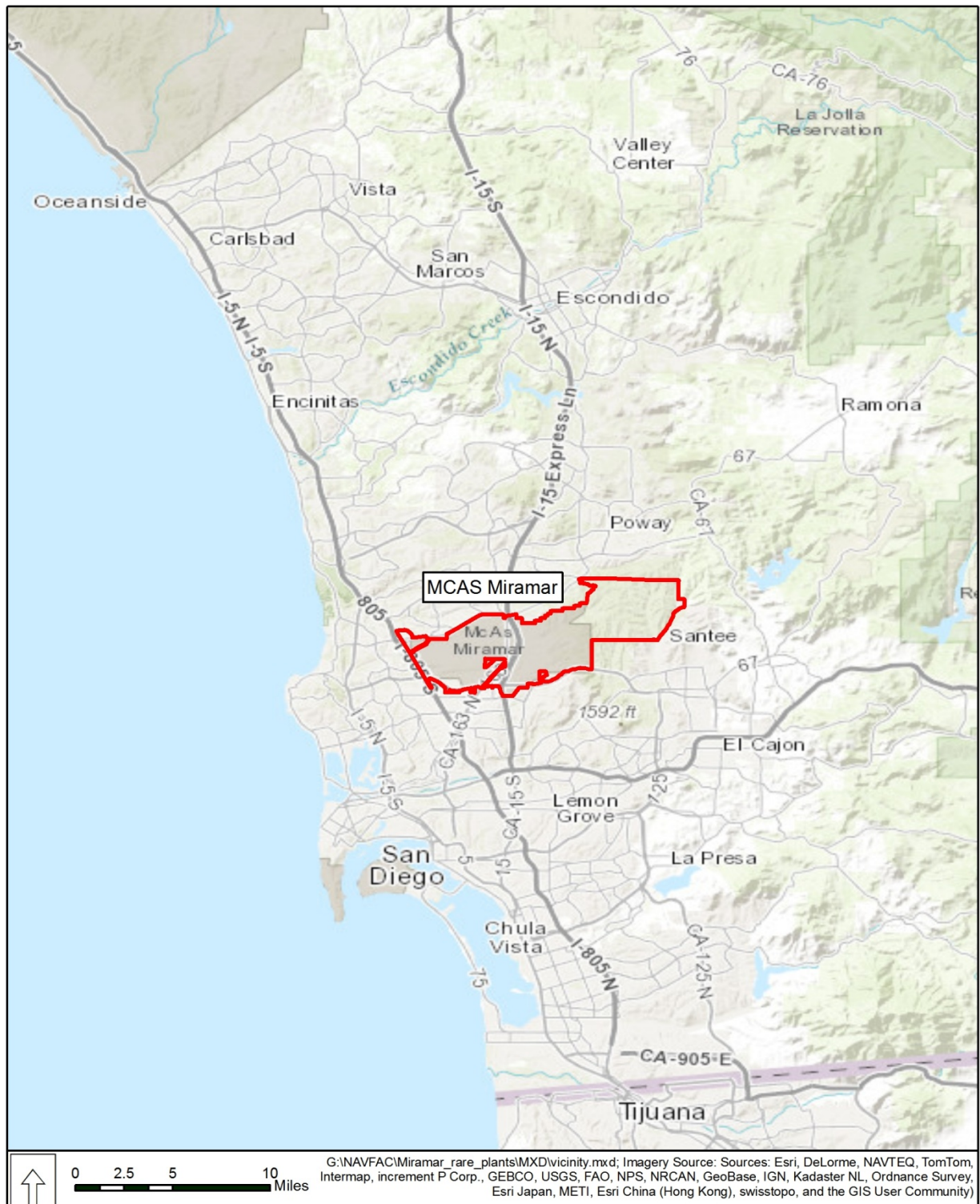


Figure 1-1. Location of Marine Corps Air Station Miramar

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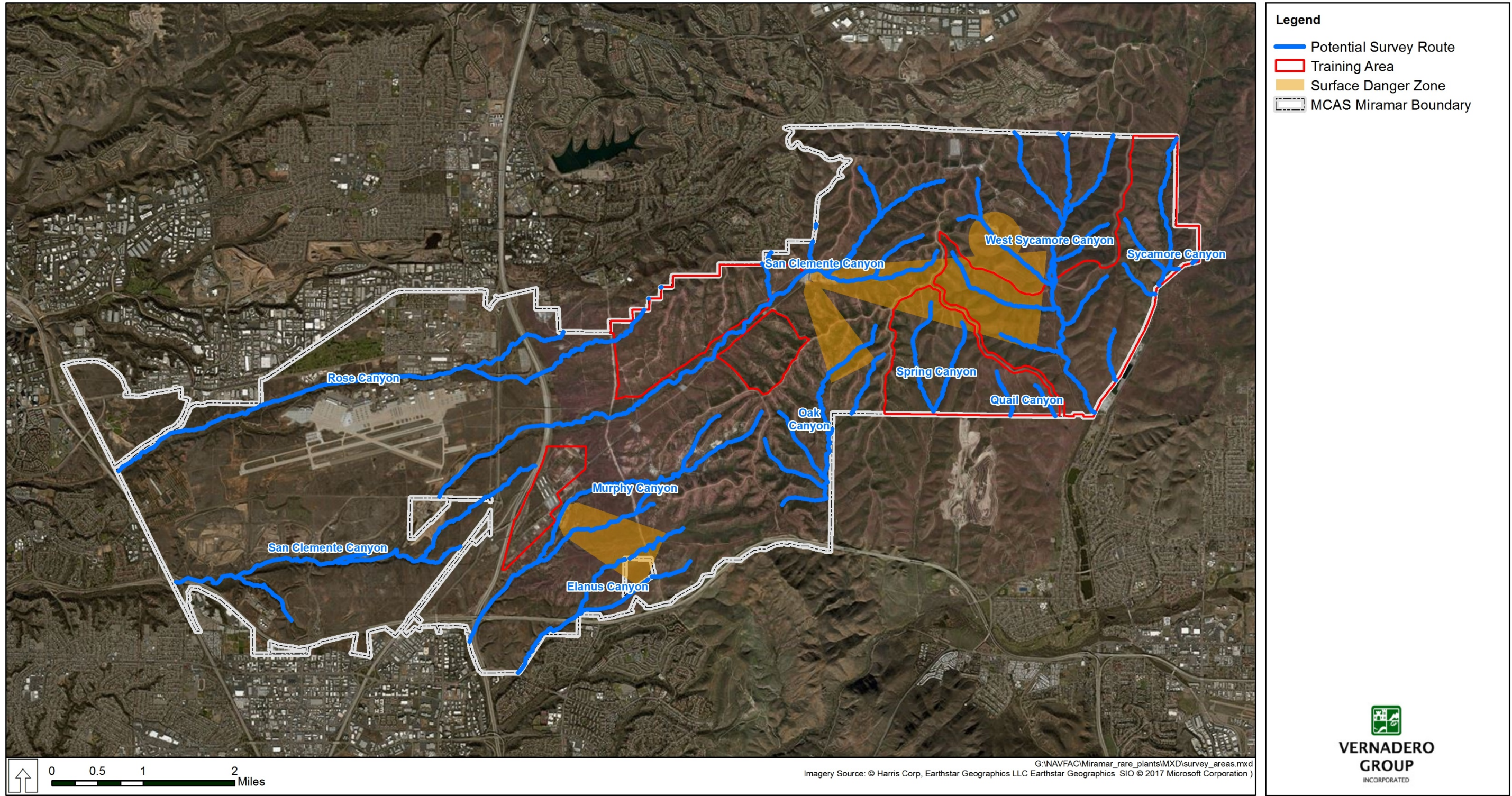


Figure 1-2. Willowy Monardella Census Locations

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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 willowy monardella is growing (USFWS 2008). Precipitation data from growing season 2012 through growing season 2020 were therefore gathered from five weather stations (National Oceanographic and Atmospheric Administration National Centers for Environmental Information 2020; National Weather Service San Diego Region 2020; Western Regional Climate Center 2020) 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, 6.55 inches at the Camp Elliott weather station, 9.23 inches at the San Miguel weather station, 11.52 inches at the Santee weather station at the Santee Airport, and 21.68 inches at the El Cajon weather station. (Note that the records were not complete for this time period at the Camp Elliott weather station and the data from the 2019-2020 growing season is substantially lower than other nearby weather stations. Also, the data from the MCAS Miramar weather station was incomplete for the 2018-2019 and 2019-2020 growing seasons and precipitation is substantially underreported, 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. The 2018 through 2020 growing seasons also had above-average rainfall.

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)	El Cajon (inches)
2011 – 2012	9.87	8.75	9.20	9.94	23.24
2012 – 2013	6.82	7.64	7.34	8.33	17.73
2013 – 2014	4.63	3.46	4.75	5.48	11.37
2014 – 2015	8.30	6.58	5.19	8.26	13.45
2015 – 2016	14.59	12.17	11.20	11.11	19.18
2016 – 2017	17.59	N/A	16.71	20.9	29.04
2017 – 2018	1.76	N/A	3.68	4.78	15.79
2018 – 2019	0.06 ^a	N/A	9.24	17.39	26.99
2019 – 2020	2.94 ^a	0.53 ^a	15.75	17.51	38.30
Mean	7.40	6.52	9.23	11.52	21.68

Sources: National Oceanographic and Atmospheric Administration National Centers for Environmental Information 2020; National Weather Service San Diego Region 2020; Western Regional Climate Center 2020

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

^a Incomplete annual precipitation data for these growing seasons.

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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 25 June 2020 through 29 July 2020. Surveyors included Dr. Ed Kentner, Ms. Sandy Leatherman, Mr. Patrick McConnell, Ms. Emily Jones, Ms. Bianca Bonilla, Mr. Justin Lepore, Mr. Dylan Karlowicz, Ms. Nicole Kimball, Ms. Brianna Brambila, Mr. Andrew Borchert, and Dr. Eric Webb. Surveyors were 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. They were all provided a copy of the task order's Work Plan, Accident Prevention Plan, and the Field Protocol Manual (MCAS Miramar 2013a) to ensure consistency in data collection.

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. We 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 we verified that the tags still existed and found them if necessary. Where plant tags were missing and a clump was observed, we installed a number tag and associated this tag number with the previous tag record. We placed a new plant tag on all newly identified plants, and the plant tag number was recorded. We 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. We mapped all plant tag locations with a global positioning system (GPS) unit 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 and 2017 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 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.

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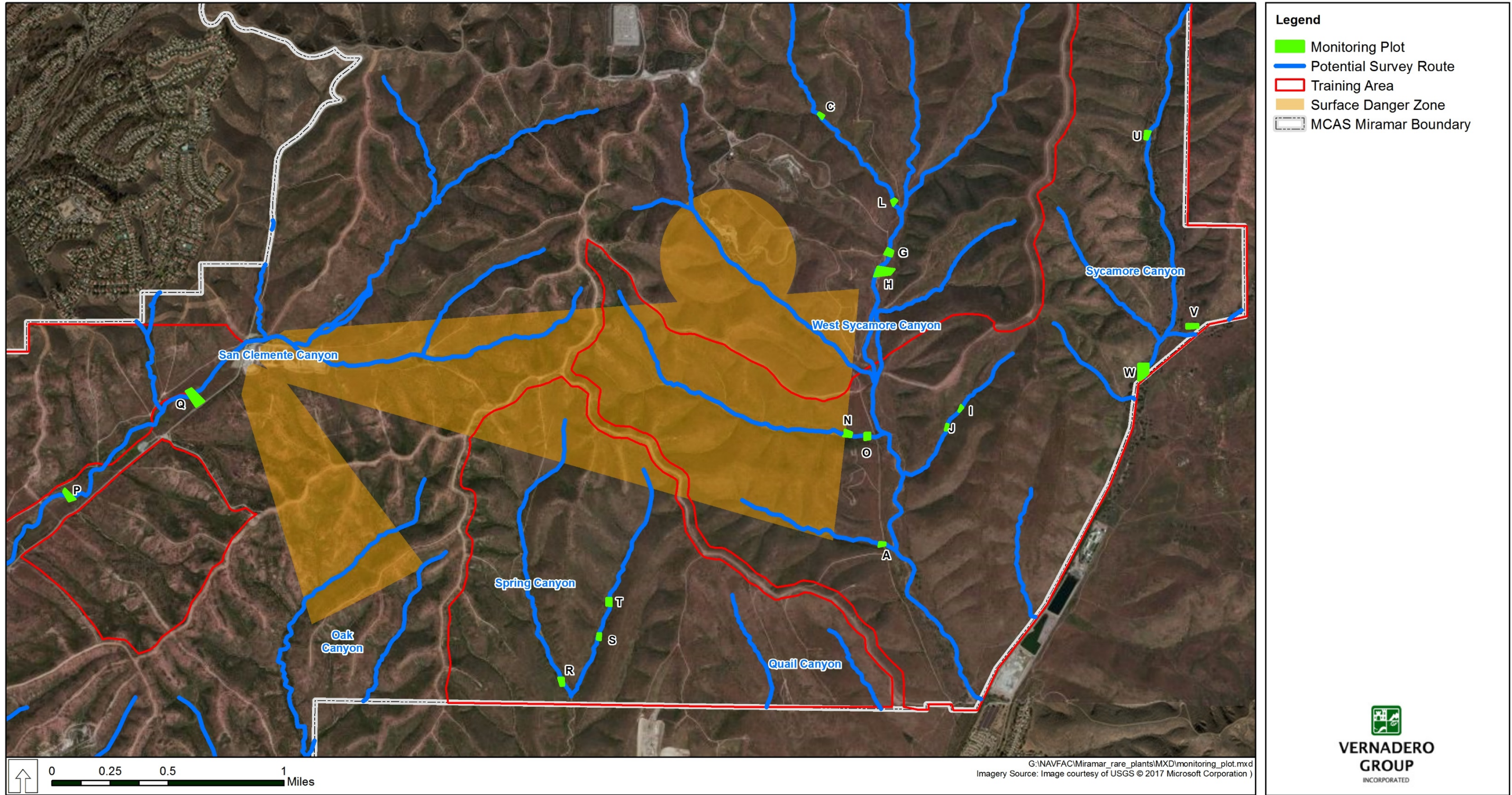


Figure 2-1. Location of Willowy Monardella Monitoring Plots at MCAS Miramar

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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 cm) 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 2012, 2017, and 2020:

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

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 Systat (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 (Coded as categorical values)
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

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.

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 (RTK) 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.

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3.0 RESULTS

3.1 Willowy Monardella Census

A total of 824 living willowy monardella clumps and 62 dead willowy monardella clumps was found during the 2020 census (Figures 3-1 through 3-8); 376 clumps that had been observed and tagged during previous surveys were not found again (Table 3-1). Of the living willowy monardella clumps, 36 were new clumps not mapped during previous surveys, 20 clumps were previously mapped as multiple clumps and were merged into a single clump, and 9 clumps were previously mapped as a single clump and were split into multiple clumps.

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

Canyon	Number of Willowy Monardella Clumps	Previously Mapped but Not Relocated
Elanus	9	2
Murphy	1	1
San Clemente	289	83
Spring	183	75
Sycamore	107	94
West Sycamore	235	121
Oak	0	0
Quail	0	0
Rose	0	0
Total	824	376

Nearly all the willowy monardella clumps observed during the 2020 surveys were either adults (777 clumps) or mature plants (44 clumps). Only three clumps were categorized as juvenile plants; no seedlings were observed (Table 3-2).

Table 3-2. Life Stage of Willowy Monardella Clumps by Canyon

Canyon	Life Stage				
	Adult	Mature	Juvenile	Seedling	Dead
Elanus	8	1	0	0	0
Murphy	1	0	0	0	0
San Clemente	264	24	1	0	44
Spring	176	6	1	0	4
Sycamore	101	6	0	0	4
West Sycamore	227	7	1	0	10
Oak	0	0	0	0	0
Quail	0	0	0	0	0

Canyon	Life Stage				
	Adult	Mature	Juvenile	Seedling	Dead
Rose	0	0	0	0	0
Total	777	44	3	0	62

Most of the clumps (763 clumps) found during the 2020 census were in the flowering stage (Table 3-3). The majority of clumps not flowering were in the vegetative phase (41 clumps). Only 17 clumps were observed to be in the seeding stage or senescent.

Table 3-3. Phenology Stage of Willowy Monardella Clumps by Canyon

Canyon	Phenology Stage					
	Vegetative	Budding	Flowering	Fruiting	Seeding	Senescent
Elanus	2	0	7	0	0	0
Murphy	1	0	0	0	0	0
San Clemente	31	2	253	0	0	3
Spring	4	0	179	0	0	0
Sycamore*	0	0	93	0	0	13
West Sycamore*	3	0	231	0	0	1
Oak	0	0	0	0	0	0
Quail	0	0	0	0	0	0
Rose	0	0	0	0	0	0
Total	41	2	763	0	0	17

* Phenology was not collected on one clump in the 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 2020 census. The mean height of willowy monardella clumps was relatively consistent across all canyons, with an overall average clump height of 50 cm (Table 3-4). The tallest clump was 155 cm in height, a total of 17 clumps was taller than 80 cm in height, and 13 clumps were less than 20 cm in height. The average clump length was 148 cm (Table 3-4); 16 clumps were more than 500 cm in length, with two of those exceeding 1,000 cm in length (1,200 cm and 1,122 cm). The average clump length was 106 cm (Table 3-4). Seven clumps were less than 10 cm in length. Two clumps were more than 800 cm in width, and 14 clumps were less than 10 cm wide. On average, the largest clumps occurred in West Sycamore Canyon (Table 3-4).



Figure 3-1. Willowy Monardella Clumps in Elanus Canyon



Figure 3-2. Willowy Monardella Clumps in Murphy Canyon

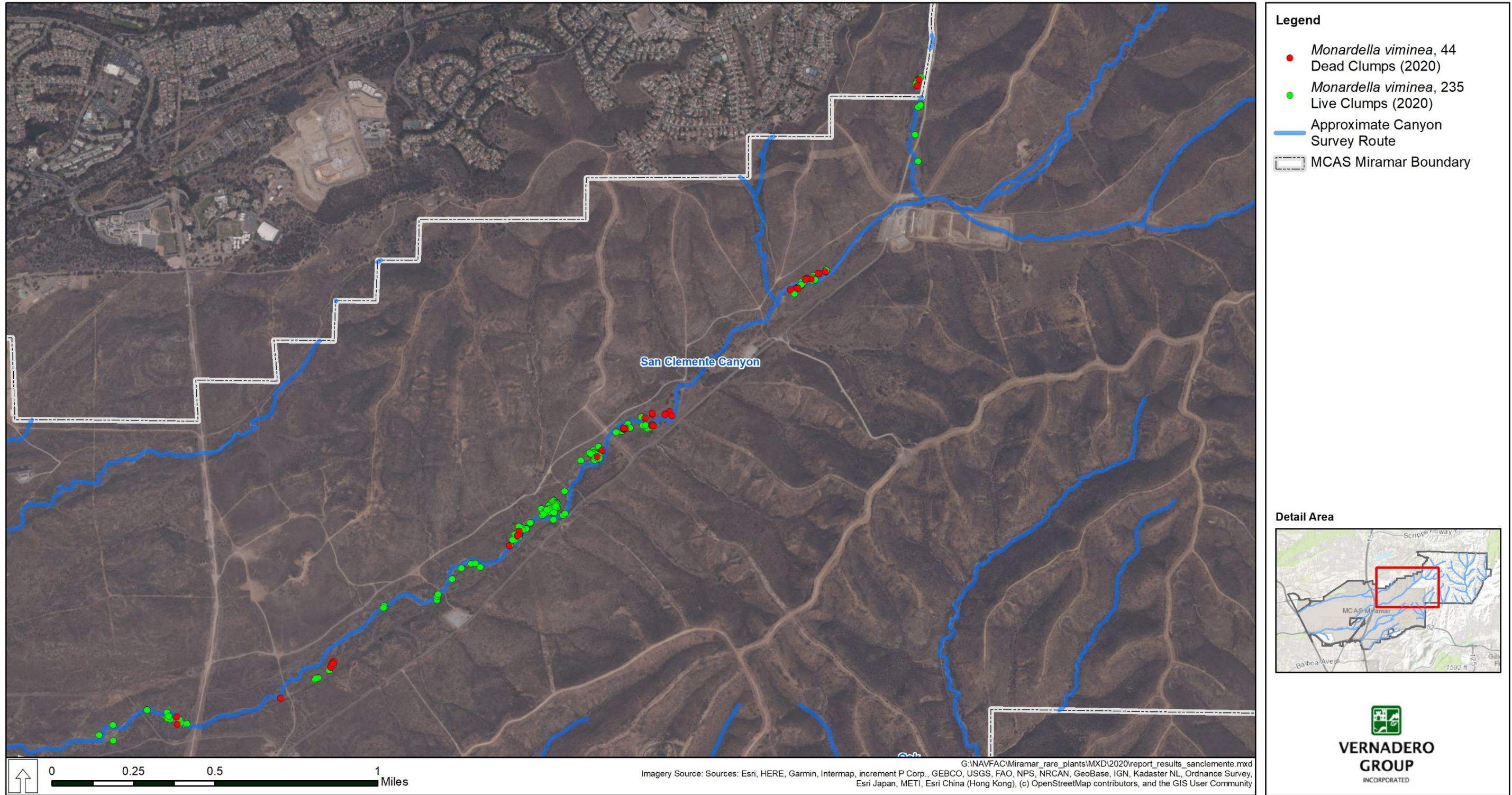


Figure 3-3. Willowy Monardella Clumps in the Eastern Portion of San Clemente Canyon

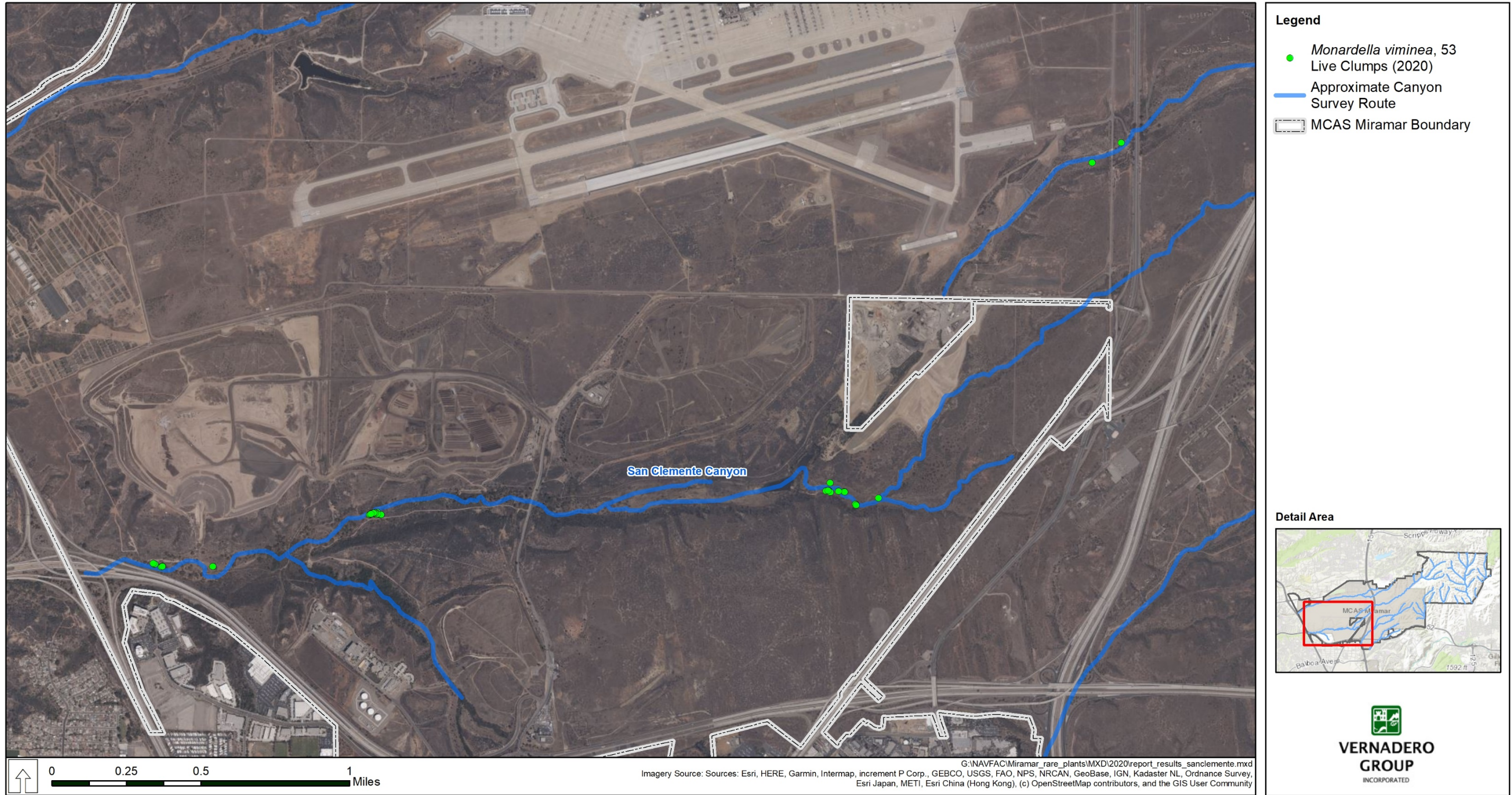


Figure 3-4. Willowy Monardella Clumps in the Western Portion of San Clemente Canyon

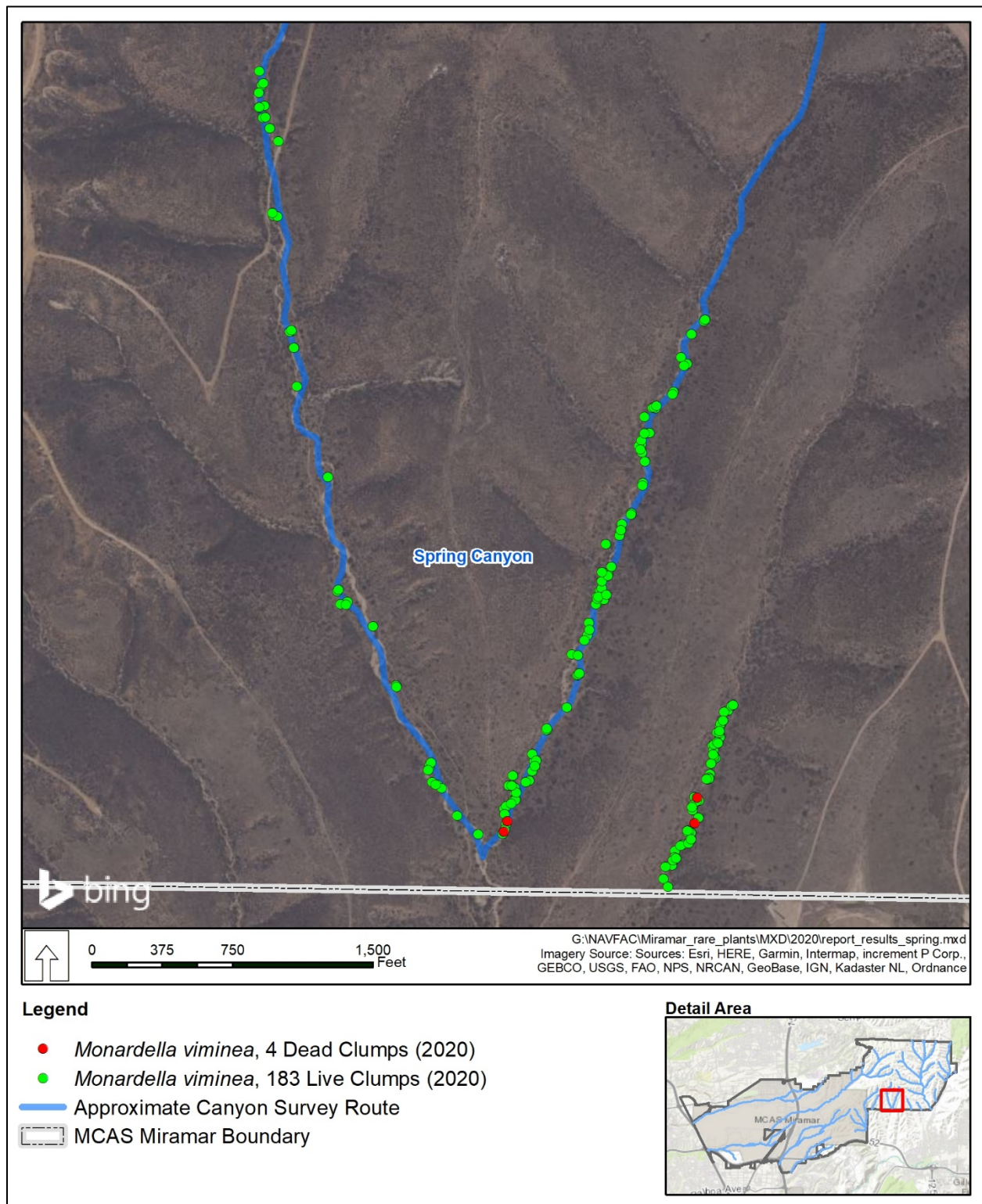


Figure 3-5. Willowy Monardella Clumps in Spring Canyon

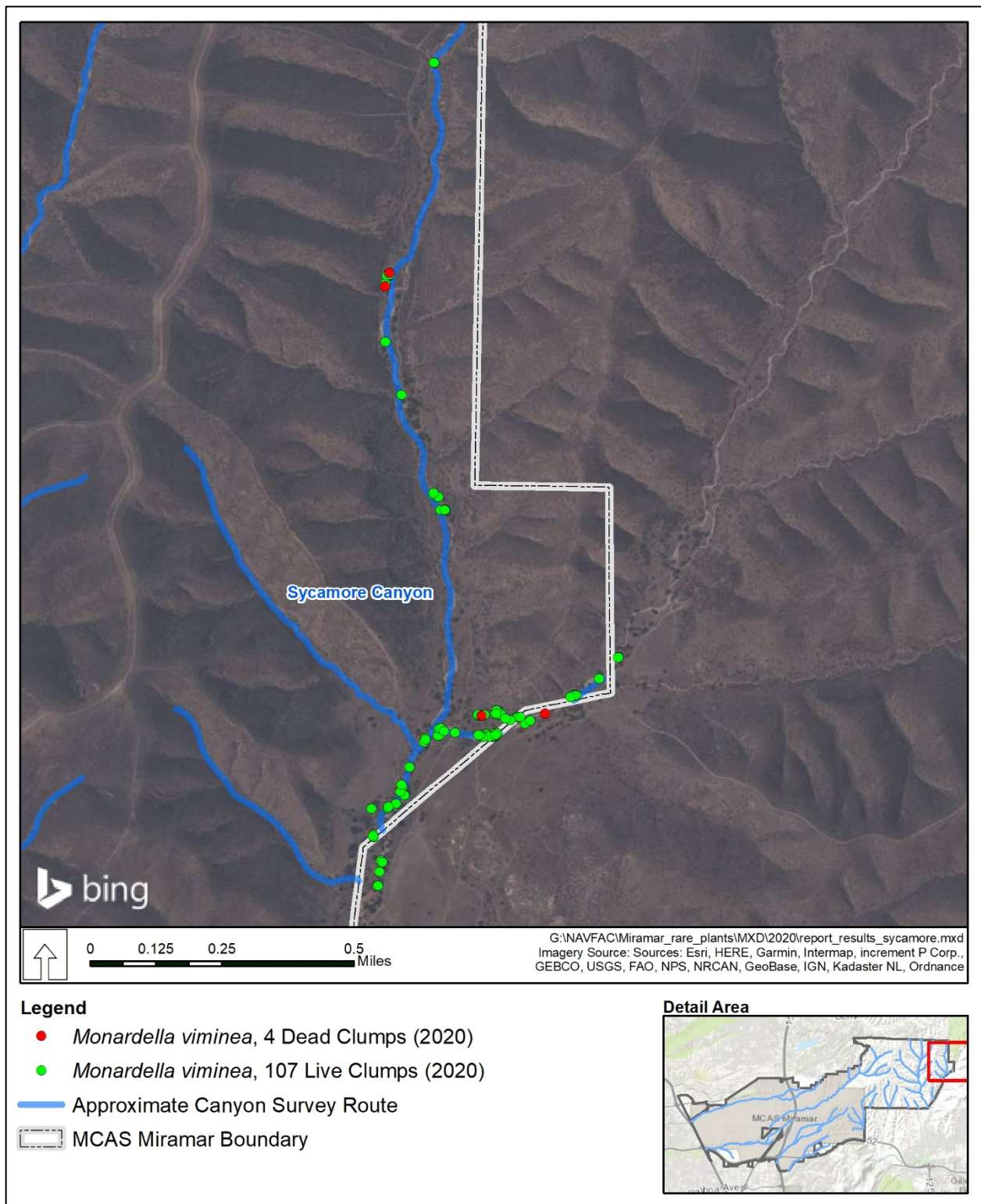
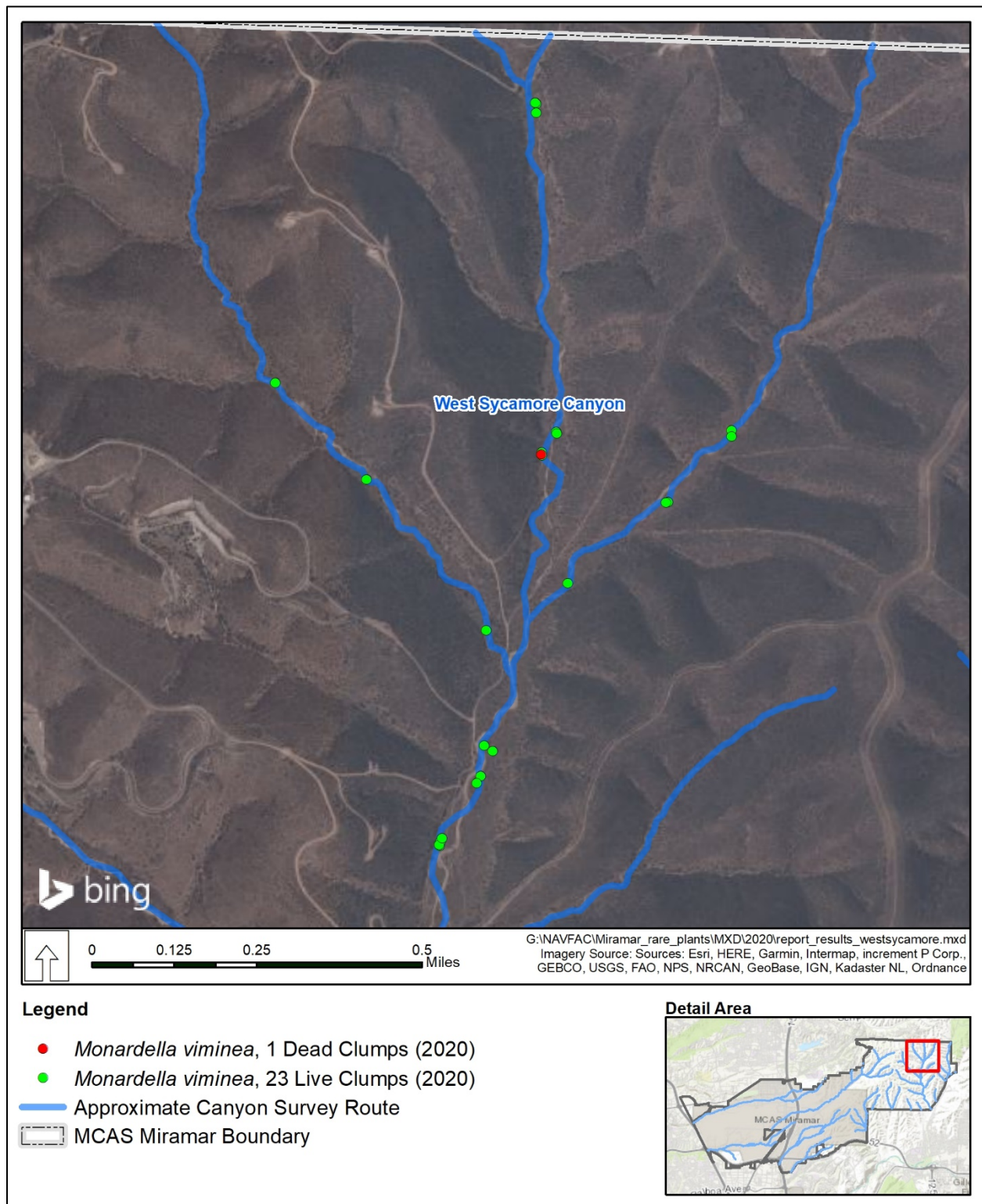
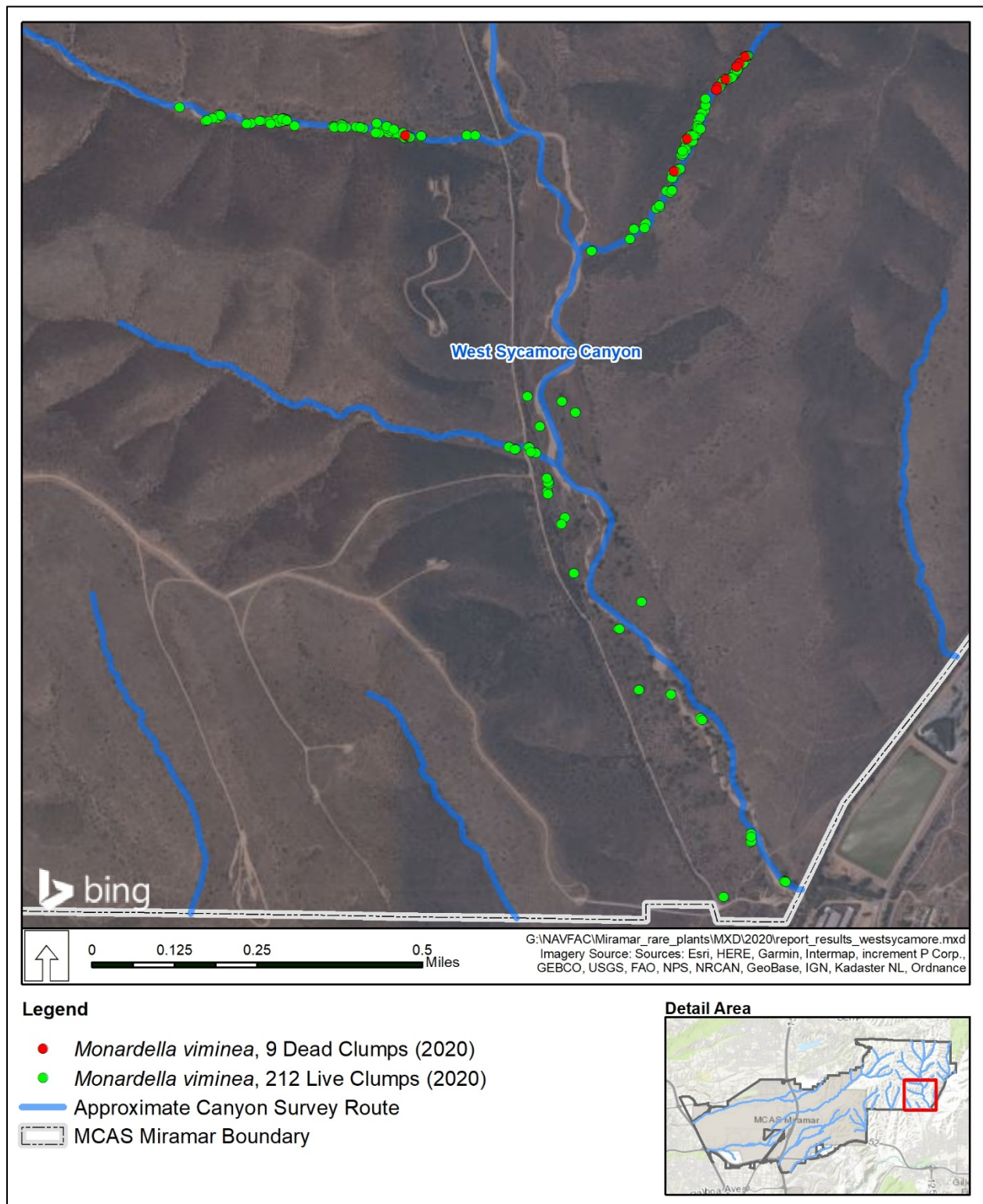


Figure 3-6. Willowy Monardella Clumps in Sycamore Canyon



**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 3-4. Mean Height, Length, and Width of Willowy Monardella Clumps by Canyon

Canyon	Mean Height (cm)	Mean Length (cm)	Mean Width (cm)
Elanus (n=9)	40	120	70
Murphy (n=1)	45	108	77
San Clemente (n=289)	45	120	82
Spring (n=183)	52	159	117
Sycamore (n=107)	51	157	112
West Sycamore (n=233)*	55	173	119
Overall Mean (n=822)	50	148	106
Minimum	8	1	1
Maximum	155	1,200	874

cm – centimeter

* Two clumps were not measured in West Sycamore Canyon.

We recorded the geomorphological location of willowy monardella clumps along drainage channels (Table 3-5). Most clumps were found in alluvial benches or flats (563 clumps) along drainage channels. When noted by surveyors, slightly more than half of all clumps were found in primary channels (361 clumps) and slightly less than half of all clumps were recorded in secondary channels (271 clumps).

Table 3-5. Location in Drainage of Willowy Monardella Clumps by Canyon

Canyon	Drainage Location		
	Alluvial Bench or Flats	Inside Edge of Curve in Meandering Drainage	Main Drainage
Elanus	7	2	0
Murphy	0	0	0
San Clemente*	251	22	13
Spring	80	87	16
Sycamore*	92	10	2
West Sycamore*	133	69	31
Oak	0	0	0
Quail	0	0	0
Rose	0	0	0
Total	563	190	62

* Drainage location not collected on three clumps each in San Clemente and Sycamore Canyons and not collected on two clumps in West Sycamore Canyon.

Some disturbance features were noted for willowy monardella clumps. Herbivory was noted in three clumps, vehicle disturbance at one clump, scour and erosion damage at seven clumps, and plant competition in nine clumps. In general, substantial die-off was noted on numerous willowy monardella clumps.

A number of potential pollinators were observed on willowy monardella clumps. Bumblebees (*Bombus* spp.) were most often noted as being present on clumps. Other potential pollinators observed on willowy monardella include beetles (Coleoptera), funereal duskywing (*Erynnis funeralis*), fiery skipper (*Hylephila phyleus*), tiger swallowtail (*Papilio glaucus*), dusky wing butterfly (*Erynnis* spp.), pale swallowtail (*Papilio eurymedon*), cabbage white (*Pieris rapae*), and buckeye butterfly (*Junonia coenia*). There were numerous observations of unidentified small, black beetles eating the willowy monardella flowers.

3.2 Willowy Monardella Plot Monitoring

A total of 125 living willowy monardella clumps was recorded in the 17 monitoring plots. All monitoring plots had at least one live clump; Monitoring Plots I, Q, S, and V contained more than 10 living clumps. Monitoring Plot V in Sycamore Canyon contained the most clumps of any of the monitoring plots (Table 3-6). Each of the four canyons where monitoring plots are located had at least one monitoring plot with more than 10 clumps.

Table 3-6. Number of Willowy Monardella Clumps by Monitoring Plot

Monitoring Plot	Number of Willowy Monardella Clumps*	Drainage Location	Survey Date
A	5	West Sycamore Canyon	8 July 2020
C	1	West Sycamore Canyon	14 July 2020
G	2	West Sycamore Canyon	14 July 2020
H	4	West Sycamore Canyon	9 July 2020
I	16	West Sycamore Canyon	7 July 2020
J	9	West Sycamore Canyon	7 July 2020
L	1	West Sycamore Canyon	14 July 2020
N	4	West Sycamore Canyon	1 July 2020
O	1	West Sycamore Canyon	1 July 2020
P	8	San Clemente Canyon	6 July 2020
Q	12	San Clemente Canyon	6 July 2020
R	4	Spring Canyon	10 July 2020
S	14	Spring Canyon	2 July 2020
T	7	Spring Canyon	2 July 2020
U	9	Sycamore Canyon	23 July 2020

Monitoring Plot	Number of Willowy Monardella Clumps*	Drainage Location	Survey Date
V	19	Sycamore Canyon	23 July 2020
W	9	Sycamore Canyon	13 July 2020

* The total includes only living clumps. One dead clump was observed in Plot V, two dead clumps were observed in Plots Q and U, three dead clumps were observed in Plot I, six dead clumps were observed in Plot P.

The mean and median elliptical areas and volumes were determined for each monitoring plot. Monitoring Plots O, G, and P had the smallest mean and median elliptical areas. Monitoring Plot I had the highest mean and median elliptical areas for plots containing more than two clumps. The overall mean and median elliptical areas were 2.14 and 0.84 square meters, respectively (Table 3-7).

Table 3-7. 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=5)	2.81	1.77	2.68
C (n=1)	3.92	3.92	0.00
G (n=2)	0.28	0.28	0.18
H (n=4)	0.63	0.42	0.61
I (n=16)	6.27	2.50	10.88
J (n=9)	2.61	1.62	2.35
L (n=1)	4.84	4.84	0.00
N (n=4)	0.93	0.42	1.29
O (n=1)	0.17	0.17	0.00
P (n=8)	0.36	0.34	0.28
Q (n=12)	0.79	0.38	1.43
R (n=4)	1.38	1.29	1.03
S (n=14)	0.98	0.83	0.88
T (n=7)	2.62	1.98	2.57
U (n=9)	0.80	0.79	0.56
V (n=19)	2.44	0.95	4.13
W (n=9)	1.19	0.58	1.34
Overall (n=125)	2.14	0.84	4.63

Monitoring Plots O, G, P, and H had the lowest mean elliptical volumes and the lowest median elliptical volumes. Monitoring Plots A, I, L, and C had the largest mean elliptical volumes and the largest median elliptical volumes. However, Monitoring Plots C and L only had one clump in

each plot. The overall mean and median elliptical volumes of willowy monardella clumps in monitoring plots were 1.24 and 0.45 cubic meters, respectively (Table 3-8).

Table 3-8. 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=5)	2.12	1.12	2.30
C (n=1)	2.78	2.78	0.00
G (n=2)	0.12	0.12	0.11
H (n=4)	0.32	0.20	0.35
I (n=16)	3.57	1.29	6.38
J (n=9)	1.42	0.94	1.09
L (n=1)	2.29	2.29	0.00
N (n=4)	0.54	0.25	0.77
O (n=1)	0.06	0.06	0.00
P (n=8)	0.19	0.19	0.18
Q (n=12)	0.60	0.21	1.27
R (n=4)	0.82	0.64	0.74
S (n=14)	0.54	0.37	0.54
T (n=7)	1.57	0.99	1.66
U (n=9)	0.41	0.35	0.29
V (n=19)	1.33	0.42	2.42
W (n=9)	0.67	0.33	0.80
Overall (n=125)	1.24	0.45	2.74

Some level of disturbance was present at all of the monitoring plots. The most common disturbances were invasive and nonnative plant species as well as walking and bike trails within monitoring plots (Table 3-9). The average drainage depth at the monitoring plots was 54 cm (Table 3-9). Only four soil types were recorded in the 17 monitoring plots, with Redding cobbly loam being the most common type (Table 3-9). The dominant plant species cover consisted mostly of nonnative plant species for all monitoring plots except A, N, O S, U, and V; a recent fire burned all of Monitoring Plots O and P, entirely eliminating nonnative species from these two plots (Table 3-9).

**Table 3-9. 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	17	SvE, RfF	50 (10)	Road located through the plot. Drainage goes through a culvert. Normal creek erosion. Invasive weeds present.
C	35	RfF, SvE	25 (55)	Invasive weeds; heavily invaded by nonnative grasses.
G	55	SvE, RfF	35 (50)	Graded power line road crosses the plot.
H	35	SvE, RfF	15 (60)	Road is located on west side of the plot. It is heavily invaded by invasive grasses.
I	34	RfF	30 (50)	Invasive grasses are present in the plot.
J	20	RfF	10 (50)	Invasive weeds present within the plot.
L	22	SvE, RfF	15 (65)	Invasive weeds present within the plot.
N	20	SvE, RfF	80 (0)	Evidence of heavy flows in the channels in the plot. Most of the plot has very recently burned.
O	30	SvE, RfF	100 (0)	The entire plot has recently burned.
P	36	VbB	40 (60)	The plot is heavily infested with weeds.
Q	47	VbB	10 (75)	Vehicle tracks located in the plot and appears as though a training exercise was conducted here. Damage to plants in the plot from vehicles. Heavily invaded by nonnative grasses.
R	38	RfF	25 (30)	The bank has eroded in the northwest corner of the plot and the stake in that corner was lost from the erosion.
S	30	SvE, RfF	65 (20)	A small walking or bike trail crossed the plot. Streambed erosion was present along the banks.
T	20	SvE, RfF	40 (40)	Numerous invasive species present in the plot.
U	0	SvE, RfF	45 (20)	Heavily used game trails were present in the plot. The plot appears to no longer receive flooding from the main drainage channel.
V	0	SvE	65 (30)	A bike or walking trail crossed through the plot.

Monitoring Plot	Drainage Depth (cm)	Soil Type	Native (Nonnative) Dominant Plant Species Percent Cover	Disturbance Notes
W	50	SvE, DaE	40 (40)	Hiking and bike trails were located through the plot. Many willowy monardella clumps in the main channel could not be relocated presumably due to flooding and scouring.

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 55 percent, and the average bare-ground relative cover was 34 percent. The relative cover of grasses and forbs were 18 percent and 9 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 1 percent and 27 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 3-10) and clump elliptical volume (Table 3-11) as the dependent variable and the habitat measurements as independent variables.

Table 3-10. Multiple Regression Results for Elliptical Area

Habitat Feature	Estimate	Mean Standard Error	Standard Error of Regression	F Value	Probability (> F)
Intercept	9.136	Intercept has no variation			
Herbivory	No herbivory noted: insufficient variation				
Unidentified Grasses	No unidentifiable grasses noted: insufficient variation				
Nonnative Herbaceous	0.077	4.043	0.1828	0.150	0.699
Nonnative Grasses	0.127	0.382	0.056	0.017	0.897
Native Herbs	-0.103	11.199	0.304	0.491	0.485
Shrub Cover	0.152	0.546	0.067	0.024	0.877
Tree Cover	0.212	1.030	0.092	0.045	0.832
Bare Ground	-0.024	33.221	0.524	1.457	0.230
Drainage Type	-0.331	9.168	0.275	0.402	0.527
RDM – Dense Thatch	1.187	29.766	0.496	1.305	0.276
RDM - Minimal	-0.726	29.766*	0.496	1.305	0.276

Habitat Feature	Estimate	Mean Standard Error	Standard Error of Regression	F Value	Probability (> F)
Total Plant Cover	-0.193	0.878	0.085	0.038	0.845
Total Herbaceous Cover	0.170	0.676	0.075	0.030	0.864

RDM – residual dry matter

* RDM has three levels, hence two degrees of freedom within this variable. For the total regression, there is only one degree of freedom for the variable RDM, and so only one analysis result.

Table 3-11. Multiple Regression Results for Elliptical Volume

Habitat Feature	Estimate	Mean Standard Error	Standard Error of Regression	F Value	Probability (> F)
Intercept	5.107	Intercept has no variation			
Herbivory	No herbivory noted: insufficient variation				
Unidentifiable Grasses	No unidentifiable grasses noted: insufficient variation				
Nonnative Herbaceous	0.044	0.105	0.029	0.137	0.712
Nonnative Grasses	0.063	0.092	0.028	0.001	0.915
Native Herbaceous	-0.053	2.925	0.155	0.365	0.547
Shrub Cover	0.077	0.141	0.034	0.018	0.895
Tree Cover	0.101	0.234	0.044	0.029	0.865
Bare Ground	-0.016	14.578	0.347	1.820	0.180
Drainage Type	-0.145	1.765	0.121	0.220	0.640
RDM – Dense Thatch	0.684	8.908	0.271	1.112	0.333
RDM - Minimal	-0.355	8.908*	0.271	1.112	0.333
Total Plant Cover	-0.101	0.241	0.045	0.030	0.863
Total Herbaceous Cover	0.085	0.168	0.037	0.021	0.885

RDM – residual dry matter

* RDM has three levels, hence two degrees of freedom within this variable. For the total regression, there is only one degree of freedom for the variable RDM, and so only one analysis result.

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; F value: test statistic representing the difference between the mean of two groups while taking into account any variation; Probability: the likelihood that the f-statistic or a sample mean will be less than or equal to a specified value.

Multiple regression calculates an F-statistic which tests the significance of the relationship between the independent variables (habitat features) and the dependent variable (elliptical area or elliptical volume). Larger F-statistics are associated with a greater likelihood of a relationship, and P is equal to the probability that a given F-statistic will be arrived at randomly (i.e., in the absence of a relationship). Significance was assessed at $p \leq 0.05$. If the F 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 F 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).

No statistically significant correlations were found from the multiple regression analysis between habitat variables and elliptical area or elliptical volume. With willowy monardella in decline, it is likely that there are increasingly insufficient data points to show a pattern.

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 and 2017 censuses 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 some cases, tags were found but clumps had disappeared and in other cases both tags and clumps were not relocated. Often, we noted field indicators that channel erosion or scour might have removed a willowy monardella clump. A total of 376 clumps was not relocated during the 2020 census, which is substantially more than the 278 clumps not relocated during the 2017 census. Given that we actively searched for each of these previously identified clumps and were not able to locate them, it indicates that these 376 clumps have disappeared from MCAS Miramar over the past five years.

There were no discernable spatial patterns to where clumps observed in 2017 were relocated in 2020 compared to where clumps were lost (i.e., could not be found) between 2017 and 2020 at MCAS Miramar (Figures 4-1 through 4-8) (MCAS Miramar 2018). 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, 2017, or 2020 censuses.

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; however, 118 willowy monardella clumps were measured in both 2017 and 2020. The mean elliptical area growth rate from 2017 to 2020 was 1.75, and the mean elliptical volume growth from 2017 to 2020 was 3.00. Of the 118 willowy monardella clumps measured in 2017 and 2020, only 41 had a decrease in the elliptical area (positive growth rate ratio of 77:118) and only 35 had a decrease in elliptical volume (positive growth rate ratio of 83:118). Given the much larger sample size in 2020, it is apparent that for those surviving willowy monardella clumps, the trend is towards increased growth.

An increase or decrease in average growth rates for elliptical area and elliptical volume were in agreement for every monitoring plot except Monitoring Plot P. This indicates that on the average where plants were increasing or decreasing in size, there was a corresponding change in plant height with plant length and width. Further, the average growth rates for elliptical area and elliptical volume increased in all of the monitoring plots except Monitoring Plots G, N, O, and V.

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Figure 4-1. Comparison between 2017 and 2020 Surveys of Willowy Monardella Clumps Observed in Elanus Canyon

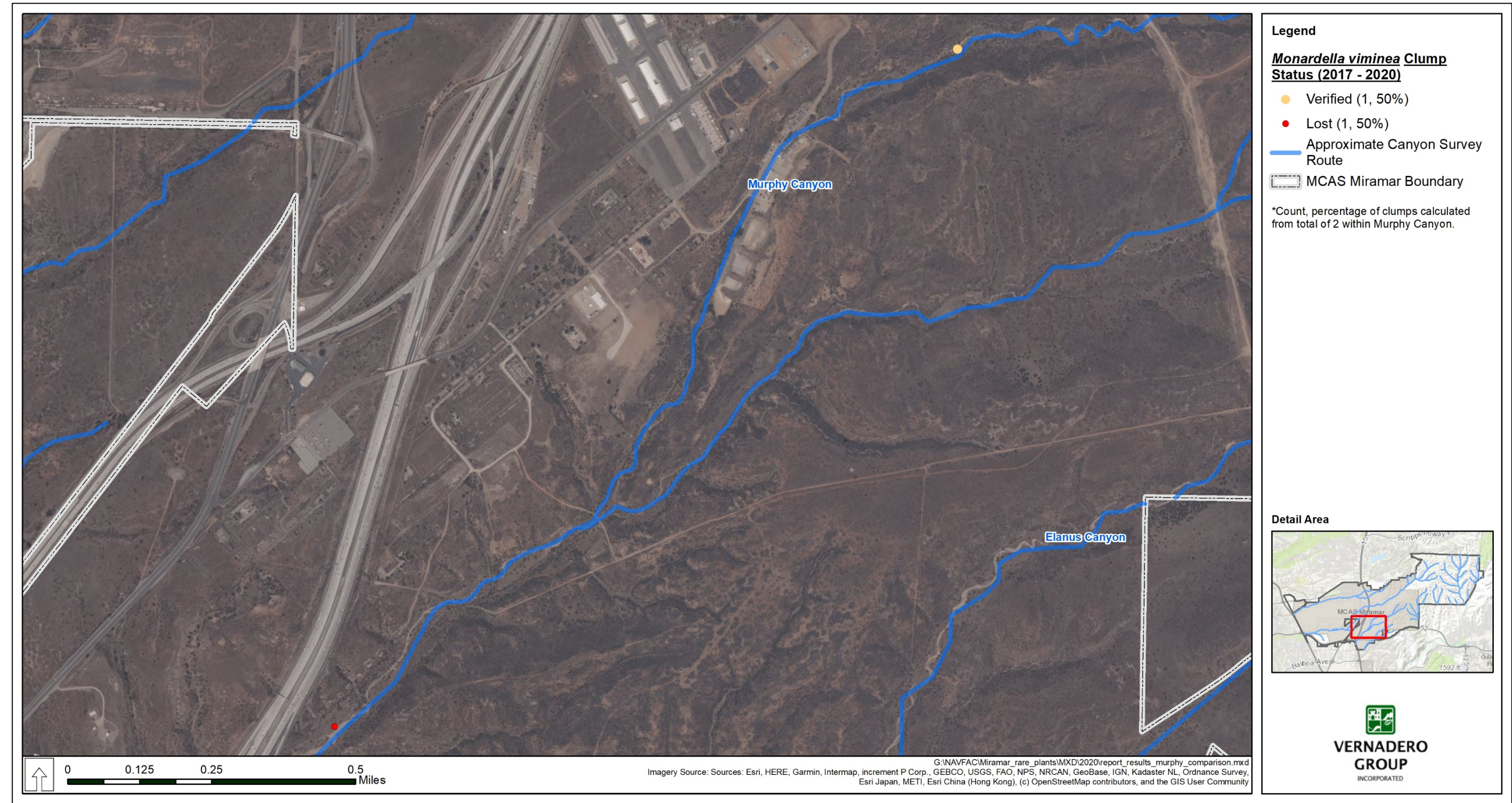


Figure 4-2. Comparison between 2017 and 2020 Surveys of Willowy Monardella Clumps Observed in Murphy Canyon

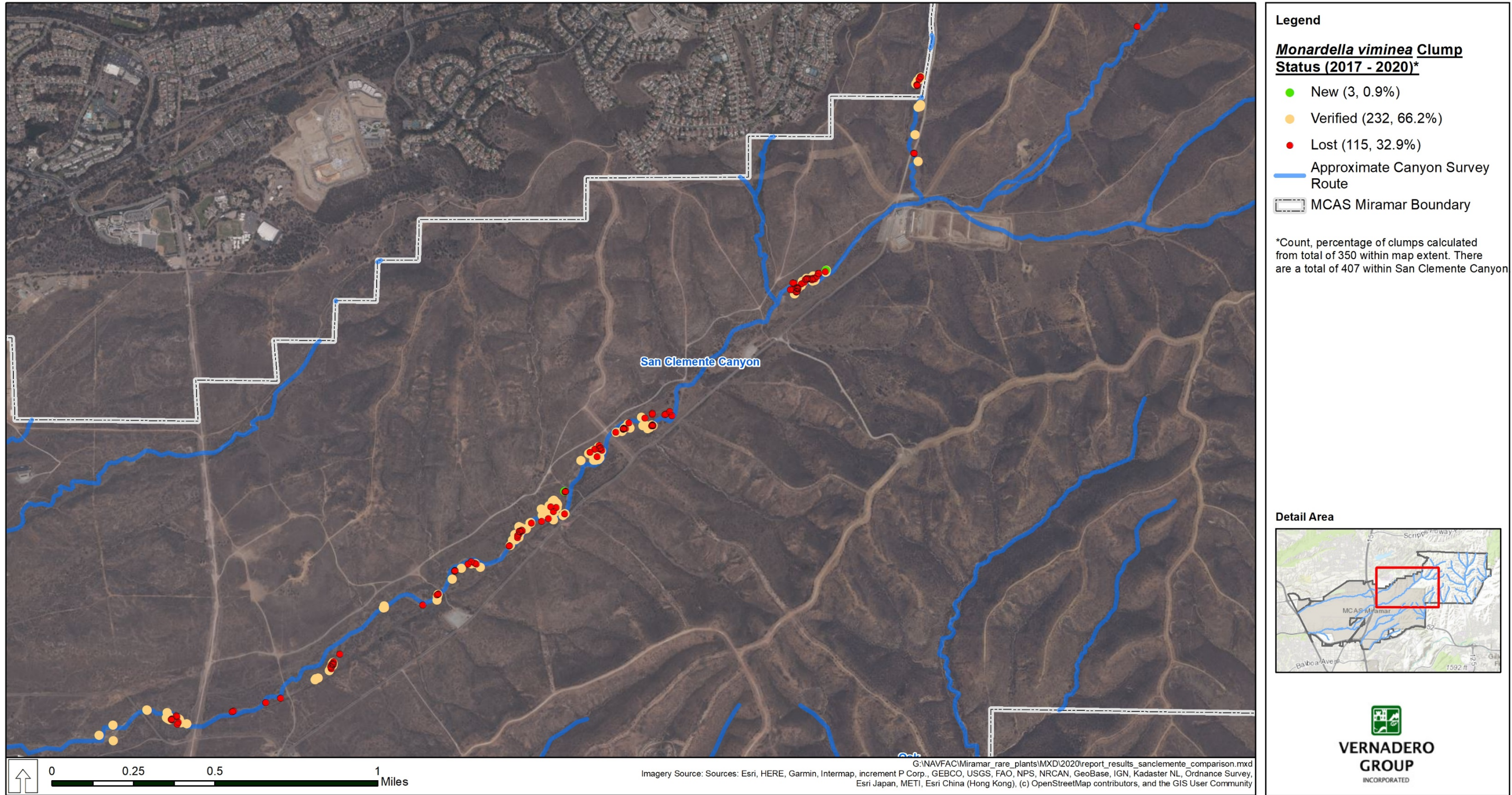


Figure 4-3. Comparison between 2017 and 2020 Surveys of Willowy Monardella Clumps Observed in the Eastern Portion of San Clemente Canyon

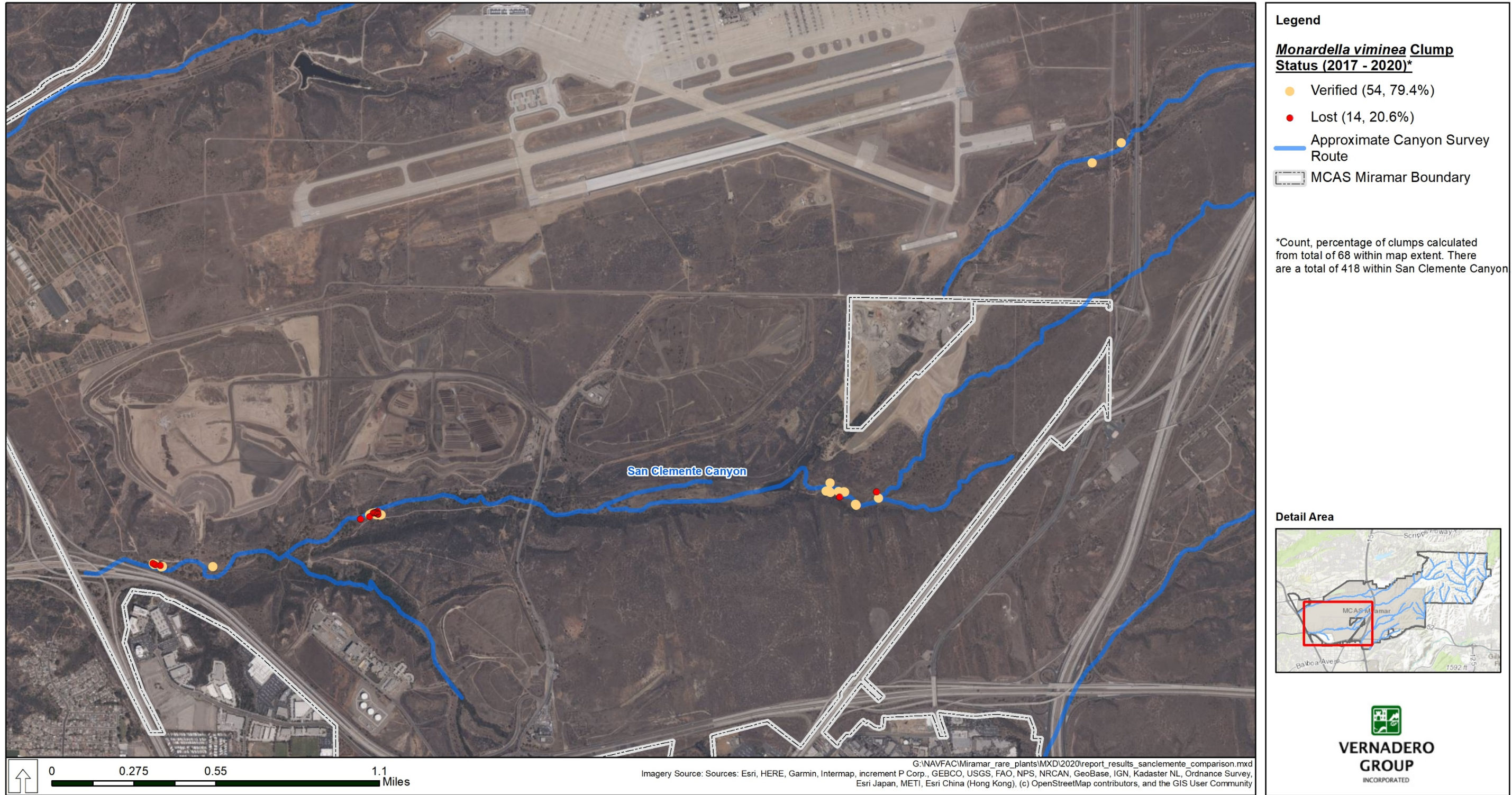


Figure 4-4. Comparison between 2017 and 2020 Surveys of Willowy Monardella Clumps Observed in the Western Portion of San Clemente Canyon

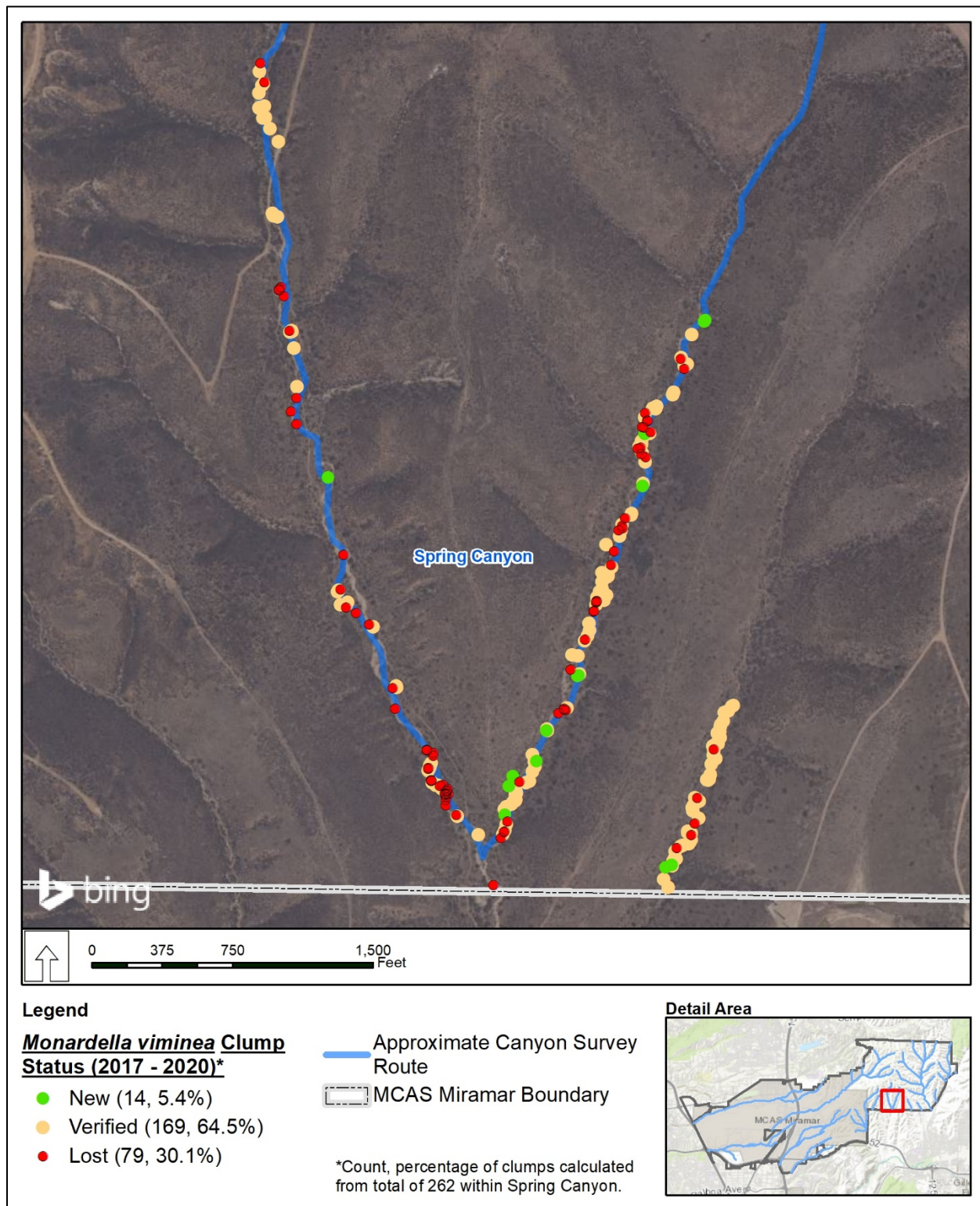
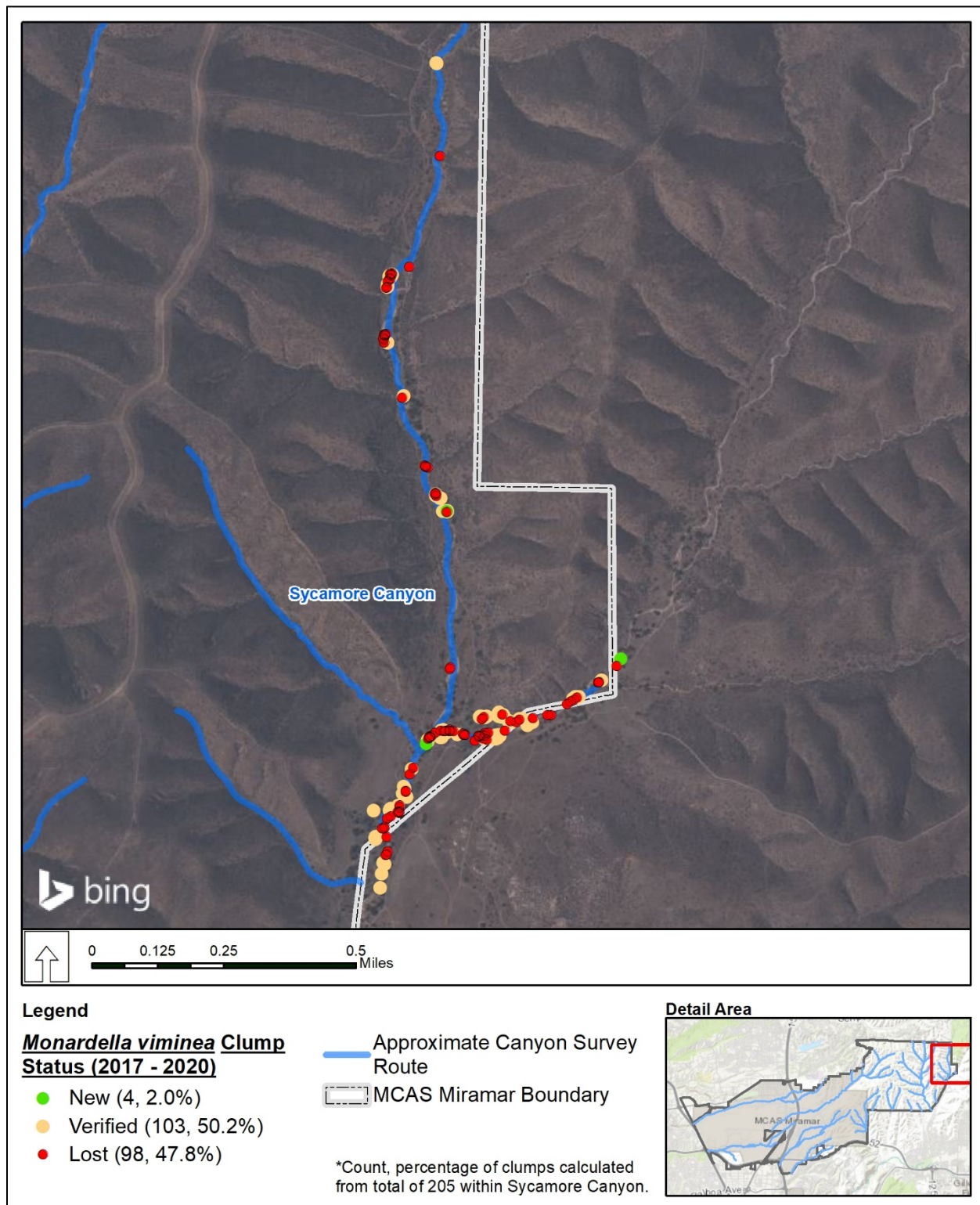


Figure 4-5. Comparison between 2017 and 2020 Surveys of Willowy Monardella Clumps Observed in Spring Canyon



**Figure 4-6. Comparison between 2017 and 2020 Surveys
of Willow Monardella Clumps Observed in Sycamore Canyon**

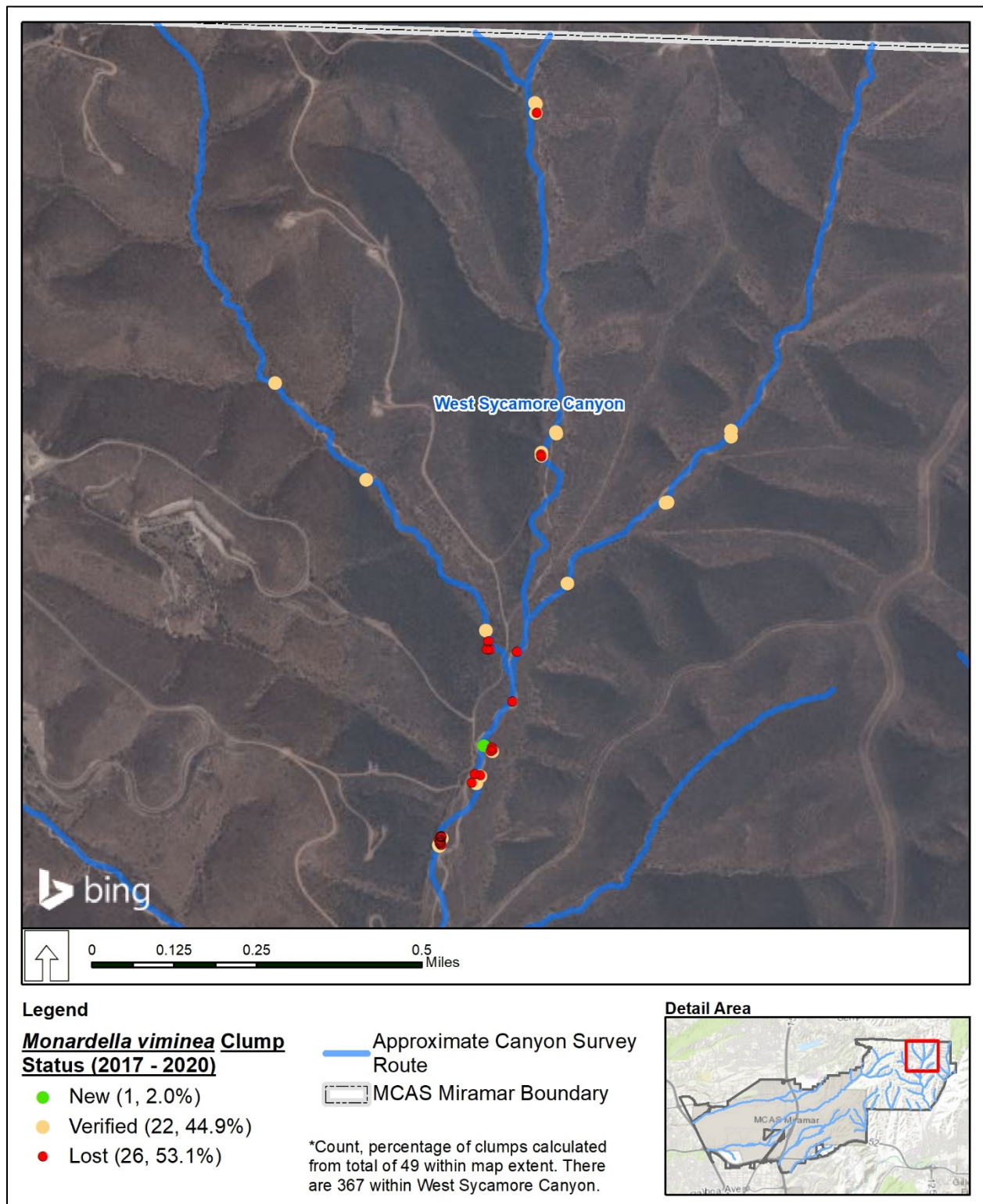


Figure 4-7. Comparison between 2017 and 2020 Surveys of Willowy Monardella Clumps Observed in the Northern Portion of West Sycamore Canyon

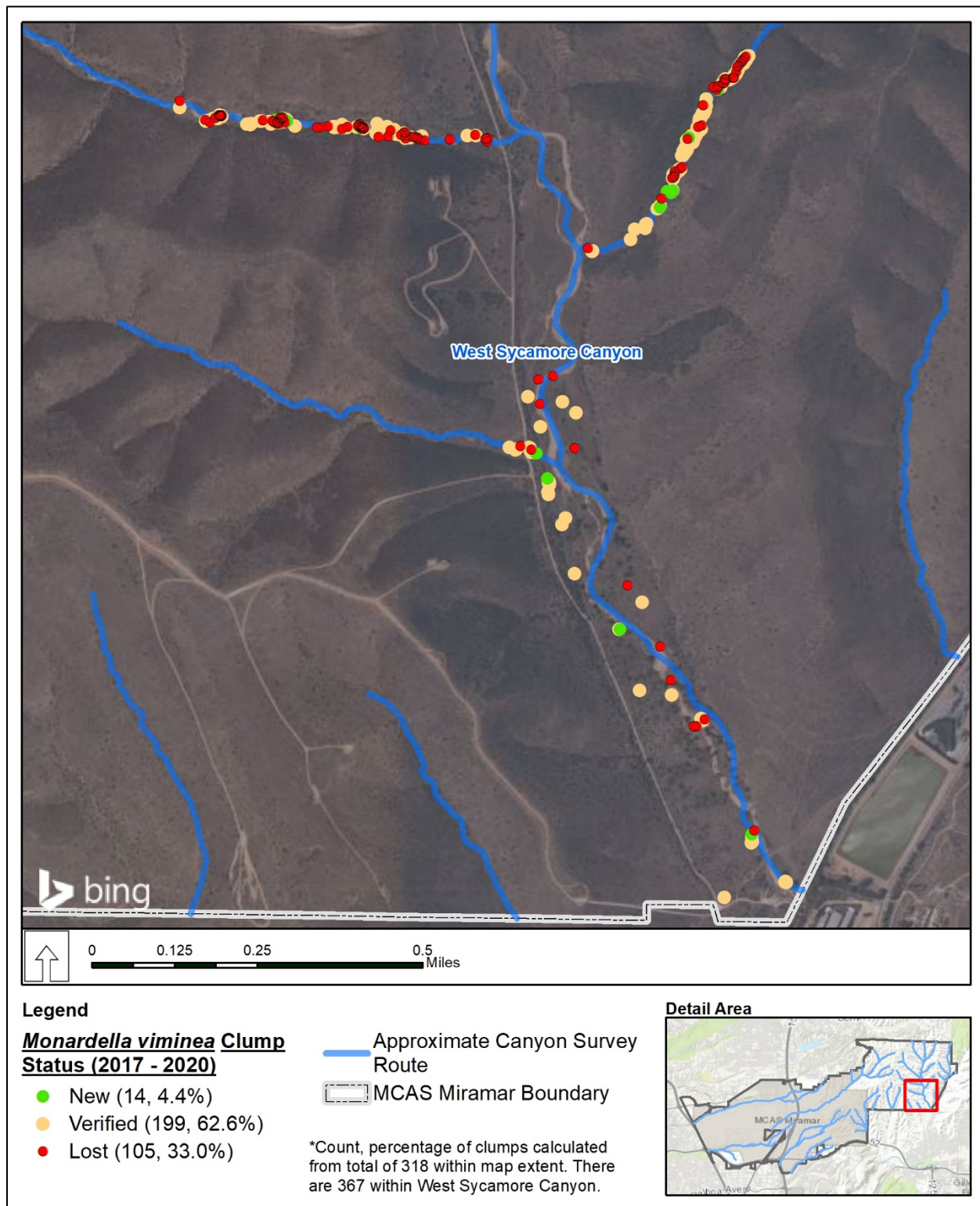


Figure 4-8. Comparison between 2017 and 2020 Surveys of Willowy Monardella Clumps Observed in the Southern Portion of West Sycamore Canyon

Table 4-1. Willowy Monardella Growth Rates 2012 – 2020*

Clump ID	2012-2017 Elliptical Area Growth Rate**	2012-2017 Elliptical Volume Growth Rate**	2017-2020 Elliptical Area Growth Rate**	2017-2020 Elliptical Volume Growth Rate**
Monitoring Plot A				
461	-	-	-0.06	-0.01
870	-	-	1.22	1.84
1607	-	-	0.11	0.29
1636	-	-	-0.23	-0.03
1656	-	-	7.52	7.52
Mean Plot A			1.71	1.92
Monitoring Plot C				
375	0.48	0.32	0.62	0.80
Monitoring Plot G				
373	-	-	-0.74	-0.84
1770	1.44	2.41	0.31	0.21
Mean Plot G	1.44	2.41	-0.22	-0.32
Monitoring Plot H				
1521	0.07	-0.12	-	-
1524	0.21	0.21	-0.35	-0.57
1530	-0.94	-0.97	-	-
1761	-0.86	-0.85	1.99	1.30
1772	-0.17	0.06	-	-
1774	1.50	1.04	-0.20	-0.33
1778	-0.68	-0.85	-	-
1780	-0.26	0.27	0.04	0.10
Mean Plot H	-0.14	-0.15	0.37	0.12
Monitoring Plot I				
390			1.14	1.29
398			2.95	4.99
946			35.63	85.45
1230	0.63	2.21	1.71	1.39
1231	4.49	7.53	-	-
1232	-0.60	-0.69	13.45	18.82
1233	-0.20	-0.02	-	-
1236	-0.99	-1.00	-	-
1237	1.67	1.54	0.21	0.08

Clump ID	2012-2017 Elliptical Area Growth Rate**	2012-2017 Elliptical Volume Growth Rate**	2017-2020 Elliptical Area Growth Rate**	2017-2020 Elliptical Volume Growth Rate**
1244	-	-	1.53	0.41
1246	-0.22	0.34	-	-
1250	7.23	7.67	1.93	1.25
1252	1.10	1.27	1.37	2.01
1253	-0.58	-0.79	-0.95	-0.96
1256	-0.33	-0.27	3.81	3.81
1257	0.65	0.71	1.32	1.09
1268	0.03	-0.36	0.46	0.39
1273	-0.05	-0.22	0.41	0.25
1286	2.37	1.20	-	-
1293	1.07	0.93	1.70	1.37
1836	-	-	9.60	12.12
Mean Plot I	1.02	1.25	4.77	8.36
Monitoring Plot J				
516	-	-	1.90	2.42
1050	-	-	28.97	24.69
1173	-0.33	-0.44	1.73	1.61
1174	0.36	0.14	-0.14	-0.12
1176	3.25	3.52	-	-
1179	1.61	3.21	0.72	0.56
1182	-0.12	-0.17	-	-
1187	-	-	0.35	0.67
1629	-	-	0.14	0.23
1733	255.25	609.12		
1837			-0.16	0.31
Mean Plot J	45.34	102.56	4.19	6.75
Monitoring Plot L				
495	-	-	6.95	8.65
Monitoring Plot N				
51	-	-	-0.95	-0.99
693	-	-	0.33	0.43
1302	-	-	-0.46	-0.51
Mean Plot N	-	-	-0.36	

Clump ID	2012-2017 Elliptical Area Growth Rate**	2012-2017 Elliptical Volume Growth Rate**	2017-2020 Elliptical Area Growth Rate**	2017-2020 Elliptical Volume Growth Rate**
Monitoring Plot O				
1522	-	-	-0.72	-0.70
Monitoring Plot P				
905	-0.26	-0.51	-0.98	-0.98
919	-0.62	-0.80	-	-
920	-0.67	-0.69	-	-
921	-0.56	-0.70	-0.51	-0.30
924	-0.27	-0.46	-	-
925	-0.55	-0.66	-0.63	-0.66
927	-0.87	-0.93	-	-
931	-0.31	-0.51	1.07	2.23
932	-0.46	-0.65	-0.11	0.19
934	0.32	0.22	-0.11	-0.24
935	-0.23	-0.40	0.04	0.20
Mean Plot P	-0.41	-0.55	-0.18	0.06
Monitoring Plot Q				
852	-0.90	-0.94	-	-
855	1.28	1.28	-0.60	-0.70
856	-0.78	-0.81	2.03	3.08
857	-0.51	-0.67	-0.18	0.30
859	-0.05	-0.43	-0.59	-0.42
861	0.79	0.65	0.35	0.64
865	-0.37	-0.40	-0.81	-0.80
866	-0.74	-0.82	0.00	0.35
867	-0.24	-0.47	-0.47	-0.30
872	0.87	0.57	-	-
873	1.46	1.25	-	-
874	-0.93	-0.95	0.56	0.77
875	-	-	-1.00	-1.00
876 (151)	0.19	-0.09	0.36	0.81
879	-0.91	-0.95	0.87	1.62
Mean Plot Q	-0.06	0.60	0.04	0.36
Monitoring Plot R				
1388	-	-	0.59	0.57
1440	-	-	0.87	0.65

Clump ID	2012-2017 Elliptical Area Growth Rate**	2012-2017 Elliptical Volume Growth Rate**	2017-2020 Elliptical Area Growth Rate**	2017-2020 Elliptical Volume Growth Rate**
1584	-	-	0.58	1.14
1611	-	-	1.47	3.54
Mean Plot R	-	-	0.88	1.47
Monitoring Plot S				
206	-	-	1.02	2.74
211	-	-	0.68	2.51
237	-	-	5.19	8.12
238	-	-	2.14	3.66
239	-	-	1.07	2.27
241	-	-	1.11	3.21
243	-	-	0.56	0.78
244	-	-	0.43	0.60
249	-	-	0.00	0.20
317	-	-	0.64	2.22
356	-	-	3.48	17.73
1762	-	-	-0.16	0.97
Mean Plot S	-	-	1.35	3.75
Monitoring Plot T				
173	-	-	0.25	0.54
187	-	-	0.04	0.67
189	-	-	0.87	0.69
190	-	-	3.82	3.38
192	-	-	0.31	0.35
199	-	-	15.03	32.45
204	-	-	-0.06	0.37
Mean Plot T	-	-	2.89	5.49
Monitoring Plot U				
319	-	-	0.01	0.27
326	-	-	0.56	1.84
331	-	-	0.24	1.03
335	-	-	0.19	0.81
339	-	-	0.88	1.33
449	-	-	25.76	45.22
1461	-	-	-0.92	-0.89

Clump ID	2012-2017 Elliptical Area Growth Rate**	2012-2017 Elliptical Volume Growth Rate**	2017-2020 Elliptical Area Growth Rate**	2017-2020 Elliptical Volume Growth Rate**
1809	-	-	5.08	7.26
Mean Plot U	-	-	3.97	7.11
Monitoring Plot V				
48	-	-	0.15	0.06
52	-	-	-0.12	-0.17
59	-	-	-0.49	-0.42
63	-	-	-0.31	-0.35
68	-	-	-0.86	-0.91
70	-	-	-0.50	-0.52
71	-	-	0.44	0.21
72	-	-	-0.06	-0.18
73	-	-	-0.20	-0.59
76	-	-	0.51	0.31
77	-	-	-0.26	-0.26
99	-	-	0.03	0.10
100	-	-	-0.13	-0.23
119	-	-	-0.73	-0.78
122	-	-	-0.09	-0.36
127	-	-	-0.42	-0.68
128	-	-	-0.51	-0.54
1500	-	-	0.38	0.52
Mean Plot V	-	-	-0.18	-0.27
Monitoring Plot W				
105	-	-	-0.64	-0.65
517	-	-	1.67	2.83
565	-	-	5.27	9.66
979	-	-	6.39	12.44
1589	-	-	0.17	0.23
1614	-	-	-0.71	-0.70
1857	-	-	0.33	0.72
1901	-	-	0.21	0.25
1990	-	-	0.73	1.30
Mean Plot W	-	-	1.49	2.90

ID – identification

- * Only 58 willowy monardella clumps in eight monitoring plots were monitored in both 2012 and 2017 allowing for a growth rate calculation. However, 118 clumps were monitored in both 2017 and 2020, 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 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 and to 2020. Data sheets from monitoring plot data collection in 2020 are provided in Appendix B.

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, 972 clumps in 2017, and 824 clumps in 2020 (MCAS Miramar 2004; MCAS Miramar 2013b; MCAS Miramar 2018). Further, there was no indication of recent plant recruitment as surveyors did not find any seedlings during the 2020 census and monitoring efforts. A total of 36 clumps was labeled as new in 2020, however, most of these newly labeled clumps were due to splitting of clumps previously mapped as a single clump and split into multiple clumps in 2020.

No willowy monardella clumps were observed in Oak, Quail, or Rose Canyons in 2012, 2017, or 2020. 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). Given the lack of recruitment overall at MCAS Miramar, it is highly unlikely that willowy monardella clumps will be observed in these canyons in the future.

No correlations between measured physical parameters in monitoring plots and elliptical volume or elliptical area were found in 2020. However, in most monitoring plots, nonnative plant species cover was high and often exceed native plant species cover. Competition from invasive plant species and nonnative grasses has 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 (USFWS 2008; MCAS Miramar 2011; MCAS Miramar 2013b). Plant competition may not be reducing growth of already established and mature willowy monardella clumps as increased growth of clumps between 2017 and 2020 was documented. Further, the lack of observations of seedlings in 2017 and 2020 census and monitoring surveys could in part be due to plant competition from nonnative grasses shading out seedlings; dense nonnative grasses are prevalent around many of the mature flowering clumps.

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). Undoubtedly scouring and erosion remove mature willowy monardella clumps as surveyors have documented clumps damaged by scouring as well as clumps entirely lost with only the associated plant tag relocated.

Precipitation since 2012 has been highly variable and included a period of below-average rainfall from 2012 through 2015, followed by exceptionally high rainfall in 2016 and 2017. Rainfall totals from 2018 through 2020 were also relatively high when compared to seasonal averages. During this time of highly variable precipitation, no new recruitment of willowy monardella was observed in the 2017 or 2020 surveys. Potentially seed production and

germination may not be precipitation dependent if neither extended droughts nor extended periods of high precipitation lead to seedling production. However, median growth rates were negative from 2012 to 2017 and positive from 2017 to 2020. Increased annual precipitation may be responsible for the increased growth of willow monardella clumps in monitoring plots.

Herbivory has been noted as a possible cause of willow monardella population decline (USFWS 2008). However, substantially less herbivory was noted during 2020 census and monitoring surveys; surveyors noted evidence of herbivory at 11 willow monardella clumps in 2020 and at 97 willow monardella clumps in 2017. Most herbivory occurred on a portion of the plants' stems, but some herbivory caused damage or removal of flower heads. Beetles were noted feeding on willow monardella flowers at several separate clumps. Browsing by rabbits may have also occurred, as rabbit scat was noted near some plants with recent herbivory damage. In the 2012 census, it was noted that 181 clumps had signs of herbivory, the clumps were usually top foraged with visible vegetative growth, and foraged 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. The 2017 census found damage to flower heads, with numerous stems and leaves browsed and flower heads left on the ground beneath clumps. But in 2020, besides noting beetles feeding on flowers at several willow monardella clumps, very little herbivory was noted overall. Although herbivory that damages flower heads has the ability to reduce seed production and consequently lead to a decline in plant recruitment, very little flower head herbivory has been noted overall in past surveys, yet plant recruitment is nearly nonexistent.

Plant pollinators observed on willow monardella flowers were primarily bumblebees and several species of butterflies. Even though surveyors recorded seeing plant pollinators on flowering willow monardella, there is little evidence that willow monardella is successfully reproducing at MCAS Miramar. Only three juveniles and one seedling were recorded during the 2017 surveys, and three juveniles and no seedlings were recorded during the 2020 surveys. Further, there has been a continuing decline in the number of clumps recorded Stationwide during the census. There is no evidence of substantial willow monardella recruitment at MCAS Miramar in the past eight years.

The definitive cause of the decline in willow monardella reproduction is unknown. Although no studies on the seed production relative to precipitation rates have been done on willow 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 willow 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 2020 and the comparison of willowy monardella monitoring among the 2012, 2017, and 2020 surveys 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. However, it appears that following a substantial drought, a return to normal or above-average rainfall increases the growth rate of adult willowy monardella plants but has no effect on willowy monardella recruitment.

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6.0 MANAGEMENT RECOMMENDATIONS

In the 2017 and 2020 surveys, we collected the length, width, and height for all willowy 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 willowy 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 willowy monardella during extended periods of drought. However, because scour and bank erosion during high stream-flow events following large storms are burying or displacing willowy monardella clumps, management of stream-channel hydrology could protect existing willowy 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 and 2020 census and monitoring, which noted substantial channel erosion and loss of willowy 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 willowy 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 willowy 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 willowy 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 and beetle herbivory of flower heads was noted in 2020, 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 willowy 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.

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 and 2020 monitoring demonstrated that nonnative grasses and herbs negatively impacted the growth rate of willowy monardella and increasing nonnative grass and herb cover is visible in nearly all of the monitoring plot photographs (Appendix A, especially noting increased grass cover in the time series photographs for Monitoring Plots I, N, P, Q, T and V). We therefore recommend that weed management be implemented for all willowy monardella clumps at MCAS Miramar. If further evidence of plant competition between nonnative grasses and willowy monardella is needed to support a Stationwide weed management program, a focused multiyear study could be conducted where randomly selected willowy monardella clumps were weeded (likely hand pulling of weeds would be required) and compared to control willowy monardella clumps where no weeding would be implemented to determine if true benefits would be realized from removal of nonnative grasses.

6.5 Soils and Substrate

The relationship between willowy monardella and soils is also important to understanding recruitment and plant distribution. Although no relationships between physical characteristics of monitoring plots and plant size were found in 2020, 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 (15.24 cm) 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.

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Appendix A. Monitoring Plot Photographs

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MONITORING PLOT A



Figure A-1. Photograph Taken on 8 July 2020



Figure A-2. Photograph Taken on 3 July 2017



Figure A-3. Photograph Taken on 15 July 2015



Figure A-4. Photograph Taken on 3 July 2012 (Tetra Tech 2013)

MONITORING PLOT C



Figure A-5. Photograph Taken on 14 July 2020



Figure A-6. Photograph Taken on 12 July 2017



Figure A-7. Photograph Taken on 16 July 2015



Figure A-8. Photograph Taken on 10 July 2012 (Tetra Tech 2013)

MONITORING PLOT G



Figure A-9. Photograph Taken on 14 July 2020



Figure A-10. Photograph Taken on 12 July 2017



Figure A-11. Photograph Taken on 16 July 2015



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

MONITORING PLOT H



Figure A-13. Photograph Taken on 9 July 2020



Figure A-14. Photograph Taken on 12 July 2017



Figure A-15. Photograph Taken on 15 July 2015



Figure A-16. Photograph Taken on 5 July 2012 (Tetra Tech 2013)

MONITORING PLOT I



Figure A-17. Photograph Taken on 7 July 2020



Figure A-18. Photograph Taken on 4 July 2017



Figure A-19. Photograph Taken on 17 July 2015



Figure A-20. Photograph Taken on 5 July 2012 (Tetra Tech 2013)

MONITORING PLOT J



Figure A-21. Photograph Taken on 7 July 2020



Figure A-22. Photograph Taken on 4 July 2017



Figure A-23. Photograph Taken on 17 July 2015



Figure A-24. Photograph Taken on 3 July 2012 (Tetra Tech 2013)

MONITORING PLOT L



Figure A-25. Photograph Taken on 14 July 2020



Figure A-26. Photograph Taken on 12 July 2017



Figure A-27. Photograph Taken on 16 July 2015



Figure A-28. Photograph Taken on 5 July 2012 (Tetra Tech 2013)

MONITORING PLOT N



Figure A-29. Photograph Taken on 1 July 2020



Figure A-30. Photograph Taken on 2 July 2017



Figure A-31. Photograph Taken on 15 July 2015



Figure A-32. Photograph Taken on 6 July 2012 (Tetra Tech 2013)

MONITORING PLOT O



Figure A-33. Photograph Taken on 1 July 2020



Figure A-34. Photograph Taken on 2 July 2017



Figure A-35. Photograph Taken on 15 July 2015



Figure A-36. Photograph Taken on 3 July 2012 (Tetra Tech 2013)

MONITORING PLOT P



Figure A-37. Photograph Taken on 6 July 2020



Figure A-38. Photograph Taken on 30 June 2017



Figure A-39. Photograph Taken on 14 July 2015



Figure A-40. Photograph Taken on 15 July 2012 (Tetra Tech 2013)

MONITORING PLOT Q



Figure A-41. Photograph Taken on 6 July 2020



Figure A-42. Photograph Taken on 1 July 2017



Figure A-43. Photograph Taken on 14 July 2015



Figure A-44. Photograph Taken on 12 July 2012 (Tetra Tech 2013)

MONITORING PLOT R



Figure A-45. Photograph Taken on 10 July 2020



Figure A-46. Photograph Taken on 5 July 2017



**Figure A-47. Monitoring Plot R – Aspect – Southeast (120 Degrees)
Photograph Taken on 17 July 2015**

MONITORING PLOT S



Figure A-48. Photograph Taken on 2 July 2020

No photograph of Monitoring Plot S was taken in 2017.



**Figure A-49. Monitoring Plot S – Aspect – South (200 Degrees)
Photograph Taken on 17 July 2015**

MONITORING PLOT T



Figure A-50. Photograph Taken on 2 July 2020



Figure A-51. Photograph Taken on 30 July 2017



**Figure A-52. Monitoring Plot T – Aspect – South (160 Degrees)
Photograph Taken on 17 July 2015**

MONITORING PLOT U



Figure A-53. Photograph Taken on 23 July 2020



Figure A-54. Photograph Taken on 18 July 2017



**Figure A-55. Monitoring Plot U – Aspect – South (175 Degrees)
Photograph Taken on 20 July 2015**

MONITORING PLOT V



Figure A-56. Photograph Taken on 13 July 2020



Figure A-57. Photograph Taken on 15 July 2017



**Figure A-58. Monitoring Plot V – Aspect – South (170 Degrees)
Photograph Taken on 20 July 2015**

MONITORING PLOT W



Figure A-59. Photograph Taken on 13 July 2020



Figure A-60. Photograph Taken on 14 July 2017



**Figure A-61. Monitoring Plot W – Aspect – South (170 Degrees)
Photograph Taken on 21 July 2015**

Appendix B. Monitoring Plot Data Sheets

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Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	A
Date	July 8, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	17
Photo Point ID	422B7D86
Photo Filename	11.jpg
Photo Aspect	W

Demographic Data			
Life Stage		Phenology	
Number of Clumps	5	Number of Vegetative Individuals	6
Number of Adults	5	Number of Budding Individuals	6
Number of Mature Individuals	0	Number of Flowering Individuals	4
Number of Juvenile Individuals	0	Number of Seeding Individuals	6
Number of Seedlings	0	Number of Fruiting Individuals	7
		Number of Dead/Dormant	

Disturbance Observations	
	Road and culvert bisect plot. Normal creek erosion, invasive weeds

General Observations
Bumblebees and tiger swallowtail butterflies visiting Monardella

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	C
Date	July 14, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	35
Photo Point ID	D1CF429B
Photo Filename	16.jpg
Photo Aspect	E

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	

Disturbance Observations	
	Invasive weeds

General Observations	
	Heavily invaded by nonnative grasses. Dense thatch in much of plot

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	G
Date	July 14, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	55
Photo Point ID	451A1B06
Photo Filename	17.jpg
Photo Aspect	E

Demographic Data			
Life Stage		Phenology	
Number of Clumps	2	Number of Vegetative Individuals	0
Number of Adults	1	Number of Budding Individuals	0
Number of Mature Individuals	1	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
Graded power line road through plot

General Observations
Heavy invasion by nonnative grasses, thatch build up

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	H
Date	July 9, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	35
Photo Point ID	9CB46512
Photo Filename	12.jpg
Photo Aspect	W

Demographic Data			
Life Stage		Phenology	
Number of Clumps	4	Number of Vegetative Individuals	0
Number of Adults	3	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	4
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 on west side of plot

General Observations
Most of plot is composed of loamy soils that are heavily invaded by invasive grasses and are unsuitable habitat for Monardella.

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	I
Date	July 7, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	34
Photo Point ID	FBFC71FA
Photo Filename	09.jpg
Photo Aspect	NE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	19	Number of Vegetative Individuals	0
Number of Adults	18	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	16
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	3

Disturbance Observations
Some normal erosion in drainage, invasive grasses

General Observations
Monardella in full flower, abundant bumble bees visiting them. Population appears generally healthy

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	J
Date	July 7, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	20
Photo Point ID	AD65D5E8
Photo Filename	10.jpg
Photo Aspect	S

Demographic Data			
Life Stage		Phenology	
Number of Clumps	9	Number of Vegetative Individuals	0
Number of Adults	9	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	0

Disturbance Observations	
	Normal streambed erosion, invasive weeds

General Observations
ant bumble bees seem to be exclusively visiting Monardella. Dusky winds and tiger swallowtails also observed visiting Monardella.

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	L
Date	July 14, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	22
Photo Point ID	F14C2E86
Photo Filename	18.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	

Disturbance Observations	
	Invasive weeds

General Observations	
	Heavy invasion by nonnative grasses, dense thatch build up

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	N
Date	July 1, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	20
Photo Point ID	FFA43468
Photo Filename	04.jpg
Photo Aspect	E

Demographic Data			
Life Stage		Phenology	
Number of Clumps	4	Number of Vegetative Individuals	3
Number of Adults	4	Number of Budding Individuals	6
Number of Mature Individuals	0	Number of Flowering Individuals	3
Number of Juvenile Individuals	0	Number of Seeding Individuals	6
Number of Seedlings	0	Number of Fruiting Individuals	6
		Number of Dead/Dormant	

Disturbance Observations	
Most of plot has very recently burned in a stand replacing fire. There is evidence of heavy water flows in the channels	

General Observations	
Area recently burned to mineral soil. Areas that did not burn have a heavy thatch of annual grasses. Bumble bees observed pollinating flowers.	

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	O
Date	July 1, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	30
Photo Point ID	6EABAB3F
Photo Filename	02.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	

Disturbance Observations
Recent severe fire

General Observations	
Entire plot recently burned. All shrubs and herbaceous cover burned except for a small island within the drainage	

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	P
Date	July 6, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	36
Photo Point ID	ED94DC95
Photo Filename	07.jpg
Photo Aspect	W

Demographic Data			
Life Stage		Phenology	
Number of Clumps	14	Number of Vegetative Individuals	0
Number of Adults	14	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	8
Number of Juvenile Individuals	0	Number of Seeding Individuals	0
Number of Seedlings	0	Number of Fruiting Individuals	0
		Number of Dead/Dormant	6

Disturbance Observations	

General Observations	
	Plot is heavily infested with weeds, <i>Hirschfeldia</i> , <i>Avena</i> , <i>Bromus</i> , <i>Brachypodium</i> , etc.

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	Q
Date	July 6, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	47
Photo Point ID	B7F07C9E
Photo Filename	08.jpg
Photo Aspect	SW

Demographic Data			
Life Stage		Phenology	
Number of Clumps	14	Number of Vegetative Individuals	0
Number of Adults	13	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	12
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	
Vehicle tracks in plot, appears as though a training exercise was conducted here. Damage to plants by vehicles	

General Observations	
	Most of plot falls well outside of suitable <i>Monardella</i> habitat. Heavily invaded by non-native grasses and <i>Hirschfeldia</i>

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	R
Date	July 10, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	38
Photo Point ID	AF02BAE7
Photo Filename	13.jpg
Photo Aspect	SE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	4	Number of Vegetative Individuals	0
Number of Adults	4	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	4
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	
	Bank has eroded the steep bank at the NW plot corner such that the stake was lost and cannot be safely replaced in its original

General Observations
tiger swallowtails visiting Monardella. The plot is placed so that the majority of it falls in adjacent upland chaparral that's is

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	S
Date	July 2, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	35
Photo Point ID	B6586864
Photo Filename	05.jpg
Photo Aspect	S

Demographic Data			
Life Stage		Phenology	
Number of Clumps	14	Number of Vegetative Individuals	0
Number of Adults	14	Number of Budding Individuals	0
Number of Mature Individuals	0	Number of Flowering Individuals	14
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	
	Streambed erosion at banks. Small walking trail through plot

General Observations	
	Abundant bumble bees visiting Monardella

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	T
Date	July 2, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	20
Photo Point ID	01410E7D
Photo Filename	06.jpg
Photo Aspect	S

Demographic Data			
Life Stage		Phenology	
Number of Clumps	7	Number of Vegetative Individuals	0
Number of Adults	6	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	7
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
Brachypodium and other invasive species

General Observations
Bumble bees on some monardella

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	U
Date	July 23, 2020
Surveyors	SL
Drainage Mapped	No
Depth of Drainage (centimeters)	0
Photo Point ID	BAD06791
Photo Filename	20.jpg
Photo Aspect	S

Demographic Data			
Life Stage		Phenology	
Number of Clumps	11	Number of Vegetative Individuals	0
Number of Adults	10	Number of Budding Individuals	0
Number of Mature Individuals	1	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	2

Disturbance Observations
Game trails heavily used in area, heavy thatch throughout all three species of Bromus

General Observations	
1	yes; no herbivory, sign of pocket gopher, wood rat, rabbit; area appears to no longer receive flooding from main drainage line

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	V
Date	July 13, 2020
Surveyors	EK
Drainage Mapped	No
Depth of Drainage (centimeters)	
Photo Point ID	682A02C6
Photo Filename	14.jpg
Photo Aspect	SE

Demographic Data			
Life Stage		Phenology	
Number of Clumps	20	Number of Vegetative Individuals	0
Number of Adults	19	Number of Budding Individuals	0
Number of Mature Individuals	1	Number of Flowering Individuals	19
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	
	Foot trail through plot

General Observations	
	Plot visited in morning, no pollinators observed

[illegible]

[illegible]

Long-Term Willowy Monardella Monitoring Data Sheet

General Information	
Plot	W
Date	July 13, 2020
Surveyors	EK
Drainage Mapped	Yes
Depth of Drainage (centimeters)	50
Photo Point ID	17202DFF
Photo Filename	15.jpg
Photo Aspect	N

Demographic Data			
Life Stage		Phenology	
Number of Clumps	9	Number of Vegetative Individuals	0
Number of Adults	6	Number of Budding Individuals	0
Number of Mature Individuals	3	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	

Disturbance Observations	
	Hiking and biking trails in plot

General Observations	
No pollinators observed. Many plants in main channel could not be relocated presumably due to flooding in main channel	

[illegible]

[illegible]