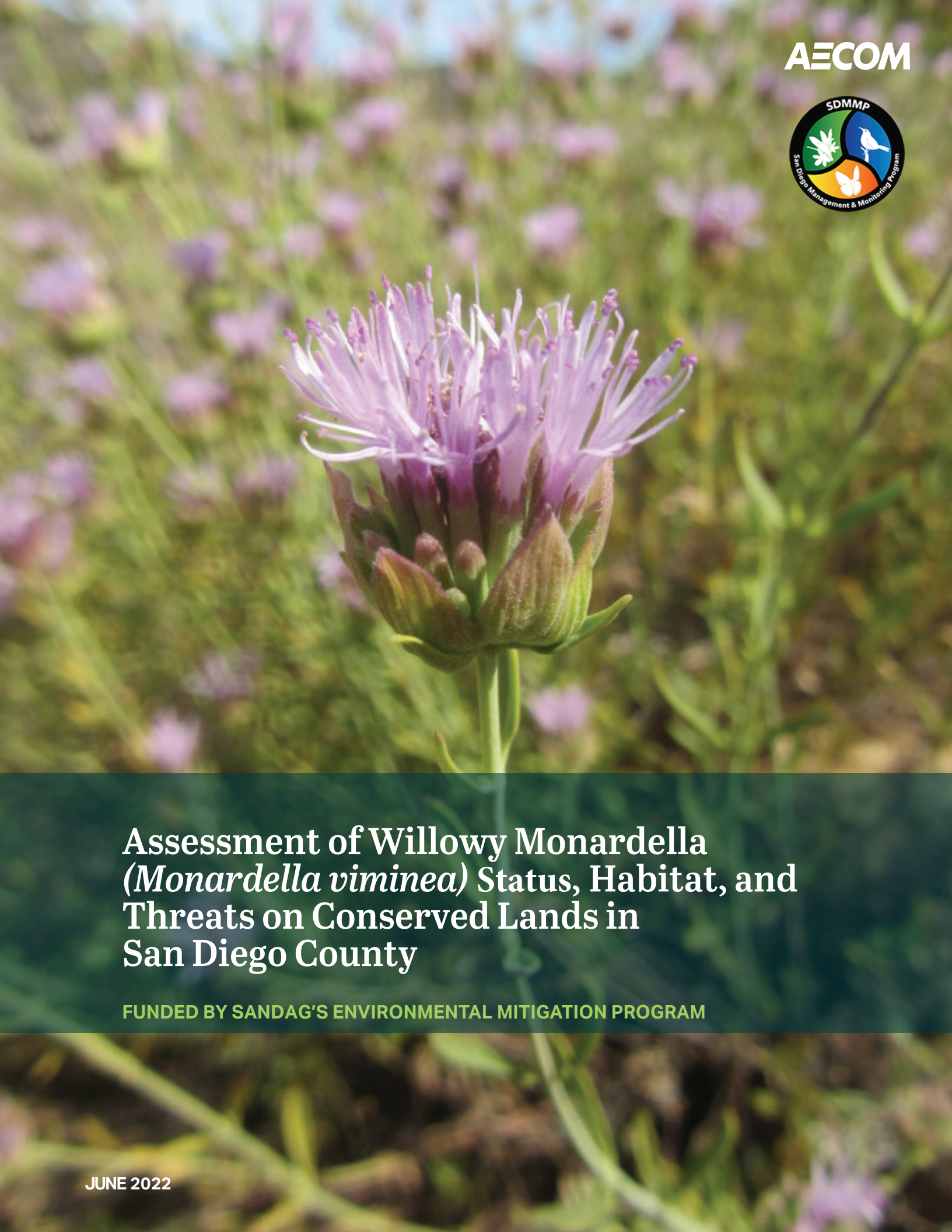

AECOM

SDMMP
San Diego Management & Monitoring Program

Assessment of Willowy Monardella *(Monardella viminea)* Status, Habitat, and Threats on Conserved Lands in San Diego County

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Prepared for:

San Diego Association of Governments (SANDAG) and
San Diego Management and Monitoring Program (SDMMP).

Prepared by:

AECOM
401 W A Street
Suite 1200
San Diego, CA 92101
aecom.com

Photograph credits:

Photographs on covers taken by Conservation Biology Institute (Jessie Vinje).

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1. Introduction

Willowy monardella (*Monardella viminea;* monardella) is a state and federally listed endangered species. It was first listed using its former botanical name *Monardella liniodes* ssp. *viminea* by the State of California in 1979 and by the federal government in 1998 under the auspices of the state and federal Endangered Species Acts, respectively. In 2012, the taxonomic identification of willowy monardella was changed, and the species listing was revised to reflect the new name. Since its listing, willowy monardella has continued to face pressures from urbanization within San Diego County, as well as ongoing drought.

The San Diego Management and Monitoring Program (SDMMP) was established in 2008 to facilitate and assist the San Diego Association of Governments (SANDAG), local jurisdictions, wildlife agencies, and other regional stakeholders and land managers in implementing conservation management and monitoring within San Diego County. SDMMP is responsible for updating and implementing the Management and Monitoring Strategic Plan (MSP Roadmap), and managing the collection, analysis, and archiving of data, and directing the prioritization of monitoring activities based on the needs of individual species and habitats (SDMMP 2022).

In March 2020 as part of the MSP Roadmap objectives, the Conservation Biology Institute and AECOM in collaboration with SDMMP, prepared a Framework Rare Plant Management Plan for Conserved Lands in Western San Diego County (FRPMP) for SANDAG. The FRPMP provides guidelines to manage MSP-rare plants on conserved lands in western San Diego County by determining key factors for management, recommending management strategies and priority actions, and identifying research needs. The March 2020 FRMP included species-specific chapters for four MSP rare plants; an update to the FRMP completed March 2021 added new species-specific chapters for three additional MSP rare plants, including willowy monardella.

1.1 Project Description

The FRPMP released in 2021 included a species-specific management plan for willowy monardella that recommended a framework for managing known populations and suggested the following information needs: 1) Identify sites where willowy monardella has been extirpated but would be suitable for reintroduction, 2) Identify locations that contain suitable habitat for willowy monardella to be introduced into, and 3) Develop hydrology models based on analysis of locations where monardella exists to identify which areas of suitable habitat have hydrology most conducive to the establishment and survival of willowy monardella.

The FRPMP recommendations include the field collection of data regarding the physical and biotic characteristics, hydrology, and levels of disturbance in existing populations of willowy monardella and ground-level assessment of other locations that may support the same characteristics as the known locations. This project addresses these recommendations.

The goal of these assessments is to identify potential receptor sites for establishment of new willowy monardella populations or locations of historical populations suitable for reintroduction of willowy monardella. The assessment also evaluated management needs within these suitable receptor locations as well as existing, occupied drainages. Receptor sites and management

actions were identified through the collection of data about the physical and biotic characteristics, hydrology, and levels of disturbance.

1.2 Project Location

Willowy monardella's present range is restricted to drainages within canyon systems of the following three main watersheds in San Diego County (SDNHM 2021):

- Peñasquitos watershed, which includes Mission Bay, La Jolla, most of Marine Corps Air Station (MCAS) Miramar, and Poway
- San Diego River watershed, which includes the San Diego River and its tributaries, the southwestern portion of MCAS Miramar, and extends as far east as Julian
- Pueblo watershed, which includes downtown San Diego, National City, and La Mesa

Known extant occurrences span from Lopez Canyon in the west to Sycamore Canyon in the east. Historically, there have also been populations in Balboa Park, Poway, and University City; however, these populations are presumed extirpated (Consortium California Herbaria 2020; SDNHM 2021; CDFW 2020; Conservation Biology Institute 2020). Approximately 70% of the known willowy monardella populations are located within MCAS Miramar (USFWS 2012) (Appendix A, Figure 1). For the purposes of this assessment, the project study area excluded the most eastern and most urban portions of the three main watersheds listed above.

Fifteen canyon systems located within conserved lands that currently support, are in proximity to, or have historically contained willowy monardella populations were included in the project study area. The majority of canyon systems (12) were within the Peñasquitos and San Diego River watersheds; only three canyon systems (34th Street, Switzer, and Florida) from the heavily urbanized Pueblo watershed were included (Appendix A, Figure 1). The majority of surveys were conducted in canyons with connectivity to MCAS Miramar occurrences, including Spring Canyon and Oak Canyon near Mission Trails Regional Park, upper Sycamore Canyon, and Clark Canyon, but also included some smaller systems with extant populations or occurrences (Appendix A, Figure 1). Conserved lands are defined under San Diego County's MSP Roadmap as lands that have been legally conserved to protect natural habitats, contribute to the existing or planned regional habitat preserve system, and are managed to protect open space or natural resources. Conservation may occur through public or private acquisitions, conservation easements, land dedications, mitigation, mitigation banks, covenants, or other mechanisms that prevent development of the land.

1.3 Natural History

Willowy monardella is an aromatic perennial subshrub in the mint family (*Lamiaceae*). It typically spreads by underground runners and grows in dense clumps or mat-like forms with stems less than 2 feet in height. The typical lifespan of a plant is not known; however, it is presumed to be long-lived. Although this species is a perennial, it does not produce vegetative growth or flowers every year and can remain dormant through dryer than normal seasons (City of San Diego 2012). Willowy monardella blooms between May and August, after the majority of the rainfall occurs but before the soil has completely dried out. It has white-to pink-lavender flowers that occur in terminal clusters and produce up to four seeds. Willowy monardella reproduces both by seed and asexually via vegetative shoots.

Willowy monardella is endemic to San Diego County near the coast, where its habitat is restricted to ephemeral drainages composed of rocky, coarse, and sandy alluvium where it may be found growing within drainages, or on raised alluvial terraces (MCAS Miramar 2015). It has strong correlations with drainages composed of Stony Land and Riverwash soil series in the drainage channel and Redding and Visalia soil series in the terraces (MCAS Miramar 2015).

The structure of the drainage channels is important for willowy monardella. Most occurrences are found in areas with wide, well-developed, mainly unvegetated channels, with active overflow forming braiding (MCAS Miramar 2011). Occupied channels are typically ephemeral in nature, remaining wet for 24 to 48 hours following a rain event (Elvin and Sanders 2003). Soils within occupied drainages are generally sandy wash materials composed of cobbles and gravel, with other coarse alluvium mixed in. Occupied drainages also tend to have wide alluvial benches that are characterized by higher clay content, and less cobble and gravel. The alluvial benches form a floodplain for the main channel(s) and are extremely important habitat for willowy monardella. Studies on MCAS Miramar show approximately 65% of the monitored plants occurred on the alluvial benches, compared to only 34% that were growing within the channel bottom (15%) or on the bank of the drainage channel (19%) (MCAS Miramar 2015).

Vegetation within occupied habitat is typically open coastal sage scrub or riparian scrub habitats with little understory cover (USFWS 2008). Broom baccharis (*Baccharis sarothroides*) and coastal California buckwheat (*Eriogonum fasciculatum*) are the most common species associated with monardella, though there is no evidence to suggest a beneficial relationship between those species (MCAS Miramar 2015). It is likely, rather, that all three species are adapted to withstand scouring events after heavy rainfall.

1.3.1 Risks to Species/Threats

The primary risk to willowy monardella is increasing urbanization and development around its suitable habitat and associated changes in hydrology. Although the canyon bottoms that it inhabits are not being directly developed, the increased dry season runoff due to urbanization of the surrounding mesas has led to the extirpation of several populations when the formerly ephemeral drainages began to be permanently wet and converted to riparian forest. Rose Canyon (Marian Bear Park) is a prime example of loss of habitat due to urban runoff. In 1981, the canyon contained over 100 individuals between Regents Road and Interstate 805. That number dwindled throughout the 1980s and by 2005, after the completion of the Highway 52 extension, a survey determined that no suitable habitat remained due to increased competition from willow species (CDFW 2021). Urban runoff also impacts willowy monardella habitat even when urbanization is not directly adjacent to a population. During heavy rain events, increases in impervious surfaces in upstream development result in increased flow levels and erosion of the channels and alluvial benches, and the uprooting or silting of vegetation that grows in the drainages and channel bottoms. Urbanization has led to an increased frequency of strong flood events (where water flow is fast enough to cause significant erosion) within the watersheds where willowy monardella is found, with an estimated 350 to 700% increase in the number of events between 1998 and 2006, even when no increase in rainfall was present (White and Greer 2006).

Additional risks are posed by climate change, which is associated with the increase in a variety of stressors. Drought is expected to continue to worsen as temperatures rise and reliability of normal precipitation is reduced, leading to lower recruitment and increased mortality. Current climate models also suggest that the precipitation patterns in Southern California during drought years will be characterized by an increase in extreme rain events where extreme dry weather is

punctuated by a few wet weather systems that provide most of the annual rainfall, rather than rainfall occurring in evenly spaced but low precipitation events (Swain et al. 2018). This poses several risks to monardella occurrences. First, in combination with increased urbanization as discussed above, there is the likelihood of increased frequency of extreme flooding events, which may lead to increased mortality of existing plants through silting in or uprooting and may also prevent the establishment of new individuals through mortality and the removal of existing seed bank. Second, extended drought conditions have prolonged the dry season in recent years, overlapping with Santa Ana winds and leading to increased fire risk (USFWS 2012; Goss et al. 2020). Although willowy monardella is able to resprout after fires, the loss of upland and valley vegetation caused by fire can lead to higher velocity flow within the channels, eroding streambed banks, and washing away of established plants, which may or may not be able to reestablish downstream (MCAS Miramar 2015). In addition, wildfires often lead to the invasion of wildlands by nonnative grasses and forbs. Nonnative grasses and forbs are quick germinators and can quickly outcompete willowy monardella seedlings and young plants. Lastly, drought may result in changes in water regimes necessary to sustain existing populations, resulting in reduced health, or death of mature plants. Similarly, establishment of new seedlings may be reduced due to lack of water during the growing season.

1.4 Existing Data and Past Studies

The majority of studies pertaining to the population status, life history, and effects of different management strategies have been performed within MCAS Miramar, which as previously noted contains 70% of the existing willowy monardella population (MCAS Miramar 2015; USFWS, 2012).

Willowy monardella surveys have been conducted on the installation since 2002, shortly after the species was originally listed. A complete census of all plants on the installation has taken place four times to-date (2002, 2009, 2012, 2017), with the establishment and monitoring of plots conducted an additional five times in between (2003, 2004, 2005, 2006, 2015). In 2013, a final standard monitoring protocol and plan was implemented and has been used in all subsequent censuses conducted on the installation (MCAS Miramar 2013).

In addition to the population monitoring, MCAS Miramar conducted a 3-year study on the impacts of habitat enhancement that concluded in 2011. Habitat enhancements included the removal of competing nonnatives through herbicide application, herbicide application combined with the removal of grass thatch, and placement of rock cobble around monardella plants as a sort of rock mulch (MCAS Miramar 2015). The results of the habitat enhancement study concluded that there was an inverse relationship between nonnative plant cover and the presence of willowy monardella, and that lower native shrub cover were associated with higher vigor in willowy monardella. The study further suggested that, while there is a clear preference of willowy monardella for early successional habitats indicative of frequently scoured streambeds, erosion associated with extreme flooding events was one of the primary causes of mortality (MCAS Miramar 2011).

Prior to 2014, the monitoring of willowy monardella outside of MCAS Miramar was undertaken independently by each land management entity (City of San Diego, San Diego County, etc.), and the methodology was inconsistent and not well coordinated (CBI, AECOM, and SDMMP 2020). In 2014 SDMMP and its land management partners developed a regional rare plant monitoring program. They developed and tested the Inspect and Manage (IMG) rare plant monitoring protocol for the MSP roadmap, using as the basis the City of San Diego's monitoring

protocol. The IMG monitoring protocol standardized the data collection, format, and protocols for willowy monardella and 29 other rare plant species and created a central database of IMG data administered by SDMMP.

Future studies of willowy monardella and management initiatives are intended to be driven by SDMMP's FRPMP and the results of IMG monitoring for all populations located outside of MCAS Miramar.

2. Survey Methods

AECOM conducted willowy monardella habitat assessments, discovery surveys, and IMG surveys for two occurrences during 2021. The goals of the surveys were to identify high-quality habitat where willowy monardella could be introduced or reintroduced and help prioritize occupied habitat for management, and to confirm the status of historical occurrences and search for previously unknown occurrences within San Diego's conserved lands.

2.1 Determining Project Survey Areas

Canyon systems included in the project were selected within conserved lands based on the location and presence of extant and historical subpopulations. MCAS Miramar, where the majority of known willowy monardella habitat and individuals occur, is owned and managed by the Department of Defense and is outside of the purview of the SDMMP regional monitoring and management program that focuses on conserved lands. Therefore, all MCAS Miramar lands were excluded from the study and the canyon systems included in this study represent the outermost extents of the willowy monardella range.

As a preliminary step the canyon systems within the larger project area were assessed and ranked as either high, moderate, or low priority areas to receive species surveys. The preliminary assessment was based on a desktop analysis of extant and historical records of monardella. Criteria used for assigning priority levels to survey areas are presented below:

High priority canyon systems: These included canyon systems where extant subpopulations of willowy monardella are currently monitored or where monitoring plots have been established. High priority canyon systems also included canyons that are adjacent to and share channels farther downstream with known subpopulations. All high priority survey areas determined at the planning stage occur upstream or downstream of MCAS Miramar local watershed occurrences. The surveys within these canyon systems were scheduled to occur at the peak blooming season and were prioritized for completion.

Moderate priority canyon systems: These included canyon systems where historical willowy monardella occurrences have been recorded but did not have recently verified mapping (based on California Natural Diversity Database [CNDDB] records). Moderate priority canyon systems identified through these criteria were expanded to include adjacent canyons. Moderate priority canyon systems were subject to elimination if more time or resources were needed to complete surveys of high priority systems; however, that did not become necessary, and all moderate priority canyon systems were surveyed.

Low priority canyon systems: These included canyons in proximity of extant populations but not located within the same local watershed or lacking connectivity to known extant populations (i.e., were not connected either upstream or downstream to an occupied canyon system). Low priority canyon systems were ultimately eliminated from the final surveys.

The final survey priorities are detailed in Table 1.

Once the survey priority was assigned to a canyon system, a single polygon was drawn around the canyon and its accessory drainages based on aerial imagery. The large polygon was then sectioned into smaller polygons so that each represented a single, nonbranching drainage (Table 1). These smaller polygons ("survey areas") were then assigned unique identifiers. A total of 219 discrete survey areas were mapped prior to initiating field survey efforts. The final survey areas for the 2021 blooming season are shown in Appendix A, Figure 2. Five of the 219 survey areas were located on privately owned land proposed or considered for conservation. Habitat quality assessments for these five areas are included herein but are not reflected spatially on figures to preserve privacy.

Table 1. Canyon Systems and Survey Priority

Canyon System	Priority	Number of Survey Areas
34th Street	High	12
Beeler	High	32
Carroll	High	1
Elanus	High	1
Flannery	High	1
Los Peñasquitos (Lopez)	High	15
Marian Bear	High	11
Spring Canyon	High	12
Switzer	High	1
Upper San Clemente	High	12
Upper Sycamore/Upper West Sycamore/Clark	High	95
Del Mar Mesa	Medium	1
Florida	Medium	2
Oak Canyon	Medium	8
Slaughterhouse	Medium	15
Iron Mountain	Low	–
South Poway	Low	–
Total Survey Polygons:		**219**

2.2 Data Form Development

A form was developed to collect data on suitable habitat based on factors that were identified as potentially significant willowy monardella habitat quality indicators during previous studies of the species and the known life history and biology. Information from MCAS Miramar studies provided much of the guidance for abiotic and biotic conditions that may be significant indicators of suitable willowy monardella habitat.

The data forms focused primarily on five different attributes, discussed in greater detail below in Section 2.3.1. An example of the data form is provided in Appendix B.

2.3 Field Survey Methods

Surveys took place within each of the survey areas identified as High or Moderate in Table 1. Survey data were collected using Esri Survey123 mobile data collection application. Field surveys were conducted during the 2021 blooming season for willowy monardella (May through July) to maximize the visibility of individuals in the field. Surveys were conducted by two AECOM biologists who visited each of the High and Moderate priority survey areas and determined whether potential habitat existed by walking two meandering transects (one going upstream, and one going downstream) through the survey area. If no potential habitat was present, a form detailing the name of the survey area and the rationale for the determination was entered using and electronic data form on Survey123 (see Section 2.3.1 for more information). If potential habitat was found within the survey area, it was mapped using a line feature on ArcCollector, and a habitat suitability assessment was performed on Survey123 (see section 2.3.1). Willowy monardella was mapped using a submeter Global Positioning System when found during field surveys. Known populations with IMG plots were mapped as part of the 2021 IMG surveys according to the IMG protocol.

2.3.1 Habitat Suitability Assessments

The presence of potential willowy monardella habitat for each survey area was determined in the field based on observations and mapped historic occurrences. A survey area was considered to have potential habitat if it had a defined channel with a cobble-gravel substrate greater than 1 meter (m) in width with open or low growing vegetation, and the presence of alluvial benches. A survey area was not considered to have potential habitat if it lacked a defined channel with cobble-gravel substrate or alluvial benches that were less than 1 m in width or were densely vegetated (closed canopy with few or no openings) with woody vegetation. However, all survey areas with known extant occurrences were considered to have potential habitat regardless of channel, bench, and vegetation characteristics.

A habitat quality assessment was not performed in survey areas where no potential habitat was identified.

If a survey area was determined to contain potential habitat, then information was collected on the following five metrics relevant to habitat quality for willowy monardella; 1) vegetation communities, 2) landform/terrain characteristics, 3) hydrology, 4) soils and substrates, and 5) an assessment of potential threats.

One habitat quality assessment was completed for each survey area with potential habitat. The habitat quality assessment was only completed for those portions of the survey area that contained potential habitat. If the potential habitat was not contiguous within the survey area (i.e., more than one section of suitable habitat existed) then the collected data represents the average of the metrics from each patch of potential habitat within that survey area. Therefore, the area of potential habitat represented by each form was variable and ranged from 172 to over 6,000 linear feet. The five metrics assessed are discussed in more detail below.

2.3.1.1 Vegetation Communities

Within each survey area, the vegetation composition of the channel and the alluvial benches was assessed. The cover of natives, nonnatives and “other” cover (thatch, litter, cryptogametic crust, etc.) was estimated visually, and a list of dominant species (species with greater than

20% relative cover) was made. Separate assessments were conducted for the channel and alluvial benches.

2.3.1.2 Landform/Terrain Characteristics

Channel characteristics, including the drainage type (primary, secondary, etc.), the estimated average width of the channel, and the estimated average and maximum depths of the channel from Ordinary High Water Mark (OHWM) were collected in each suitable drainage.

Average alluvial bench width and the percentage of channel with alluvial benches present were recorded, where each side of the channel counted for 50% of the possible 100%.

2.3.1.3 Hydrology

Hydrology observations were based on metrics used in the California Rapid Assessment Method (CRAM) for episodic riverine systems (CMWM 2020) to assess the hydrology of ephemeral drainages for indicators of altered sediment transport.

Surveyors completed a checklist for indicators of natural processes (i.e., a stable system) and a checklist for indicators of altered sediment transport. Based on the checklists, the habitat could be classified by characteristics of channel stability and altered sediment transport.

2.3.1.4 Soils and Substrate

Within each survey area, the percent of boulder, cobble, gravel, sand, and fines that composed the visible surface of the ground was estimated visually for the channel and the alluvial benches.

2.3.1.5 Assessment of Potential Threats

Potential threats to willowy monardella were assessed in each survey area using a similar method and threat scoring system as the threat assessment portion of the IMG monitoring protocol. Habitat threat scores were collected for a total of 23 different threat categories. Each threat was assessed for its priority level between 1 and 7 based on how prevalent the threat was within the survey area and the surrounding area (Figure 1). Threat categories with a lower value represented lower risk threats to willowy monardella, while higher values represented increased risks.

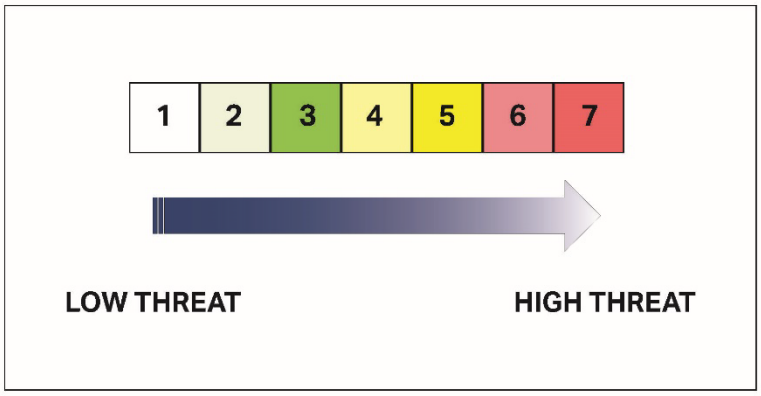

Figure 1. Classification of Threat Scores

2.3.2 Discovery Surveys

As habitat surveys were conducted, the surveyors searched for previously unknown populations of willowy monardella, and for the presence of this species at locations with historic populations reported in the CNDDB that did not have recently verified mapping.

Surveys were conducted by performing meandering transects along the channel and alluvial benches of all suitable drainages. If historic or unverified populations were present on the CNDDB maps, then the biologists performed a spiraling transect starting at the center of the mapped point or polygon and ending once the edges of the suitable habitat were reached.

2.3.2.1 IMG Surveys

Known populations of willowy monardella were mapped during 2021 as part of SDMMP's IMG monitoring. The IMG monitoring was performed by AECOM, the City of San Diego, and the County of San Diego.

As part of the IMG surveys, all willowy monardella plants present in the known extent were mapped, and the number of clumps were counted. See the official SDMMP IMG monitoring protocol for more detailed information on methods used (SDMMP 2021).

3. Results

3.1 Survey Dates/Conditions

Surveys were conducted over the course of 23 days between June 2 and August 4, 2021. Survey personnel and dates for each of the 219 survey areas are provided in Appendix C.

3.2 Survey Areas without Potential Habitat

Of the 219 survey areas, 43 were determined to contain suitable habitat. The remaining 176 survey areas were determined to not contain suitable habitat. Absence of suitable habitat was

based on the lack of suitable substrate, a wide (>1m) open channel, or alluvial benches (see Section 2.3.1 above). A map series showing the extent of suitable habitat based on surveys is provided in Appendix A, Figure 3. The areas containing unsuitable habitat did not receive discovery surveys and were not field evaluated any further for habitat characteristics.

3.3 Unoccupied Habitat

Of the 43 survey areas with suitable habitat, 34 did not have any willowy monardella present (unoccupied habitat).

The channels in unoccupied habitat had an estimated average width of approximately 1.8m, and an average depth from OHWM of 39.0 centimeters (cm). Substrate composition within the channels was characterized by high gravel and cobble content, with some sand and boulders, and very little fines (Table 2).

Table 2. Channel Characteristics in Unoccupied Habitat

Channel Characteristic		Average value
Average depth at OHWM (cm)		39.0
Max depth (cm)		93.9
Average channel width (m)		1.8
Substrate composition (%)	Boulder	4.9
	Cobble	47.0
	Gravel	40.0
	Sand	7.5
	Fines	0.6

The alluvial benches in unoccupied habitat had an average width of 7 m and were present along 64% the channel. The substrate composition of the alluvial benches was primarily sand and fines over gravel and cobble (Table 3).

Table 3. Alluvial Bench Characteristics in Unoccupied Habitat

Bench Characteristic		Average Value
Average width of alluvial bench (m)		7.0
Average percent of channel with alluvial benches (%)		64.6
Average ratio of channel to bench		1:1
Avg. Substrate composition (%)	Boulder	1.2
	Cobble	15.3
	Gravel	21.0
	Sand	35.6
	Fines	25.1

The channels in unoccupied habitat had an average estimated total cover of 14.9%, with an average native cover of 8.7%, nonnative cover of 6.1%, and 0.1% "other" cover (Table 4). The most common dominant species were coastal buckwheat, compact brome (*Bromus madritensis*), wild oat (*Avena* spp.), broom baccharis, and purple false brome (*Brachypodium distachyon*).

The alluvial benches in unoccupied habitat had an average estimated total cover 67.5%, with an average native cover of 30.1%, an average nonnative cover of 34.1%, and 3.3% "other" cover (Table 4). The most common dominant species were coastal buckwheat, wild oat, and ripgut brome (*Bromus diandrus*).

Table 4. Average Vegetation Cover in Unoccupied Habitat

Cover Type	Channel	Alluvial Bench
Cover Native (%)	8.7	30.1
Cover Nonnative (%)	6.1	34.1
Cover "other"(%)	0.1*	3.3**
Total	**14.9**	**67.5**

*Thatch only. Results from Marian Bear A were excluded from the analysis, as they were highly atypical (79% cover of standing water in the channel).
**Thatch, floodborne woody debris and dead shrubs.

Unoccupied drainages were generally hydrologically stable, with most having at least three indicators of natural hydrological processes and one or fewer indicators of altered sediment transport (based on criteria referenced in Section 2.3.1.3). The most common indicators of stability were a well-defined channel, distinct soil texture and grain sizes between different parts of the channel, and embedded woody debris consistent with the adjacent area. The most common indicators of altered sediment processes were steep or undercut banks and channels with a homogenous grain size (Table 5).

Photographs showing representative images of suitable habitat are provided in Appendix D.

3.4 Occupied Habitat

The remaining nine suitable drainages surveyed were determined to be occupied habitat (Appendix A, Figure 3).

Channels in occupied habitat had an estimated average width of approximately 3.8 m. Lopez Canyon was excluded from the average width calculation as its width was an extreme outlier that artificially inflated the average channel width to 10.8 m due to the small number of occupied channels. The channels had an average depth from OHWM of 59 cm. Substrate composition within the channels was characterized by very coarse material (boulders, cobble, and gravel) with small amounts of sand and fines (Table 6).

Table 5. Summary of Channel Stability Indicators in Unoccupied Habitat.

Criteria	Number of Drainages
Indicators of channel stability/equilibrium	
Distinct soil texture and grain size differences between different parts of the drainage	25
Channels contain embedded woody debris of the size and amount consistent with the adjacent area	23
Channel bars consist of well-sorted bed material	8
Channel is well defined	33
Channel has braided compound channels	12
There is a high density of channels	–
Number of indicators of channel stability recorded in drainages	
One indicator	2
Two indicators	8
Three indicators	13
Four or more indicators	11
Indicators of altered sediment processes	
Channel is characterized by steep or undercut banks	12
An obvious historical floodplain has been abandoned	2
The channel is scoured to bedrock or dense clay in places	3
Soil texture and grain size differences between the low flow channel and floodplain are not evident or distinct	9
The channel is ill defined	1
Several previously distinct channels have coalesced	–
Channel bed and bars (if present) are not well sorted but rather a homogenized mix of grain sizes	6
Number of indicators of altered sediment processes recorded in drainage	
No indicators	12
One indicator	10
Two indicators	11
Three indicators	1
Four or more indicators	–

Table 6. Channel Characteristics in Occupied Habitat

Channel Characteristic		Average value
Average depth at OHWM (cm)		59
Max depth (cm)		99.4
Average channel width (m)		3.8
Substrate composition (%)	Boulder	5.9
	Cobble	46.3
	Gravel	42.9
	Sand	5.0
	Fines	0.3

Alluvial benches in occupied habitat had an average width of 14.4 m and were present along 80% the channels. The substrate composition of the alluvial benches was an even mix of cobbles, gravel, sand, and fines, with sand being slightly more prevalent (Table 7).

Table 7. Alluvial Bench Characteristics in Occupied Habitat

Bench Characteristic		Average Value
Average width of alluvial bench (m)		14.4
Average percent of channel with alluvial benches (%)		80.0
Average ratio of channel to bench		4:5
Avg. Substrate composition (%)	Boulder	0.5
	Cobble	23.4
	Gravel	20.6
	Sand	32.1
	Fines	20.1

Channels in occupied habitat had an average estimated total cover of 5.9% with an average native cover of 3.1%, nonnative cover of 2.7%, and 0.1% “other” cover (Table 8). The most common dominant species were willowy monardella, compact brome, wild oat, and smooth cat’s ear (*Hypochaeris glabra*).

Alluvial benches in occupied habitat had an average estimated total cover 81.6%, with an average native cover of 38.8%, an average nonnative cover of 39.3%, and 3.5% “other” cover, which was entirely composed of thatch (Table 8). The most common dominant species were coastal buckwheat and white sage (*Salvia apiana*).

Table 8. Average Vegetation Cover in Occupied Habitat

Cover Type	Channel	Alluvial Bench
Cover Native (%)	3.1	38.8
Cover Nonnative (%)	2.7	39.3
Cover “other”(%)	0.1*	3.5**
Total	**5.9**	**81.6**

*Plant litter
**Thatch

Occupied drainages were generally hydrologically stable, with most having at least three indicators of natural hydrological processes and one or fewer indicators of altered sediment transport. Like unoccupied habitat, the most common indicators of stability were well-defined channels and distinct soil texture and grain size between different parts of the drainage, and the presence of channel bars with well-sorted soil. The most common indicator of altered sediment processes was steep or undercut channel banks (Table 9).

Table 9. Summary of Channel Stability Indicators in Occupied Habitat

Criteria	Number of Drainages
Indicators of channel stability/equilibrium	
Distinct soil texture and grain size differences between different parts of the drainage	7
Channels contain embedded woody debris of the size and amount consistent with the adjacent area	4
Channel bars consist of well-sorted bed material	6
Channel is well defined	8
Channel has braided compound channels	3
There is a high density of channels	3
Number of indicators of channel stability recorded in drainages	
Two indicators	1
Three indicators	–
Four indicators	4
Five Indicators	1
Six indicators	3
Indicators of altered sediment processes	
Channel is characterized by steep or undercut banks	3
An obvious historical floodplain has been abandoned	–
The channel is scoured to bedrock or dense clay in places	–
Soil texture and grain size differences between the low flow channel and floodplain are not evident or distinct	–
The channel is ill defined	–
Several previously distinct channels have coalesced	–
Channel bed and bars (if present) are not well sorted but rather a homogenized mix of grain sizes.	1
Number of indicators of altered sediment processes recorded in drainage	
No indicators	4
One indicator	4
Two indicators	–
Three indicators	–
Four or more indicators	–

Photographs showing representative images of occupied habitat are provided in Appendix D.

3.4.1 IMG Monitoring and Subpopulation Mapping

IMG monitoring was conducted at all SDMMP willowy monardella monitoring plots during the 2021 growing season. The surveys were carried out by the City of San Diego, Environmental Science Associates and Helix (on behalf of the County of San Diego), and AECOM. AECOM performed IMG surveys at three monitoring plots: MSP occurrences MOLIV_4SYCA006_3 (Clark Canyon A, lower survey area), MOLIV_4SPCA008_1 (adjacent to Spring Canyon 3A and Spring Canyon 2A), and MOLIV_4WSYCA003_1 (Upper West Sycamore Canyon 1-A) (SDMMP 2021). AECOM mapped new plants in Clark Canyon A and Upper Sycamore Canyon 5A; however, they were determined to be part of the MOLIV_4SYCA006 maximum extent, and not a new subpopulation. The new plants occurred near or within CNDDB polygons, but they had not been previously mapped as part of IMG surveys. No new occurrences were found during the AECOM IMG surveys (Appendix A, Figure 3).

3.5 Habitat Threat Scoring

Of the 23 threat categories for which field data were collected, five parameters were selected for additional analysis based on the literature review and observed severity. These threats to willowy monardella habitat were fossorial mammal species activity, nonnative forbs, nonnative grasses, altered hydrology and urban runoff. The extent of each threat was assessed in each survey area and assigned a corresponding threat level. A summary of these threat scores for each survey area is presented in Table 10. An average threat score was then applied to each survey area (Table 10).

Table 10. Threats to Habitat and Threat Level

Survey Area	Threats*						Average Threat Rating
	Fossorial Mammal Species Activity	Non-Native Forbs	Non-Native Grasses	Altered Hydrology	Urban Runoff	Average Threat Score	
34thStCynA	3	5	3	7	7	25	5.0
34thStCynL	3	3	3	7	7	23	4.6
BeelerCyn1A	5	6	7	1	1	20	4.0
BeelerCyn1C	4	6	7	1	1	19	3.8
BeelerCyn1I	7	3	6	1	5	22	4.4
BeelerCyn1U	7	7	7	7	7	35	7.0
ElanusCynA	5	7	7	7	7	32	6.4
FloridaCyn2A	4	3	4	1	3	15	3.0
LopezCynA	3	3	4	7	1	18	3.6
LopezCynM	2	3	3	7	3	18	3.6
MarianBearA	1	3	4	7	7	22	4.4
OakCyn1A	3	3	5	1	1	13	2.6
OakCyn2A	3	3	4	1	1	12	2.4
SpringCyn1A	3	3	5	1	1	13	2.6
SpringCyn3A	5	4	7	0	0	16	3.2
SpringCyn2A	3	3	5	1	1	13	2.6
SpringCyn5A	4	1	5	1	1	12	2.4
UpperClarkCynA1	5	4	7	1	1	18	3.6
PrivateA2	2	1	4	1	1	9	1.8
UpperClarkCynAE	5	7	7	1	1	21	4.2
UpperClarkCynAH	4	6	7	1	1	19	3.8
UpperClarkCynAL	3	1	7	1	1	13	2.6
UpperClarkCynAR	3	1	7	1	1	13	2.6
PrivateB	7	5	7	1	1	19	3.8
UpperClarkCynBA	1	3	7	1	1	13	2.6
PrivateO	5	3	7	0	0	15	3.0
PrivateQ	6	5	7	0	0	18	3.6
PrivateZ	3	3	7	0	0	13	2.6
UpperSycCyn1A	4	7	7	1	1	20	4.0
UpperSycCyn2A	5	6	7	1	1	20	4.0
UpperSycCyn3B	5	6	7	1	1	20	4.0
UpperSycCyn4A	5	6	7	1	1	14	2.8
UpperSycCyn4AC	3	5	5	1	1	15	3.0
UpperSycCyn4B	6	3	7	1	1	18	3.6

Survey Area	Threats*						Average Threat Rating
	Fossorial Mammal Species Activity	Non-Native Forbs	Non-Native Grasses	Altered Hydrology	Urban Runoff	Average Threat Score	
UpperSycCyn4I	7	3	7	1	1	19	3.8
UpperSycCyn4U	7	3	7	1	1	13	2.6
UpperSycCyn4X	3	1	7	1	1	13	2.6
UpperSycCyn4Z	3	3	5	1	1	12	2.4
UpperSycCyn5A	6	7	7	1	1	22	4.4
UpperWSycCyn1A	4	5	7	1	1	18	3.6
UpperWSycCyn1F	1	1	3	1	1	7	1.4
UpperWSycCyn2A	5	3	6	3	3	20	4.0
UpperWSycCyn3A	5	4	6	7	4	26	5.2

***** Threat Levels (numbers represent percent (%) of maximum extent disturbed by threat): **1** = 0% in maximum extent or adjacent 10 m buffer; **2** = 0% in maximum extent but threat detected in surrounding 10 m buffer; **3** = >0-<10% of maximum extent; **4** = 10-<25% of maximum extent; **5** = 25-<50% of maximum extent; **6** = 50-<75% of maximum extent; **7** = ≥75% of maximum extent

4. Analysis Methods

The goal of data analysis for this project was to determine which factors appear to have the strongest correlation with high quality willowy monardella habitat and create a quantitative method for identifying which of the survey areas had the highest quality habitat for willowy monardella. This information will help to identify potential areas for introduction of willowy monardella, identify extant occurrences that are at high risk, and identify mitigation and management strategies.

4.1 Identifying Factors for Occupied Habitat

After the completion of surveys, the habitat assessment data were analyzed to determine which habitat components appeared to be associated with occupied versus unoccupied habitat, and thus provide a useful tool for determining which of the unoccupied drainages contain the highest quality potential habitat for restoration or reintroduction. All data collected were initially sorted based on whether habitat was occupied or unoccupied. Within the occupied habitat areas, correlation of habitat components with occupancy was determined by reviewing collected data for each habitat component and sorting it by value (for numerical data) or into categories (for nonnumerical data such as plant species or channel stability). Habitat components where the majority of occupied habitat fell into a narrow set of values or fell within one or two closely related categories were identified as being more often associated with occupied habitat. Conversely, habitat components where occupied habitat was randomly dispersed in the data or categories were determined to not be associated with occupancy.

Habitat components that were most frequently associated with occupied habitat were then further analyzed to determine how strong the association was. A strongly associated habitat component was considered one where few unoccupied drainages fell within the same range of values or categories as the occupied drainages. Habitat components strongly associated with occupancy were also identified as those where the range of values for the majority of occupied drainages was narrow, compared to the range of all drainages as a whole. Habitat components were considered weakly associated if many unoccupied drainages fell within the same range of values or categories as the occupied drainages, or if the range of values of all the drainages fell within a relatively narrow range.

4.1.1 Scoring Matrix

After the correlation and strength of correlation of the habitat components were determined, a scoring matrix was created to provide a raw score that could be used to rank the suitable drainages by their ability to support willowy monardella.

For each habitat component, three to four value ranges were created, depending on the amount of variation present for all data. These ranges generally corresponded to data that broke down into “high,” “moderate,” “low,” or “very low” habitat quality. Categories that encompassed the values seen in the majority of occupied habitat were always considered to be the highest quality habitat category, while categories that encompassed any outlying occupied drainage values were considered moderate or low.

After the categories were established, a numeric score was assigned to the high quality habitat category for each habitat component. The scores were designed to weight each habitat component based on how strongly it was associated with occupied habitat, with highest scores given to strongly associated with habitat components and lower scores given to weakly associated habitat components. The moderate and low categories for each habitat component were then assigned a descending weighted value within each category. The final habitat scoring matrix is provided in Table 11.

Each drainage was then scored based on its categories within each habitat component, and a final raw score was calculated.

IMG data collected before 2021 were used as quality control for the scoring matrix. IMG monitoring data for each occurrence were compiled and the canyon ID corresponding to the IMG occurrence was identified (Table 12). Population trends based on the IMG monitoring data (population size, population stability) were used to test the scoring matrix. If the scoring matrix was an accurate way to identify a survey area’s suitability for willowy monardella, then survey areas with large, relatively stable occurrence sizes would be expected to have higher suitability scores than survey areas with few monardella or where there were dramatic fluctuations in the number of monardella.

Table 11. Habitat Scoring Matrix

Description of Habitat Component	Scoring	Score
Indicators of Channel Stability (based on CRAM methodology) present	4+ Indicators of channel stability, 1 or fewer indicators of altered sediment transport	8
	3 indicators of channel stability, 1 or fewer indicators of altered sediment transport, or 4+ indicators and 1+ indicators of altered sediment transport	5
	3 indicators of channel stability, more than 1 indicator of altered sediment transport	3
	2 or less indicators of channel stability	0
Average width of alluvial benches	Average alluvial bench width 10+ m	8
	Average alluvial bench width ≥3-<10 m	4
	Average alluvial bench width <3 m	0
Percent boulder, cobble, gravel, sand, silt on the alluvial benches	Boulder cobble, gravel make up ≥40%-60% of substrate	6
	Boulder, cobble, gravel make up <40% of substrate	4
	Boulder, cobble, gravel make up ≥60% of substrate	1
Percentage of channel bank with alluvial benches present	90-100% of channel has an alluvial bench	6
	50-90% of channel has an alluvial bench	3
	<50% of channel has an alluvial bench	0
Percent cover of native plants on alluvial bench	Native cover 20-50%	6
	Native cover >50%-≤70%	3
	Native cover <20% or >70%	0
Percent boulder, cobble, gravel, sand, silt in the bottom of channel	Boulder, cobble, gravel make up ≥95% of substrate	4
	Boulder, cobble, gravel make up ≥90-<95% of substrate	3
	Boulder cobble, gravel make up <90% of substrate	2
Average depth of channel at Ordinary High Water Mark (OHWM)	OHWM 20-39 cm	4
	OHWM 40-69 cm	3
	OHWM 70+ cm	2
	OHWM <20 cm	1
Average channel width	Average channel width >2 m	4
	Average channel width 1.25-2 m	2
	Average channel width <1.25 m	0
Percent cover of nonnative plants in alluvial bench	Nonnative cover ≤30%	4
	Nonnative cover >30-≤60%	2
	Nonnative cover >60%	0
Percent cover of nonnative plants in channel	Nonnative cover ≤1%	2
	Nonnative cover >1-≤10%	1
	Nonnative cover >10%	0
Percent cover of native plants in channel	Native plant cover ≤5	2
	Native plant cover >5-≤10%	1
	Native plant cover >10%	0

Table 12. Willowy Monardella: Population Size for Occurrence in Survey Area 2014–2021[1]

Occurrence ID[2]	Occurrence Name	Survey Area ID	Population Size[3]							
			2014	2015	2016	2017	2018	2019	2020	2021
MOLIV_4SYCA001[4]	Sycamore Canyon	UpperSycCyn4B	85	90	57	44	52	34	33	38
MOLIV_4SYCA002[4]	Sycamore Canyon at Sycamore Canyon Rd	UpperSycCyn4B	---	---	0	1	---	1	-	3
MOLIV_4WSCA003[5]	West Sycamore Canyon	UpperWSycCyn1A	---	---	---	---	10	9	5	7
MOLIV_4SYCA006[6]	Sycamore Canyon East	UpperClarkCynA UpperClarkCynAE	---	441	238	283	283	364	1071[8]	1710[9]
MOLIV_4SPCA008[7]	Spring Canyon	SpringCyn1A, SpringCyn2A, SpringCyn3A, SpringCyn5A,	---	31	46	42	29	28	29	6
MOLIV_6LOCA004	Lopez Canyon	LopezCynA LopezCynM	10	13	11	9	9	5	23	6
MOLIV_6FLCA007[8]	Flanders Canyon	Flannery Canyon A	---	86	45	62	73	66	66	36

[1] Table lists only occurrences in SDMMP's Master Occurrence Matrix (MOM) database on conserved lands.
[2] Occurrence Identification (ID) per SDMMP's MOM database.
[3] Population size information from IMG monitoring data, land manager data, and report and research data (CNDDB 2019); (---) = not surveyed or data not available or not provided, 0 = surveyed, no plants detected.
[4] Occurrences are upstream and separated from larger MCAS Miramar occurrences by >0.5-mile.
[5] Occurrences are part of larger populations located on MCAS Miramar or private land.
[6] Permission was given to perform IMG surveys on a privately owned parcel adjacent to conserved lands in 2020, allowing for more of the maximum extent of the occurrence to be mapped.
[7] 2020 data for the privately owned parcel was based on estimates, 2021 performed an exact count, and mapped additional willowy monardella that was determined to be part of the MOLIV_4SYCA006 occurrence.
[8] This occurrence is a translocated population and according to the criteria established for this assessment, habitat was not considered suitable. Therefore, to avoid distorting scoring, this occurrence was not included in the overall analysis.

4.1.2 Habitat Suitability Modeling

SDMMP developed a habitat model to identify high and very high suitability habitat for willowy monardella. The purpose of this habitat suitability model is to identify sites where potential management actions could increase the number and size of willowy monardella occurrences. Model predictions are being used along with field-collected habitat and hydrological information to prioritize sites on conserved lands to enhance existing occurrences and establish new occurrences.

The Partitioned Mahalanobis D^2 modeling technique was used to construct alternative models with different combinations of environmental variables. SDMMP developed models for San Diego County using willowy monardella locations recorded from 2002 through 2021. SDMMP compiled willowy monardella location data from SDMMP, the CNDDB, MCAS Air Station Miramar, City of San Diego, and Lee Gordon. Spatially redundant observations (≤150 m apart) were deleted and ended up with 184 location records. SDMMP randomly selected 60% of these locations (110) to construct models (construction locations) and the remaining 30% (74) were used to evaluate model performance (evaluation locations) and select the best-performing model.

To develop an environmental database for modeling habitat suitability across the study area, ArcGIS software was used to create a grid of points spaced 150 m apart across San Diego County. SDMMP calculated environmental variables hypothesized to be potential habitat determinants for willowy monardella. Using ArcGIS digital data layers, SDMMP calculated various climatic, topographic, land use, and vegetation variables at each point in the landscape grid. The final model is available for use on the SDMMP website.

Alternative partitioned Mahalanobis D^2 models with different combinations of environmental variables were developed and evaluated for willowy monardella in San Diego County. Mahalanobis D^2 represents a standardized distance between the multivariate mean for environmental variables at locations where a species occurs, and values calculated for the same set of environmental variables at each grid point in the landscape being modeled. The more similar environmental characteristics are at a point in the landscape to the species' multivariate mean, the more suitable the habitat is for the species. Habitat suitability for each grid cell in the study area is indicated by a Habitat Similarity Index (HSI) value that ranges from 0 (least similar to occupied habitat and considered least suitable) to 1 (most similar to occupied habitat and most suitable). Habitat suitability strata for the model are defined by HSI values as the following: Very High = 0.75–1.00; High = 0.50–0.74; Moderate = 0.25–0.49; and Low = 0–0.24.

5. Analysis Results

5.1 Raw Scoring

The raw scores for suitable habitats ranged from 17 to 51 points out of a possible 54 points. Based on the calculated mean and the standard deviations from the mean (by percent), unoccupied drainages were given a habitat quality rating (Table 13, Table 14). Of the 35 unoccupied survey areas, seven were given a quality rating of very high, 16 were given a quality

rating of high, 11 were given a quality rating of moderate, four were given a quality rating of low, and only three were given a quality rating of very low. Of the nine occupied drainages, five fell within the very high quality category, two fell within the high quality category, and two fell within the moderate category.

All four of the occupied drainages that fell outside the Very High habitat quality category (LopezCynM, high; SpringCyn1A, high; PrivateQ, moderate; and UpperWSycCyn1A, moderate) were survey areas where either 1) the extant willowy monardella was concentrated at or near the mouth where it emptied into a larger occupied drainage, or 2) the surveyed habitat crossed from a secondary channel into a primary channel and occupied habitat occurred in the downstream reach of the survey area (i.e., primary channel). In these cases the willowy monardella was located in places where the water coming down the channel was supplemented by water flow in the drainage, whether due to above ground flow, due to water "backing up" in the mouth of the drainage as it joined the larger flow, or because the plants were likely able to access the main channel's water table.

Table 13. Habitat Quality Categories Based on Habitat Scoring Matrix

	Habitat Quality
Very High	>85-100
High	>67-85
Moderate	>51-67
Low	>34-51
Very Low	≤34

5.2 Habitat Suitability Modeling Results

Twenty-two models were constructed and evaluated, and the selected model performed well in predicting suitable habitat for willowy monardella with median HSI values of 0.82 and 0.87 for the construction and evaluation datasets, respectively. Mean HSI values were 0.64 for the model construction dataset and 0.66 for the evaluation dataset. The eight variables in the top-performing model were average April to June minimum and maximum temperatures, average annual precipitation, average annual stream flow, average annual stream velocity, cumulative catchment stream length upstream of a grid point, percent of impervious surface (developed land) above a grid point, and the percent of riparian land cover within a 500-square-meter area centered on a grid point. Environmental variables that varied the least at willowy monardella occurrences were average minimum and maximum temperatures, average annual precipitation, and average annual stream velocity.

The model predicts only a small amount of suitable habitat for willowy monardella outside of the current distribution in San Diego County. The highest suitability habitat is where the current distribution is centered at MCAS Miramar and immediately adjacent lands. There are small patches of moderate to high suitability habitat to the north and south of the current range. More westerly occurrences that are now extirpated or have declined to very small numbers are predicted to be low suitability habitat. These areas have higher amounts of impervious surface, warmer minimum and maximum temperatures, lower annual rainfall, and more extensive riparian vegetation compared to occurrences east of Interstate 15.

The project survey areas occur primarily at the periphery of habitat with HSI values of high or very high (Appendix A, Figure 4). The model suggests that although most of the field assessed habitat scores (raw scoring) fell within the moderate to very high range, parameters not recorded during the field assessment such as seasonal temperature ranges, upstream hydrology, and precipitation may be used to further refine the raw scoring and better understand the overall quality of habitat within a given canyon system. It should also be acknowledged that the methods used in determining raw habitat scoring were not mapped at as fine a scale as provided by the modeling, and therefore the model may also be used to identify reaches or portions of large contiguous habitat that may have great value or function than others.

5.3 Management Prioritization

Based on the occupancy, habitat quality, and risk data collected for this project, management recommendations and prioritizations were developed as summarized in Tables 15 and 16 below. Appendix A, Figure 5 presents the categories assigned to each canyon together with the HSI modeling results by SDMMP.

Table 14. Habitat Scores by Survey Area

Canyon ID[1]	Willowy Monardella Present	Stability	Alluvial Bench Width	Alluvial Bench Substrate	Alluvial Bench Presence	Native Cover Alluvial Benches	Channel Substrate	OHWM	Channel Width	Nonnative Cover Alluvial Benches	Nonnative Cover Channel	Native Cover Channel	Total Habitat Score	Percentage
34thStCynA	No	3	4	4	6	6	2	4	0	2	1	2	34	63.0
34thStCynL	No	8	4	1	0	6	4	4	4	4	1	0	36	66.7
BeelerCyn1A	No	3	8	4	6	6	4	4	2	2	1	2	42	77.8
BeelerCyn1C	No	0	0	6	0	6	3	1	0	2	0	0	18	33.3
BeelerCyn1I	No	0	8	4	6	6	4	1	2	2	2	2	37	68.5
BeelerCyn1U	No	0	8	4	6	6	3	4	0	2	2	2	37	68.5
ElanusCynA	No	3	4	6	0	6	3	3	3	6	2	2	38	70.4
FloridaCyn2A	No	8	4	4	6	0	3	3	4	4	2	0	38	70.4
LopezCynA	Yes	8	8	4	3	6	3	4	4	4	2	1	47	87.0
LopezCynM	Yes	5	8	1	3	3	4	2	4	4	1	2	37	68.5
MarianBearA	No	5	8	6	3	6	2	2	2	4	2	0	40	74.1
OakCyn1A	No	5	0	4	3	0	4	2	0	2	2	0	22	40.7
OakCyn2A	No	8	8	1	3	6	2	4	4	4	2	0	42	77.8
SpringCyn1A	Yes	5	8	4	6	6	4	4	2	2	2	2	45	83.3
SpringCyn3A	No	5	8	4	6	6	4	4	4	2	2	2	47	87.0
SpringCyn2A	No	5	8	4	0	6	4	4	4	3	2	2	42	77.8
SpringCyn5A	No	5	1	1	0	6	2	4	0	4	2	0	25	46.3
UpperClarkCynA1	Yes	8	8	6	6	6	4	3	4	2	2	2	51	94.4
PrivateA2	Yes	8	8	6	6	6	4	3	4	2	2	2	51	94.4
UpperClarkCynAE	Yes	8	8	6	6	6	4	4	2	0	1	2	47	87.0
UpperClarkCynAH	No	3	0	6	3	6	4	4	0	4	2	2	34	63.0
UpperClarkCynAL	No	8	0	1	3	6	4	3	0	2	1	2	30	55.6
UpperClarkCynAR	No	5	0	6	0	6	4	3	0	2	0	2	28	51.9
PrivateB	No	5	8	4	6	6	4	4	2	2	2	2	45	83.3
UpperClarkCynBA	No	0	0	6	0	0	3	1	0	4	1	2	17	31.5
PrivateO	No	3	4	4	3	6	4	3	2	2	1	2	34	63.0
PrivateQ	Yes	0	4	6	3	6	3	4	2	2	1	2	33	61.1
PrivateZ	No	0	0	6	3	6	3	4	0	4	1	2	29	53.7
UpperSycCyn1A	No	3	4	6	3	6	4	4	2	2	2	2	38	70.4
UpperSycCyn2A	No	8	4	4	6	6	4	4	2	2	2	2	44	81.5
UpperSycCyn3B	No	8	4	6	6	6	3	4	2	0	1	2	42	77.8
UpperSycCyn4A	No	0	8	4	3	6	4	2	2	4	2	2	37	68.5
UpperSycCyn4AC	No	8	4	6	3	0	2	4	4	4	1	2	38	70.4
UpperSycCyn4B	Yes	8	8	4	6	6	4	3	4	2	2	2	49	90.7
UpperSycCyn4I	No	0	4	4	3	6	3	2	4	4	2	2	34	63.0
UpperSycCyn4U	No	0	0	1	0	6	4	1	0	4	0	2	18	33.3
UpperSycCyn4X	No	8	4	4	3	6	3	3	2	4	2	1	40	74.1
UpperSycCyn4Z	No	0	8	4	0	0	4	2	0	4	2	2	26	48.1
UpperSycCyn5A	No	8	8	4	6	6	3	4	4	2	2	2	49	90.7
UpperWSycCyn1A	Yes	8	4	4	3	0	4	3	0	0	2	2	30	55.6
UpperWSycCyn1F	No	5	0	1	3	6	4	4	0	4	0	0	27	50.0
UpperWSycCyn2A	No	8	4	4	6	6	3	3	2	2	2	2	42	77.8
UpperWSycCyn3A	No	5	4	4	6	6	4	4	0	2	1	0	36	66.7

[1] Grey highlights on a row indicate an occupied drainage

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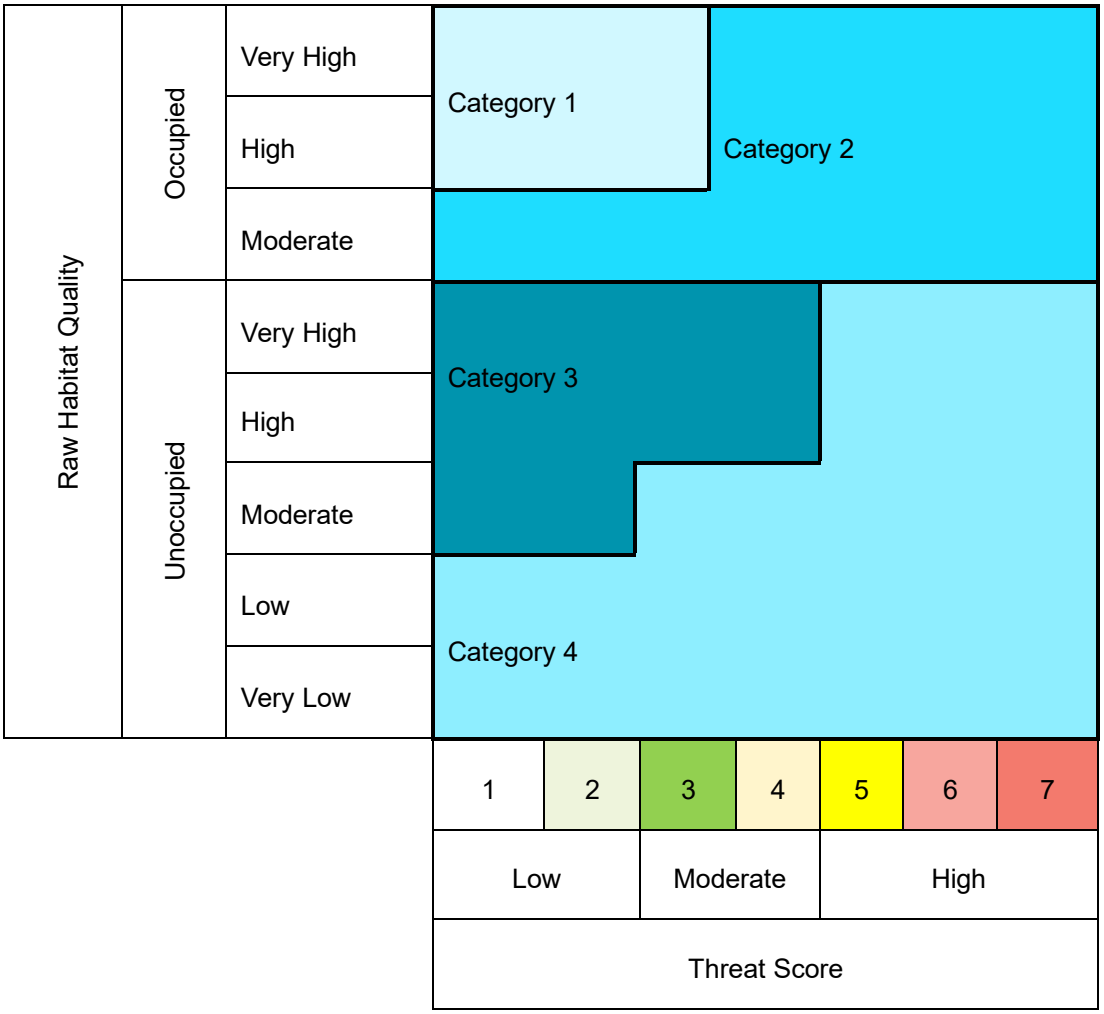
Table 15. Management Category and Recommendation

Category	Recommendation	
1	Monitor	• Occupied high to very high habitat quality with low to moderate threat score These canyons are recommended for regular monitoring to identify any new threats to populations as they arise and to manage the overall population for stability in a proactive manner.
2	Mitigation/ Restoration	• Occupied moderate habitat quality with low threats, or • Occupied high or very high habitat quality with moderate to high threat score These canyons are recommended for prioritization of restoration and/or threat reduction management activities such as stabilization of channels, reduction in forbs or nonnative species, or control of fossorial mammals.
3	Reintroduction/ Establishment	• Unoccupied high to very high habitat quality with low to moderate threats, or • Unoccupied moderate habitat quality with low threats These canyons are recommended for prioritization of reintroduction or establishment, as they offer the highest quality observed habitats in combination with low threat scores. These canyons are all currently unoccupied by willowy monardella or have previously documented occurrences that have since been extirpated.
4	No Action	• Unoccupied low to very low habitat quality, or • Unoccupied moderate to high habitat quality with high threat score No action is recommended for these canyon systems due to the high number of resources likely needed to establish and maintain willowy monardella in conjunction with the low likelihood of success. These areas are not good candidates for inclusion in any species-specific management strategy.

Table 16. Management Prioritization Category Plot



When considering recommendations and future management actions for conserved lands discussed below, it is important to consider both the overall management prioritization category (combination of observed habitat and threats) and habitat suitability modeling. For example, when deciding to allocate resources for species management between two similarly scored canyons or within a portion of a canyon, the modeled data are likely informative in refining the values of the management prioritization in relation to one another. Appendix A, Figure 5 provides a representation of the assigned management prioritization category overlaid with the habitat suitability modeling for survey areas with suitable habitat identified by field surveys.

6. Management Recommendations

The following list of recommendations is derived from several sources, including planning documents, research studies (including this assessment), identified gaps in relevant information about willowy monardella, and input from SDMMP.

Prioritization rationale (i.e., primary versus secondary priority) for these recommendations is subjective and it is understood that land managers should consider internal priorities and preserve-specific goals, as related to willowy monardella, when prioritizing management actions. Additionally, recommendations identified as secondary priority have immediate potential to become primary priority should funding become available, prerequisite activities become fulfilled (e.g., studies are completed), or if unforeseen natural or anthropogenic influences occur that could affect willowy monardella.

6.1 Primary Management Recommendations

Recommendation 1. Continue annual monitoring of all known willowy monardella occurrences.

Recommendation 2. Continue and initiate implementation of management strategies for existing occurrences as identified in the MSP Framework Rare Plant Management Plan.

Recommendation 3. Reestablish and expand the willowy monardella working group to include private and military property land managers with existing willowy monardella occurrences on their lands. Hold an annual or semi-annual meeting to share data, review relevant studies on willowy monardella, brainstorm about management priorities and feasibility, and share successes and lessons learned in management. The working group can also discuss and draw conclusions on how to prioritize and address other recommendations herein.

Recommendation 4. Engage academic institutions in potential research study topics related to willowy monardella.

Recommendation 5. Identify funding sources for immediate management needs, such as weeding, flood control, and anti-erosion measures.

Recommendation 6. Target additional parcels within Clark Canyon for inclusion in conserved lands of western San Diego County for the following reasons:

- The existing occurrence within Clark Canyon has the largest extent outside of military lands (MCAS Miramar).
- The general area contains some of the highest quality habitat in the species range.
- Many areas within Clark Canyon vicinity are accessible by vehicle from established service vehicle roads and therefore are more accessible for monitoring and management.

Recommendation 7. Engage MCAS Miramar to propose joint coordination of management and conservation plans for occurrences that span conserved and military lands.

Recommendation 8. Implement additional discovery surveys within canyons deemed potentially suitable as a result of this assessment, within areas of potentially suitable habitat on conserved lands that were not surveyed under this assessment, and on newly conserved lands with potentially suitable habitat, every 5 to 10 years.

Recommendation 9. Identify and prioritize suitable introduction and/or reintroduction sites using results of this assessment in tandem with CNDDB and other historical data, with the goal of expanding the species populations on conserved lands.

Recommendation 10. With priority areas identified and agreed upon, develop a site-specific management plan prior to seed collection, banking, and bulking and/or reintroduction or introduction of willowy monardella individuals (seed or transplants).

Recommendation 11. Implement willowy monardella seed collection, banking, and bulking from and/or introduction or reintroduction to receptor sites on conserved lands following a management plan as recommended above.

6.2 Secondary Management Recommendations

Recommendation 12. Evaluate the need and update the willowy monardella-specific chapters of the MSP FRPMP and the MSP Seed Collection, Banking and Bulking Plan for conserved lands in western San Diego County. Consider augmenting the plans with the results and conclusions of this report and future studies.

Recommendation 13. Implement additional habitat assessments and discovery surveys, outside of conserved lands as feasible, with the goal of documenting new occurrences and targeting lands with existing occurrences for conservation.

Recommendation 14. Identify and conduct studies regarding hydrologic parameters favored by willowy monardella, including slope, watershed size, flow velocity, seasonality of flow, and lack of watershed disturbances of these occupied intermittent drainages.

Recommendation 15. Identify and conduct studies regarding soil structure and soil chemistry to determine if soil-specific properties contribute to willowy monardella population health, transplanting survival rate, and germination rate.

Recommendation 16. Survey east of and at a higher elevation of the current willowy monardella range. Climate change will likely result in further drought stress and decline in the overall willowy monardella population. Therefore, introduction of the species into regions that are currently known to experience higher rainfall may be important for the long-term survival of this species.

7. Sources

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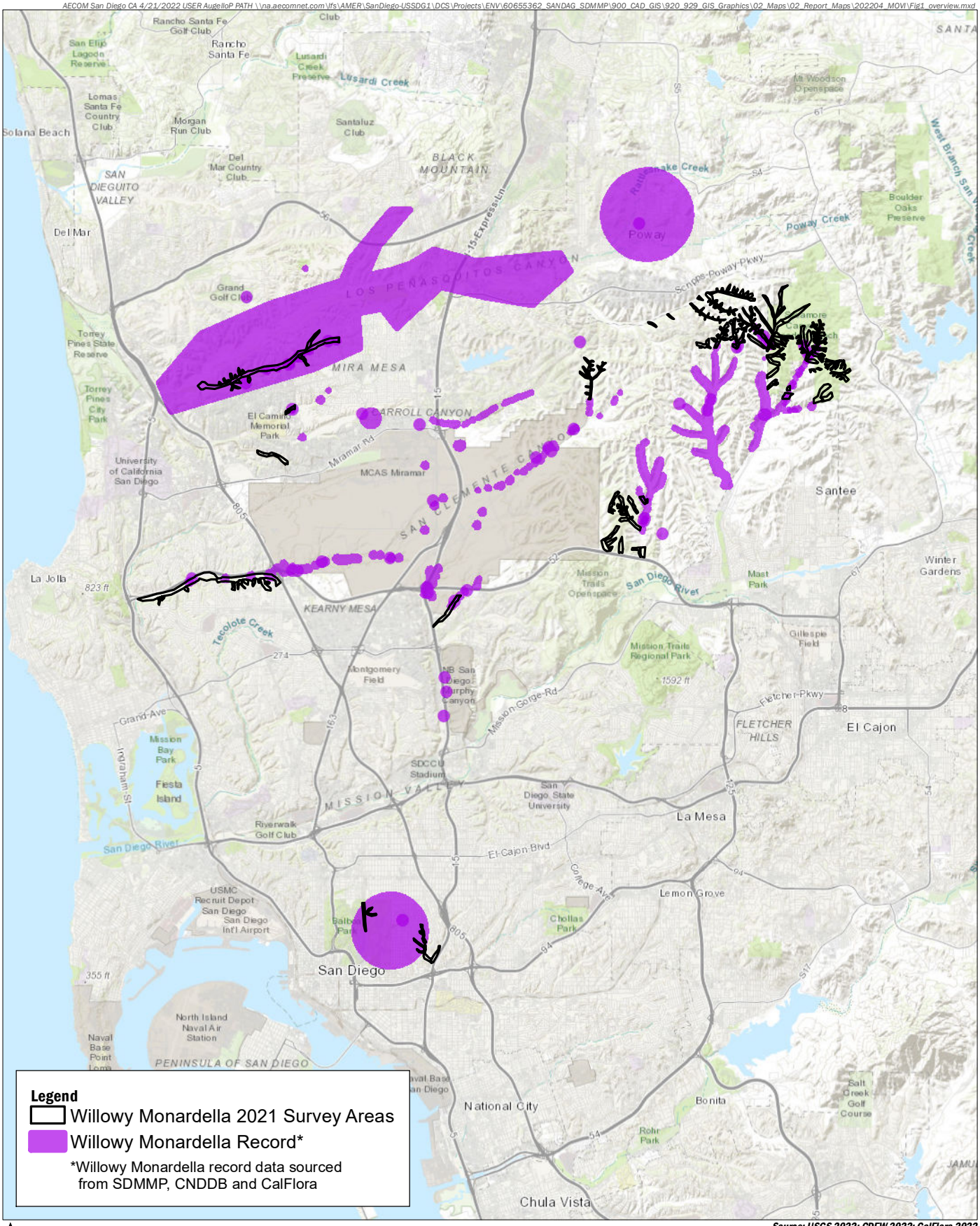
Appendix A

Maps and Figures



AECOM

SDMMP
Willowy Monardella Report

FIGURE 1 PROJECT LOCATION AND OVERVIEW OF THE DISTRIBUTION OF WILLOWY MONARDELLA

LopezCynN

LopezCynA

LopezCynM

Legend

- Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

Location Map

N

0 600

Feet

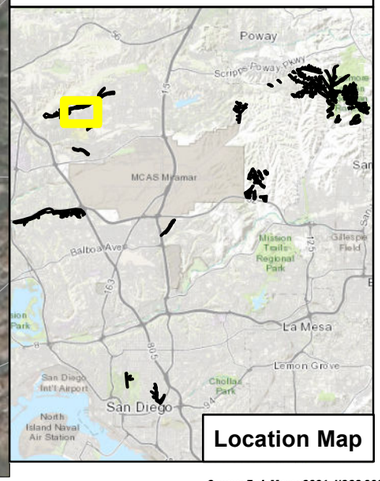
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2A SURVEY AREAS



Legend

- Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

N

0 600

Feet

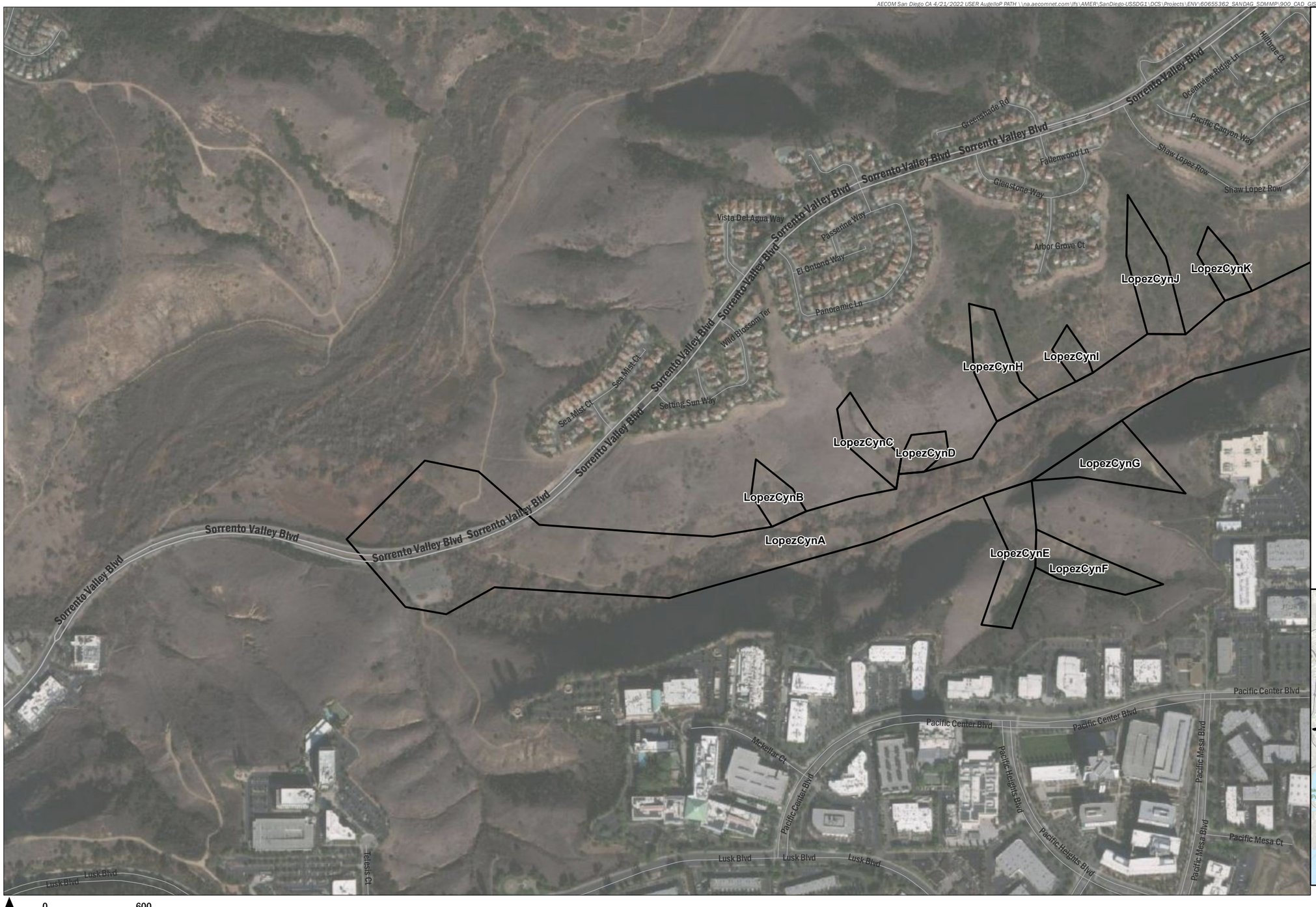
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

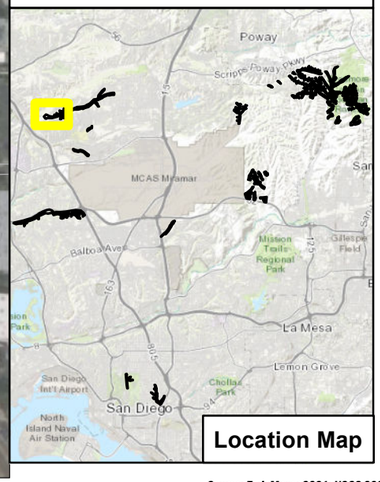
Willowy Monardella Report

FIGURE 2B SURVEY AREAS



Legend

Willowy Monardella 2021 Survey Areas



N

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Feet

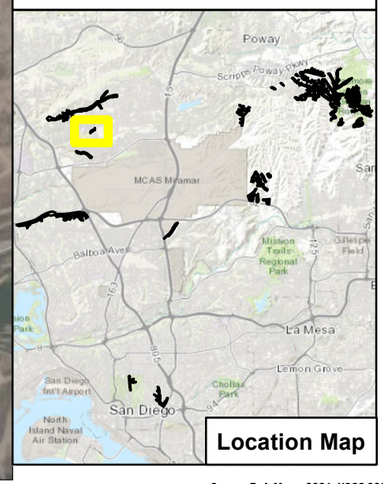
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2C SURVEY AREAS



Legend

- Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

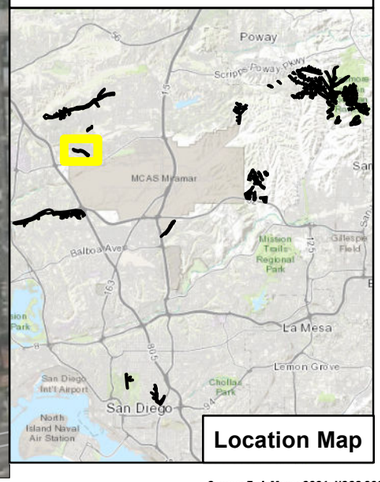
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2D SURVEY AREAS



Legend

Willowy Monardella 2021 Survey Areas

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

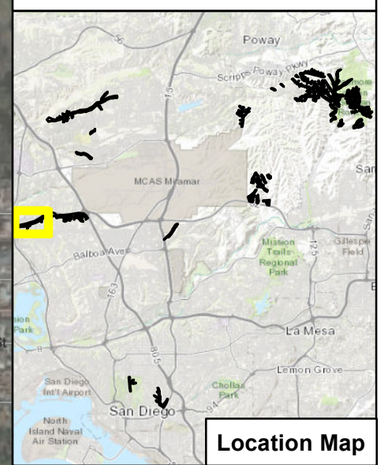
SDMMP

Willowy Monardella Report

FIGURE 2E SURVEY AREAS

Legend

Willowy Monardella 2021 Survey Areas

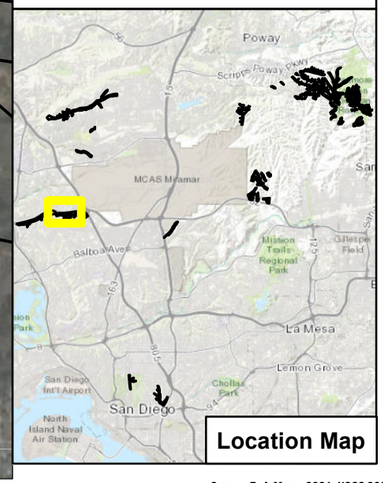


0 600 Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM
SDMMP
Willowy Monardella Report

FIGURE 2F SURVEY AREAS



Legend

Willowy Monardella 2021 Survey Areas

N

0 600

Feet

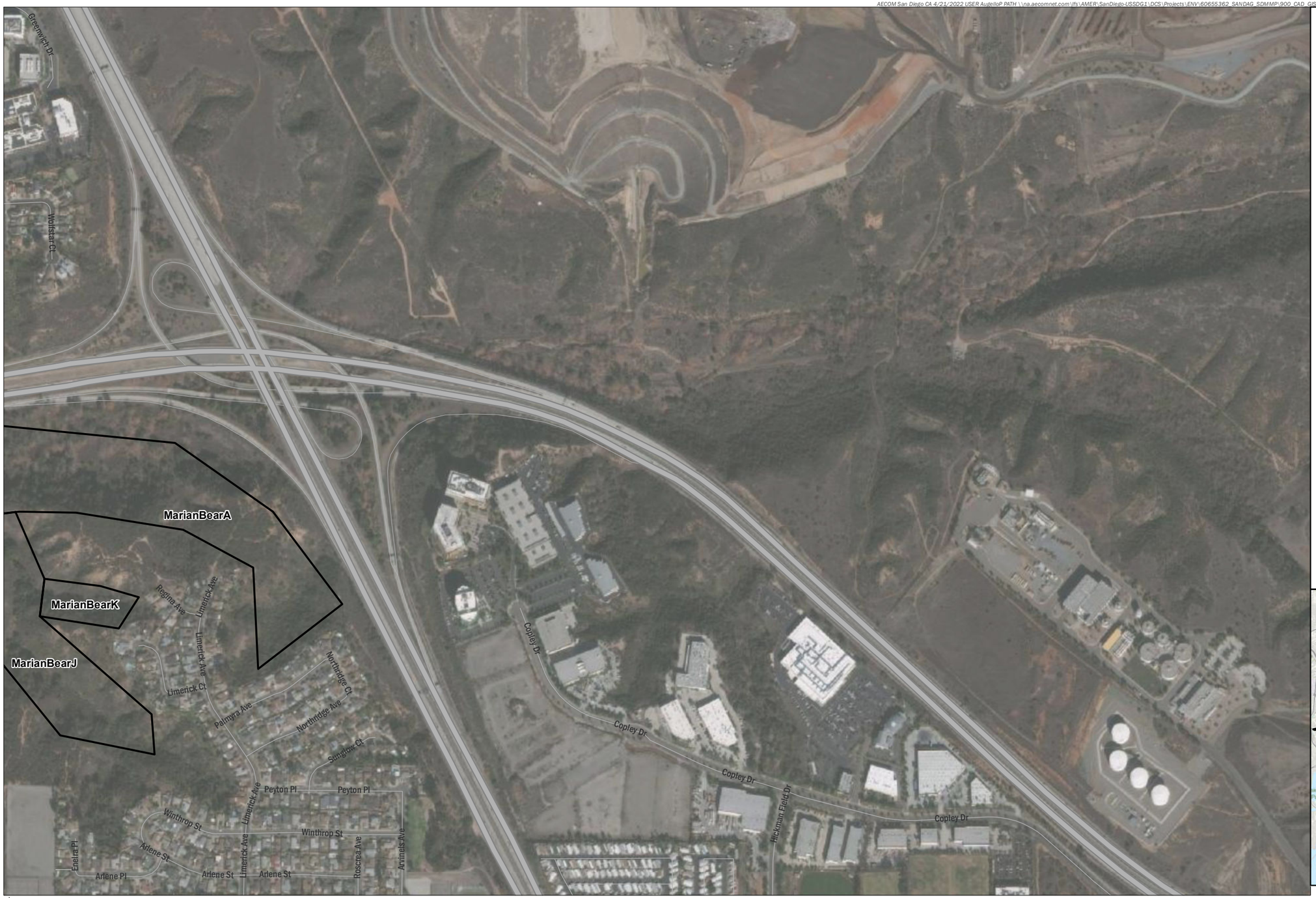
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

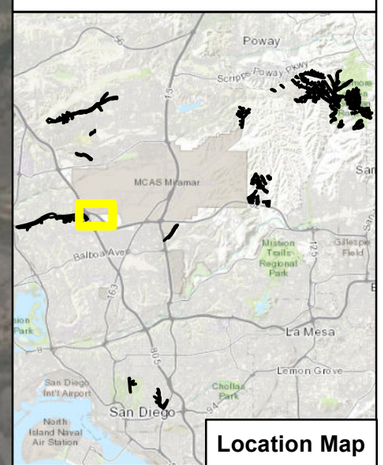
Willowy Monardella Report

FIGURE 2G SURVEY AREAS



Legend

Willowy Monardella 2021 Survey Areas



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0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

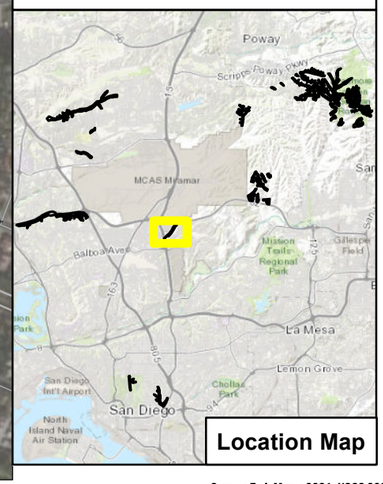
SDMMP

Willowy Monardella Report

FIGURE 2H SURVEY AREAS

Legend

Willowy Monardella 2021 Survey Areas



N

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Feet

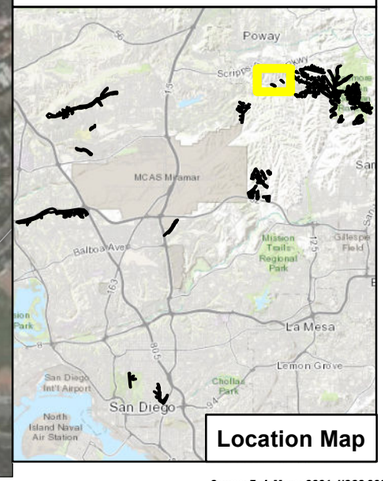
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2I SURVEY AREAS



Legend

Willowy Monardella 2021 Survey Areas

N

0 600

Feet

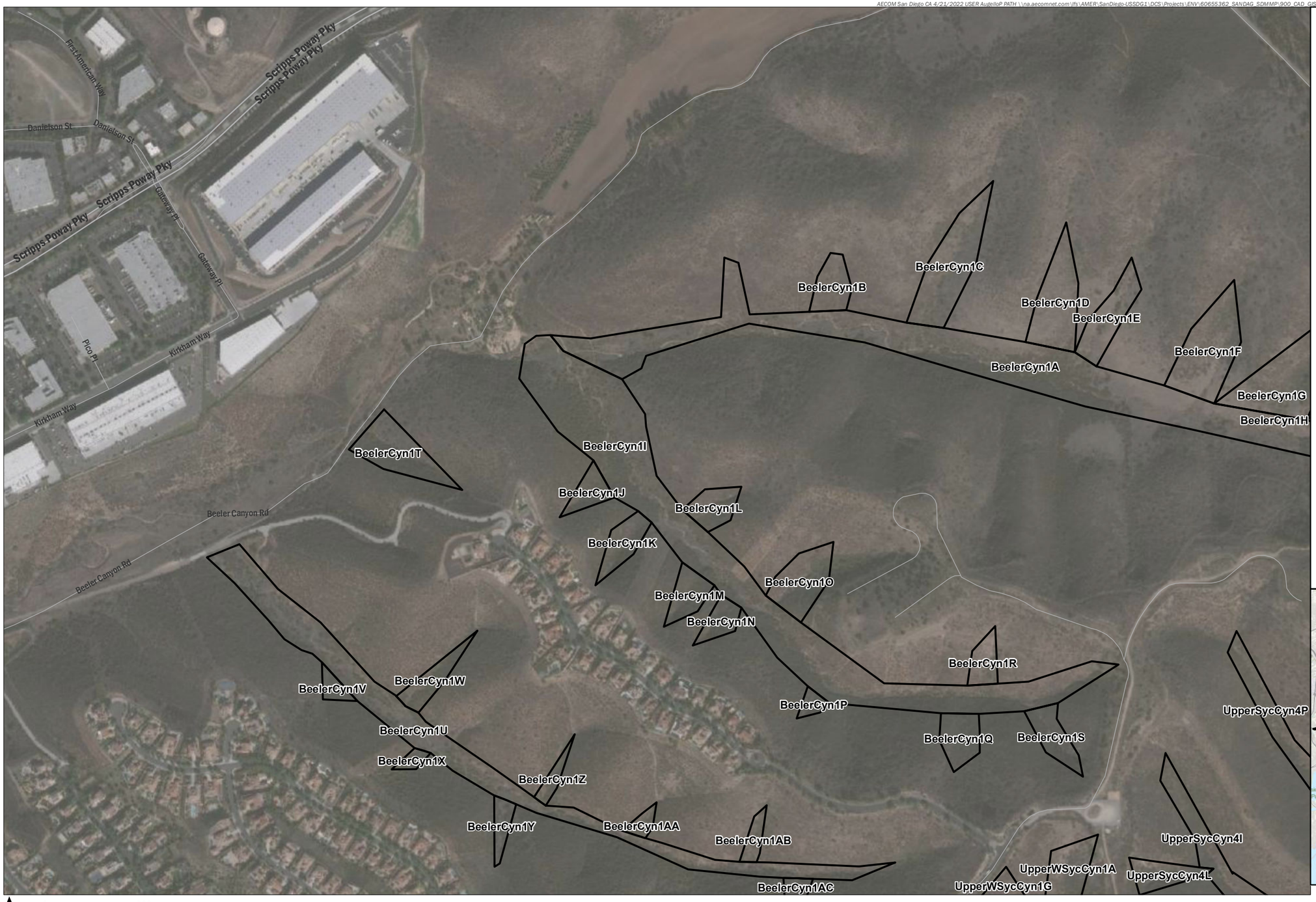
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2J SURVEY AREAS



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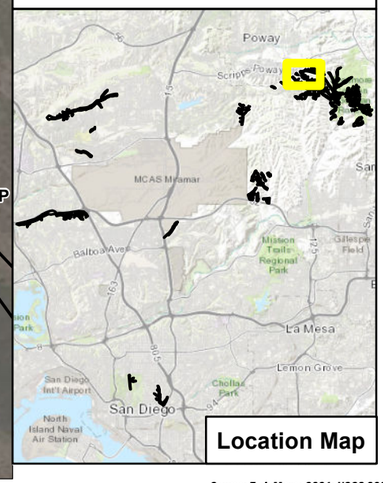
Willowy Monardella 2021 Survey Areas



N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

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Willowy Monardella Report

FIGURE 2K SURVEY AREAS

Sycamore Canyon Rd

CALLE De Rob

BeelerCyn1G

BeelerCyn1H

BeelerCyn1A

UpperSycCyn4AA

UpperSycCyn4Z

UpperSycCyn4AB

UpperSycCyn4N

UpperSycCyn4O

UpperSycCyn4P

UpperSycCyn4X

UpperSycCyn4AC

UpperSycCyn4B

UpperSycCyn4M

UpperSycCyn4Y

Legend

Willowy Monardella 2021 Survey Areas

Location Map

Poway

MCAS Miramar

La Mesa

Lemon Grove

San Diego

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

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Willowy Monardella Report

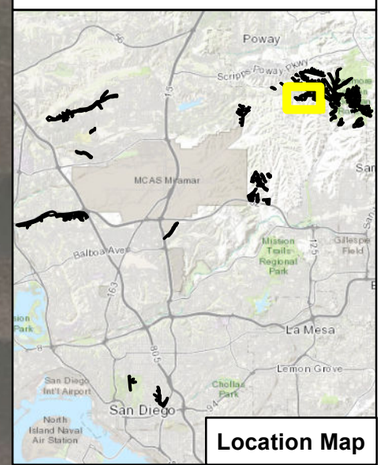
FIGURE 2L SURVEY AREAS

Legend

Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

- 2018
- 2019
- 2020
- 2021



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Feet

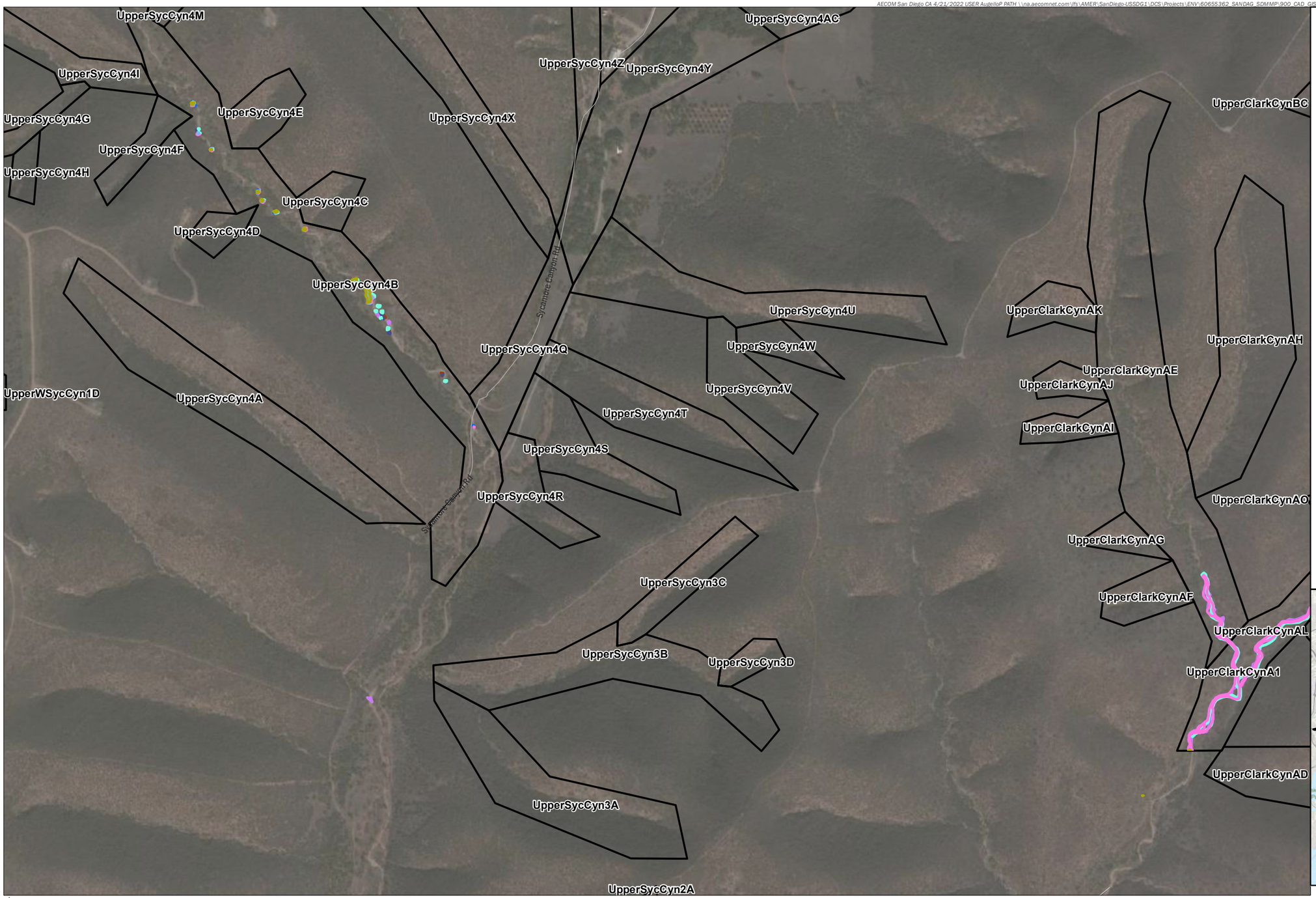
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2M SURVEY AREAS

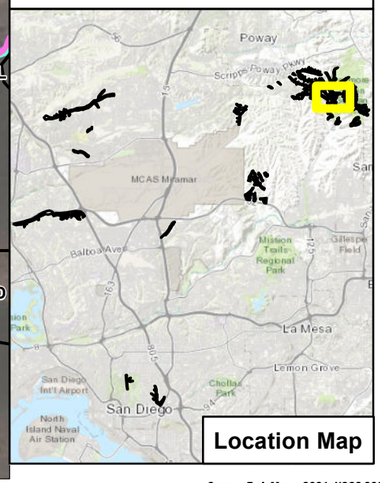


Legend

- Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021



N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2N SURVEY AREAS

UpperClarkCynBB
UpperClarkCynBD
UpperClarkCynBA
UpperClarkCynAZ
UpperClarkCynA1
UpperClarkCynAX
UpperClarkCynAY
UpperClarkCynAW
UpperClarkCynAV
UpperClarkCynAU
UpperClarkCynAS
UpperClarkCynAT
UpperClarkCynAR
UpperClarkCynAO
UpperClarkCynAP
UpperClarkCynAQ
UpperClarkCynAL
UpperClarkCynAN
UpperClarkCynAM
UpperClarkCynAD
SlaughterhouseCyn1J
SlaughterhouseCyn1C
SlaughterhouseCyn1A
SlaughterhouseCyn1B

N

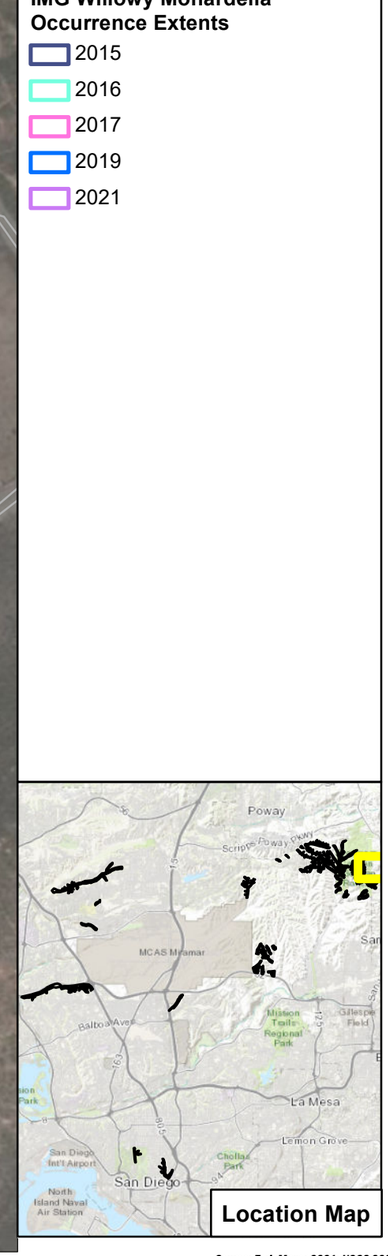
0 600
Feet

Legend

Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

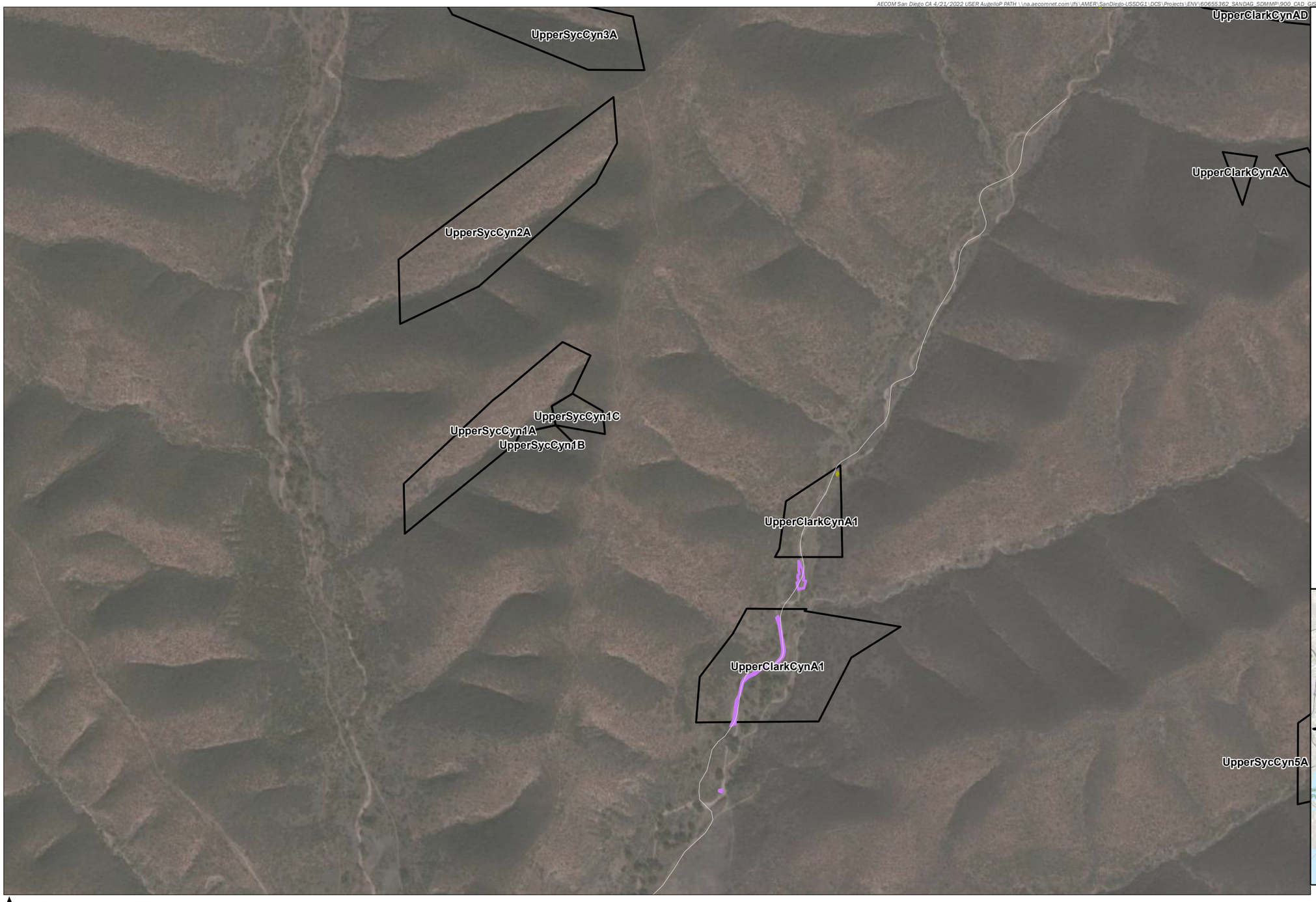
- 2015
- 2016
- 2017
- 2019
- 2021



Source: Esri, Maxar 2021; USGS 2022

AECOM
SDMMP
Willowy Monardella Report

FIGURE 20 SURVEY AREAS



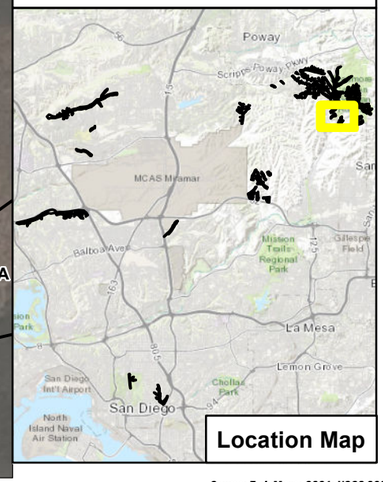
Legend

Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

2020

2021



N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

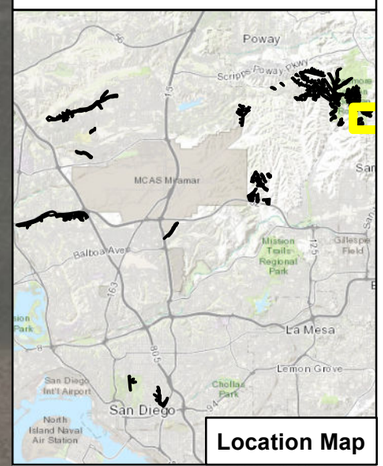
Willowy Monardella Report

FIGURE 2P SURVEY AREAS

UpperClarkCynAD
SlaughterhouseCyn1J
SlaughterhouseCyn1C
SlaughterhouseCyn1H
SlaughterhouseCyn1F
SlaughterhouseCyn1I
SlaughterhouseCyn1B
SlaughterhouseCyn1D
SlaughterhouseCyn1A
SlaughterhouseCyn1G
SlaughterhouseCyn1E
UpperClarkCynAC
UpperClarkCynAB
SlaughterhouseCyn2C
SlaughterhouseCyn2E
SlaughterhouseCyn2D
SlaughterhouseCyn2A
SlaughterhouseCyn2B
UpperSycCyn5A
UpperSyc5CynB
Slaughterhouse Canyon Rd

Legend

Willowy Monardella 2021 Survey Areas



N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

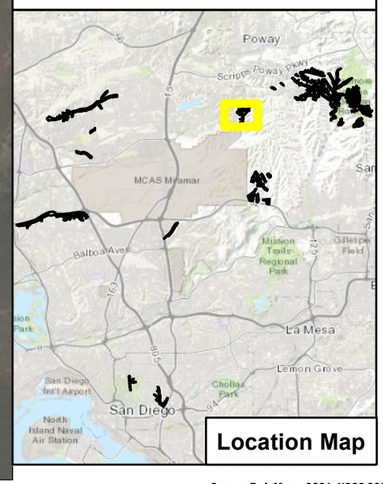
SDMMP

Willowy Monardella Report

FIGURE 2Q SURVEY AREAS

Legend

Willowy Monardella 2021 Survey Areas



Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2R SURVEY AREAS

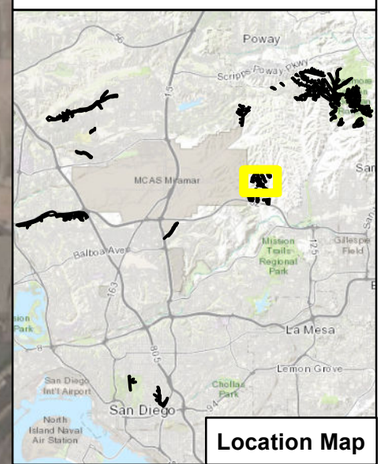
OakCyn1A
OakCyn1B
OakCyn1C
OakCyn1D
OakCyn2B
SpringCyn1A
SpringCyn2A
SpringCyn3A
SpringCyn3B
SpringCyn3C
SpringCyn3D
SpringCyn3E
SpringCyn3F
SpringCyn3G
SpringCyn3H

Legend

Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021



N

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Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

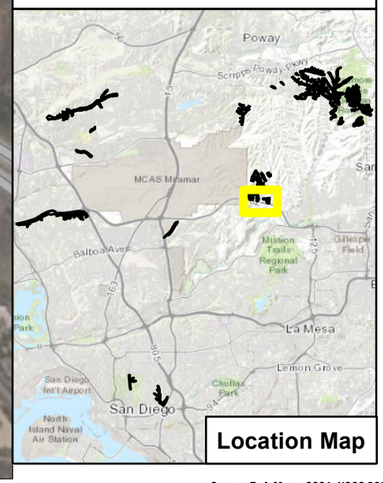
SDMMP

Willowy Monardella Report

FIGURE 2S SURVEY AREAS

Legend

Willowy Monardella 2021 Survey Areas



N

0 600

Feet

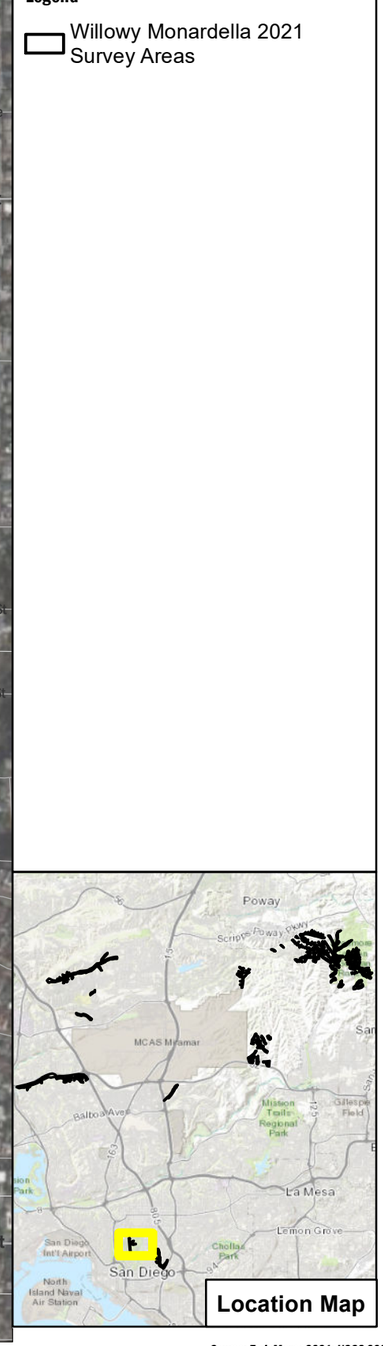
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2T SURVEY AREAS



Legend

Willowy Monardella 2021 Survey Areas

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2U SURVEY AREAS

Legend

Willowy Monardella 2021 Survey Areas

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 2V SURVEY AREAS

Source: Esri, Maxar 2021; USGS 2022

AECOM
SDMMP
Willowy Monardella Report

FIGURE 3A SUITABLE HABITAT AND RAW HABITAT SCORES

Legend

Willowy Monardella 2021 Survey Areas

Habitat Quality Percentage

High (>67-85)

Total Habitat Score: 40

Total Habitat Score: 40

Total Habitat Score: 40

MarianBearA

MarianBearB

MarianBearC

MarianBearD

52

Location Map

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3B SUITABLE HABITAT AND RAW HABITAT SCORES

Legend

Willowy Monardella 2021 Survey Areas

Habitat Quality Percentage

High (>67-85)

ElanusCynA

Total Habitat Score: 38

Location Map

0 600

Feet

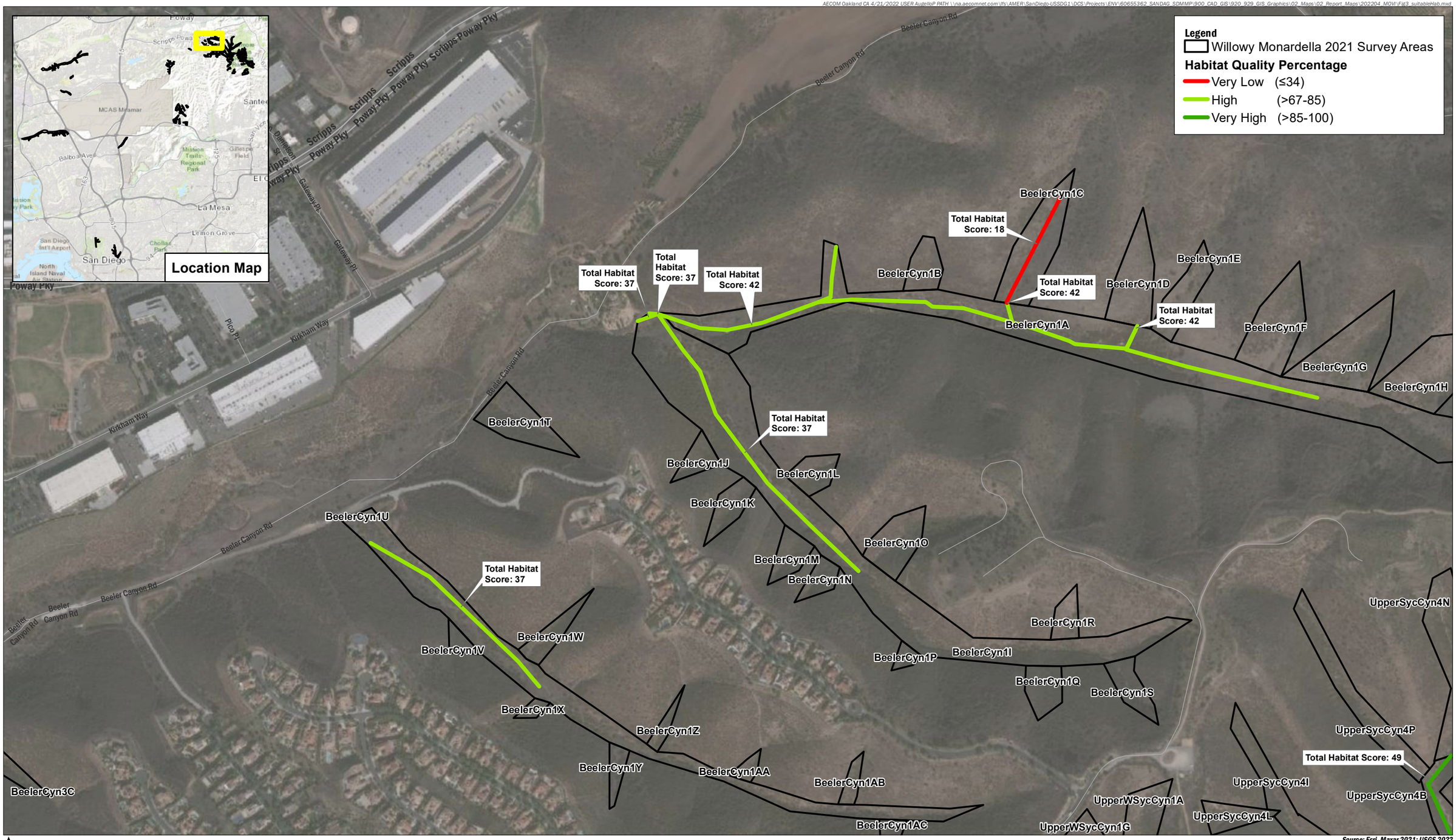
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3C SUITABLE HABITAT AND RAW HABITAT SCORES



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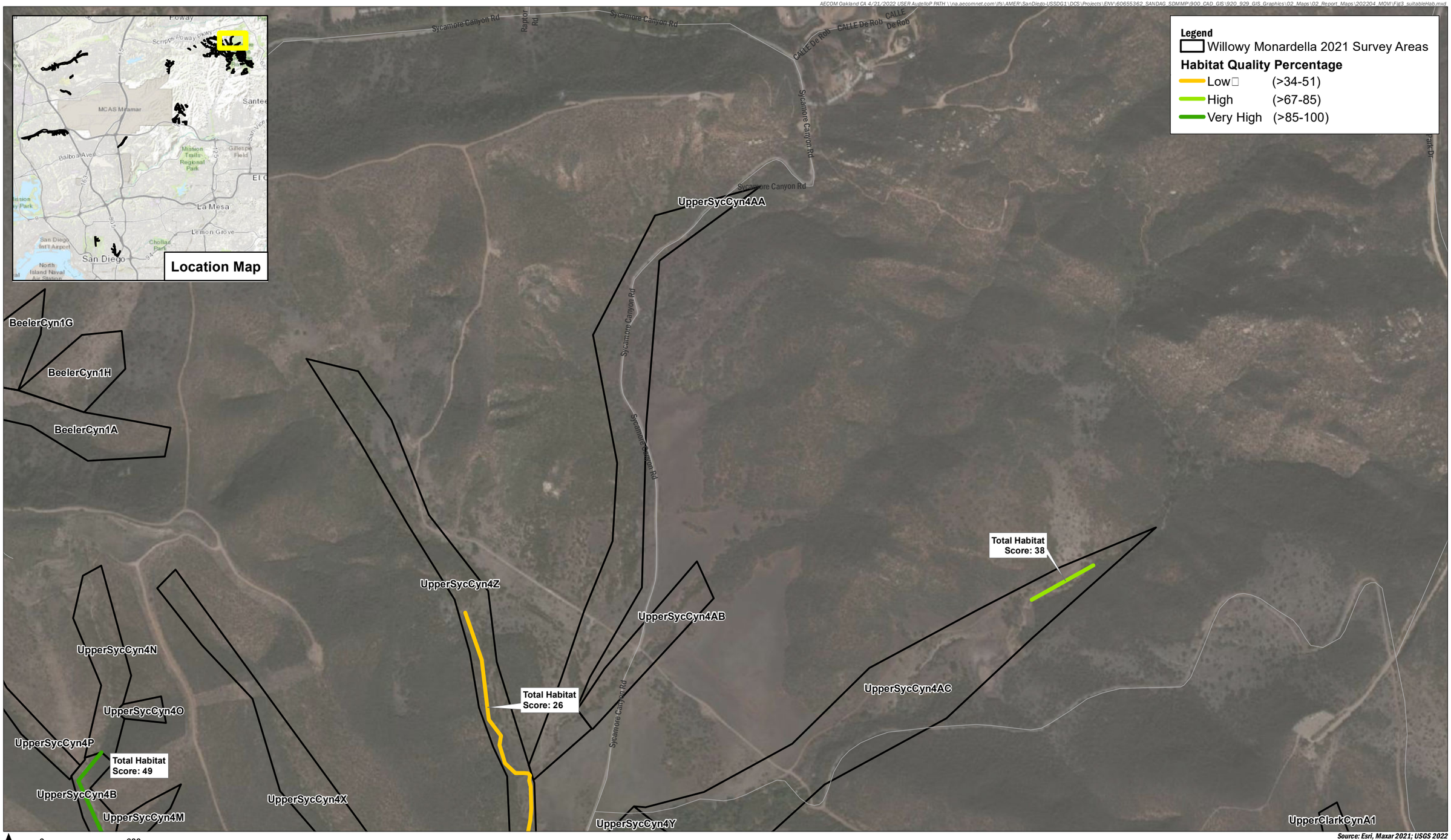
Willowy Monardella Report

FIGURE 3D SUITABLE HABITAT AND RAW HABITAT SCORES



Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3E SUITABLE HABITAT AND RAW HABITAT SCORES

Legend

Willowy Monardella 2021 Survey Areas

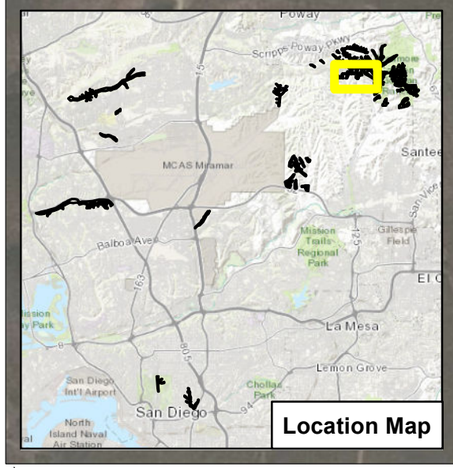
IMG Willowy Monardella Occurrence Extents

- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

Habitat Quality Percentage

- Low (>34-51)
- Moderate (>51-67)
- High (>67-85)
- Very High (>85-100)

BeelerCyn1AC
UpperWSycCyn1G
UpperSycCyn4M
UpperSycCyn4X
UpperSycCyn4K
UpperSycCyn4I
Total Habitat Score: 34
UpperSycCyn4J
Total Habitat Score: 40
UpperSycCyn4E
UpperWSycCyn2G
UpperWSycCyn1A
UpperSycCyn4G
UpperSycCyn4H
UpperSycCyn4F
Total Habitat Score: 27
UpperWSycCyn1F
UpperWSycCyn2F
UpperSycCyn4C
UpperSycCyn4D
Total Habitat Score: 49
UpperWSycCyn2E
UpperWSycCyn2A
UpperSycCyn4B
UpperWSycCyn2C
UpperWSycCyn1C
UpperWSycCyn1E
UpperWSycCyn2D
Total Habitat Score: 30
UpperSycCyn4T
UpperSycCyn4Q
UpperWSycCyn2B
Total Habitat Score: 42
UpperWSycCyn1D
UpperSycCyn4A
UpperWSycCyn3A
Total Habitat Score: 36
Total Habitat Score: 37
UpperSycCyn4R
UpperSycCyn4S
UpperWSycCyn3C
UpperWSycCyn1B
Total Habitat Score: 49
UpperWSycCyn3B
Total Habitat Score: 49
Total Habitat Score: 42
UpperSycCyn3B
UpperSycCyn3A
Sycamore Canyon Rd



N

0 600

Feet

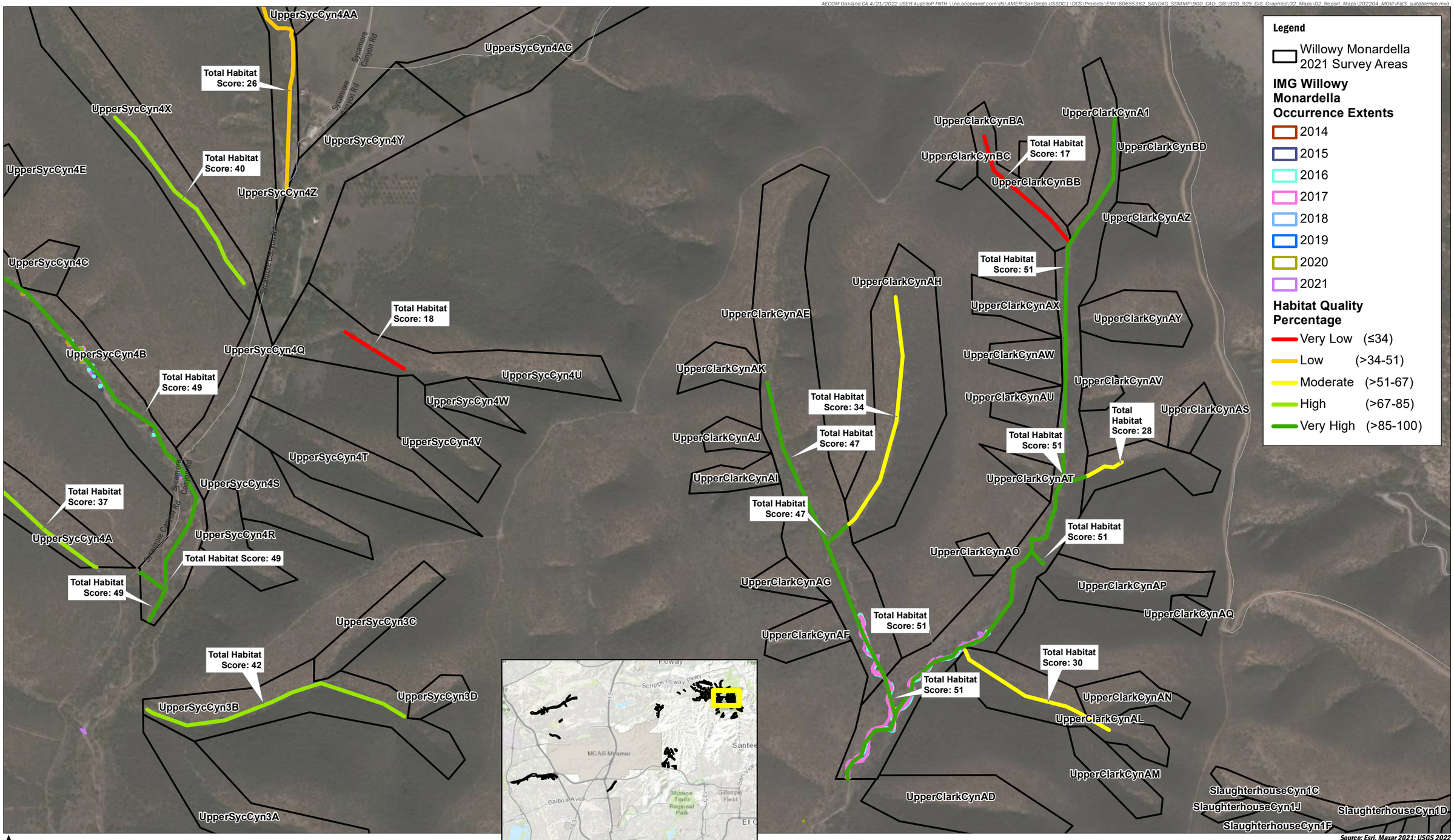
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3F SUITABLE HABITAT AND RAW HABITAT SCORES



AECOM

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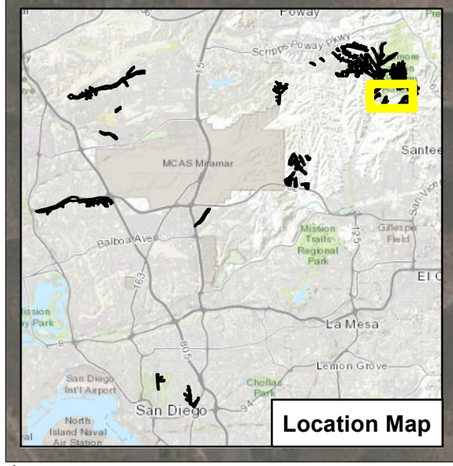
Willowy Monardella Report

FIGURE 3G SUITABLE HABITAT AND RAW HABITAT SCORES

UpperSycCyn3A
UpperClarkCynAD
UpperClarkCynAM
SlaughterhouseCyn1J
SlaughterhouseCyn1C
SlaughterhouseCyn1H
SlaughterhouseCyn1I
SlaughterhouseCyn1D
SlaughterhouseCyn1G
SlaughterhouseCyn1E
UpperClarkCynAC
UpperClarkCynAA
UpperClarkCynAB
SlaughterhouseCyn2A
SlaughterhouseCyn2E
SlaughterhouseCyn2D
Total Habitat Score: 44
UpperSycCyn2A
UpperSycCyn1A
UpperSycCyn1C
Total Habitat Score: 38
UpperSycCyn1B
Total Habitat Score: 51
UpperClarkCynA1
UpperSycCyn5A
Total Habitat Score: 51
UpperClarkCynA1
Total Habitat Score: 49
Total Habitat Score: 49
UpperSyc5CynB



Legend

- Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

- 2020
- 2021

Habitat Quality Percentage

- High (>67-85)
- Very High (>85-100)

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3H SUITABLE HABITAT AND RAW HABITAT SCORES

Legend

Willowy Monardella 2021 Survey Areas

IMG Willowy Monardella Occurrence Extents

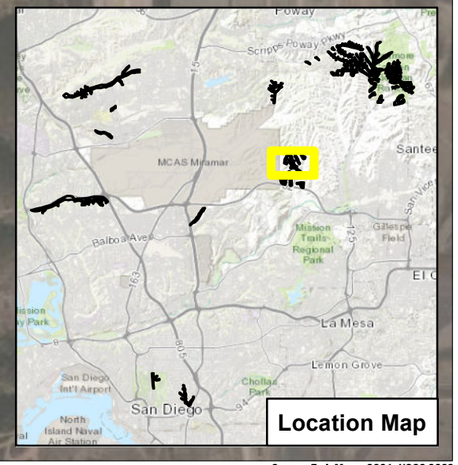
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

Habitat Quality Percentage

- Low (>34-51)
- High (>67-85)
- Very High (>85-100)

OakCyn1A
OakCyn1B
OakCyn1C
OakCyn1D
OakCyn2B
SpringCyn1A
SpringCyn2A
SpringCyn3A
SpringCyn3B
SpringCyn3C
SpringCyn3D
SpringCyn3E
SpringCyn3F
SpringCyn3G
SpringCyn3H

Total Habitat Score: 22
Total Habitat Score: 45
Total Habitat Score: 45
Total Habitat Score: 42
Total Habitat Score: 47



N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3I SUITABLE HABITAT AND RAW HABITAT SCORES

Legend

Willowy Monardella 2021 Survey Areas

Habitat Quality Percentage

- Low (>34-51)
- High (>67-85)
- Very High (>85-100)

SpringCyn3A

OakCyn2B

OakCyn2C

Total Habitat Score: 42

OakCyn2A

Total Habitat Score: 42

OakCyn2D

SpringCyn4A

SpringCyn5B

SpringCyn5A

Total Habitat Score: 25

Sycamore Landfill Rd

52

52

52

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3J SUITABLE HABITAT AND RAW HABITAT SCORES

Legend

- Willowy Monardella 2021 Survey Areas

Habitat Quality Percentage

- High (>67-85)

FloridaCyn2A

FloridaCyn1B

FloridaCyn1A

Total Habitat Score: 38

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3K SUITABLE HABITAT AND RAW HABITAT SCORES

Legend

- Willowy Monardella 2021 Survey Areas

Habitat Quality Percentage

- Moderate (>51-67)

Total Habitat Score: 34

Total Habitat Score: 34

34thStCynB

34thStCynA

34thStCynH

34thStCynI

Total Habitat Score: 36

34thStCynJ

34thStCynL

Location Map

N

0 600

Feet

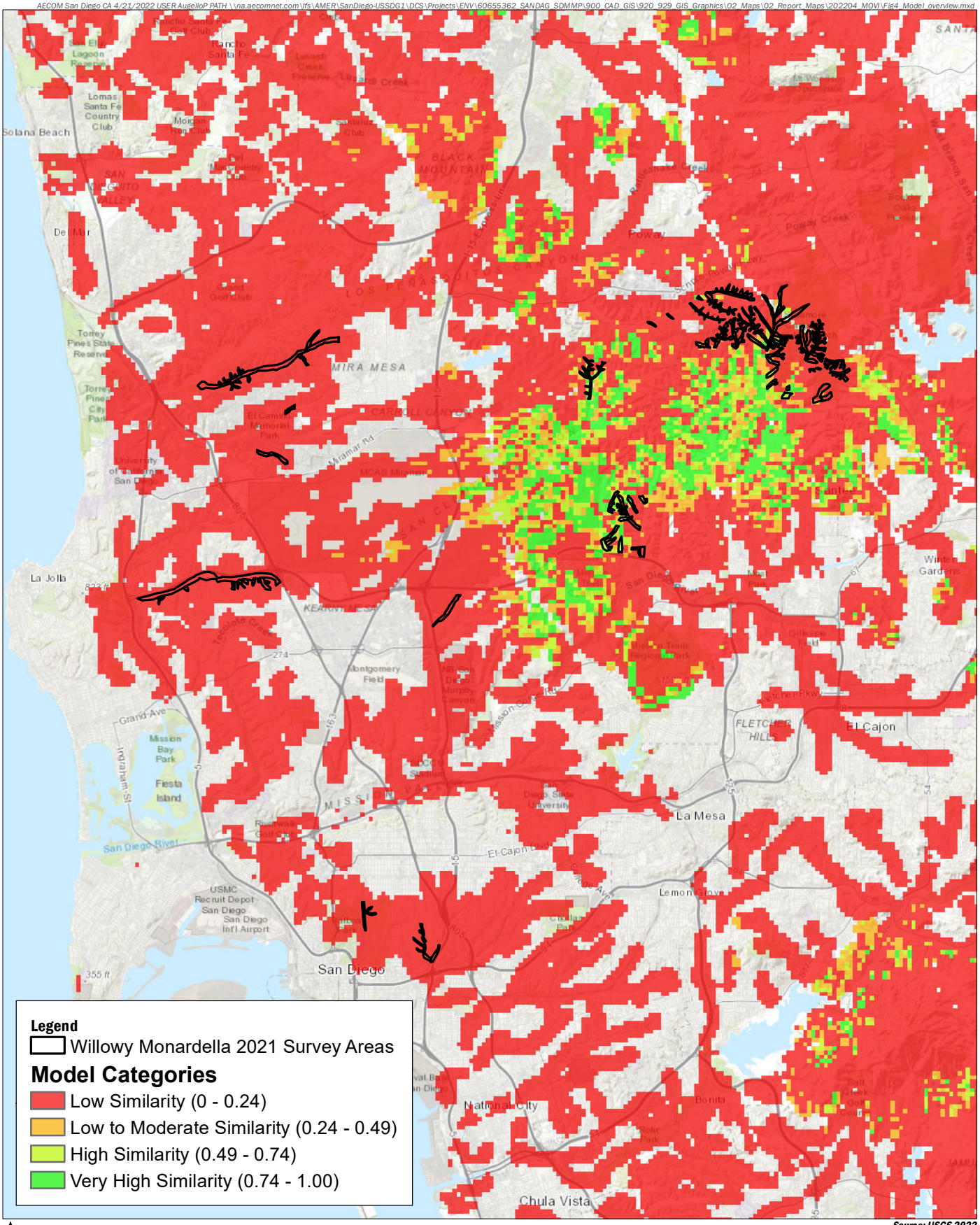
Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 3L SUITABLE HABITAT AND RAW HABITAT SCORES



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Willowy Monardella Report

FIGURE 4 HABITAT SUITABILITY MODELING OVERVIEW

Legend

Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

Category 1

Model Categories

Low Similarity (0 - 0.24)

Low to Moderate Similarity (0.24 - 0.49)

High Similarity (0.49 - 0.74)

Very High Similarity (0.74 - 1.00)

LopezCynN

LopezCynA

LopezCynM

Location Map

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

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Willowy Monardella Report

FIGURE 5A MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Legend

- Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

- Category 3

Model Categories

- Low Similarity (0 - 0.24)
- Low to Moderate Similarity (0.24 - 0.49)
- High Similarity (0.49 - 0.74)
- Very High Similarity (0.74 - 1.00)

MarianBearA

MarianBearB

MarianBearC

MarianBearD

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

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Willowy Monardella Report

FIGURE 5B MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Legend

Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

Category 4

Model Categories

Low Similarity (0 - 0.24)

Low to Moderate Similarity (0.24 - 0.49)

High Similarity (0.49 - 0.74)

Very High Similarity (0.74 - 1.00)

ElanusCynA

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

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Willowy Monardella Report

FIGURE 5C MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Legend

Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

- Category 2
- Category 3
- Category 4

Model Categories

- Low Similarity (0 - 0.24)
- Low to Moderate Similarity (0.24 - 0.49)
- High Similarity (0.49 - 0.74)
- Very High Similarity (0.74 - 1.00)

BeelerCyn1C
BeelerCyn1B
BeelerCyn1D
BeelerCyn1E
BeelerCyn1A
BeelerCyn1F
BeelerCyn1G
BeelerCyn1H
BeelerCyn1T
BeelerCyn1J
BeelerCyn1L
BeelerCyn1K
BeelerCyn1U
BeelerCyn1O
BeelerCyn1M
BeelerCyn1N
BeelerCyn1W
BeelerCyn1V
BeelerCyn1X
BeelerCyn1R
BeelerCyn1P
BeelerCyn1I
BeelerCyn1Q
BeelerCyn1S
BeelerCyn1Z
BeelerCyn1Y
BeelerCyn1AA
BeelerCyn1AB
BeelerCyn1AC
UpperSycCyn4N
UpperSycCyn4P
UpperSycCyn4I
UpperSycCyn4B
UpperSycCyn4L
UpperWSycCyn1A
UpperWSycCyn1G

Beeler Canyon Rd
Scripps Poway Pky
Gateway Pl
Pico Pl
Kirkham Way
Sycamore Canyon Rd

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

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Willowy Monardella Report

FIGURE 5D MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Legend

Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

- Category 2
- Category 3
- Category 4

Model Categories

- Low Similarity (0 - 0.24)
- Low to Moderate Similarity (0.24 - 0.49)
- High Similarity (0.49 - 0.74)
- Very High Similarity (0.74 - 1.00)

Sycamore Canyon Rd

Raptor Rd

CALLE De Rob

UpperSycCyn4AA

BeelerCyn1G

BeelerCyn1H

BeelerCyn1A

UpperSycCyn4Z

UpperSycCyn4AB

UpperSycCyn4N

UpperSycCyn4O

UpperSycCyn4P

UpperSycCyn4B

UpperSycCyn4M

UpperSycCyn4X

UpperSycCyn4AC

UpperSycCyn4Y

UpperClarkCynA1

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 5E MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Legend

Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

- Category 2
- Category 3
- Category 4

Model Categories

- Low Similarity (0 - 0.24)
- Low to Moderate Similarity (0.24 - 0.49)
- High Similarity (0.49 - 0.74)
- Very High Similarity (0.74 - 1.00)

BeelerCyn1AC
UpperWSycCyn1G
UpperSycCyn4M
UpperSycCyn4X
UpperSycCyn4K
UpperSycCyn4I
UpperSycCyn4J
UpperSycCyn4E
UpperSycCyn4G
UpperSycCyn4H
UpperSycCyn4F
UpperWSycCyn2G
UpperWSycCyn1A
UpperWSycCyn1F
UpperSycCyn4C
UpperSycCyn4D
UpperWSycCyn2F
UpperWSycCyn2E
UpperWSycCyn2A
UpperWSycCyn2C
UpperWSycCyn1E
UpperWSycCyn2D
UpperWSycCyn1C
UpperWSycCyn2B
UpperWSycCyn1D
UpperSycCyn4A
UpperSycCyn4Q
UpperSycCyn4T
UpperWSycCyn3A
UpperSycCyn4B
UpperWSycCyn3C
UpperWSycCyn1B
UpperSycCyn4S
UpperWSycCyn3B
UpperSycCyn4R
UpperSycCyn3B
UpperSycCyn3A
Sycamore Canyon Rd
Poway
Scripps Poway Pkwy
MCAS Miramar
Santee
Mission Trails Regional Park
Gillespie Field
Ralbo Ave
La Mesa
Lemon Grove
San Diego Int'l Airport
Chollas Park
San Diego
North Island Naval Air Station
Location Map

0 600
Feet

Source: Esri, Maxar 2021; USGS 2022

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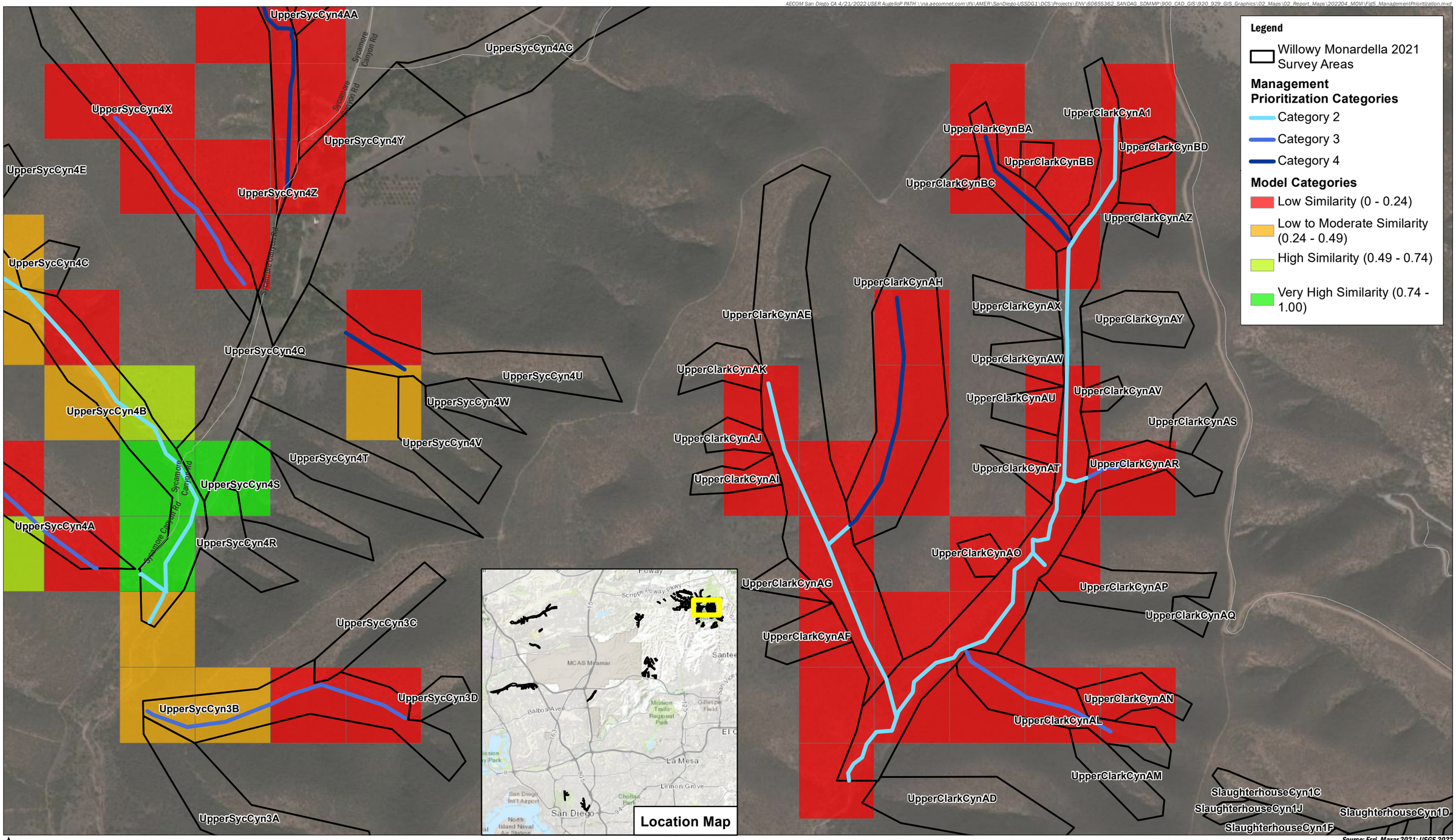
SDMMP
Willowy Monardella Report

FIGURE 5F MANAGEMENT PRIORITIZATION AND MODELED HABITAT



Source: Esri, Maxar 2021; USGS 2022

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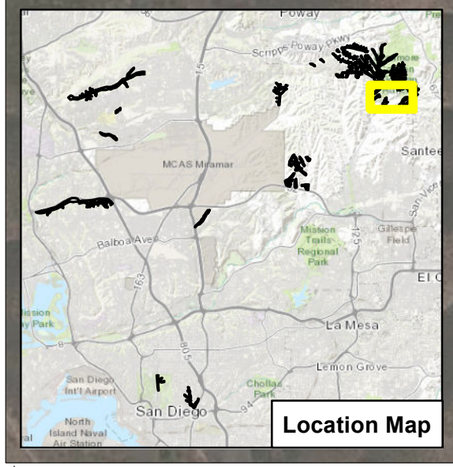
Willowy Monardella Report

FIGURE 5G MANAGEMENT PRIORITIZATION AND MODELED HABITAT

UpperSycCyn3A
UpperClarkCynAD
UpperClarkCynAM
SlaughterhouseCyn1J
SlaughterhouseCyn1C
SlaughterhouseCyn1H
SlaughterhouseCyn1I
SlaughterhouseCyn1D
SlaughterhouseCyn1G
SlaughterhouseCyn1E
UpperClarkCynAC
UpperClarkCynAA
UpperClarkCynAB
UpperSycCyn2A
SlaughterhouseCyn2A
SlaughterhouseCyn2E
SlaughterhouseCyn2D
UpperSycCyn1A
UpperSycCyn1C
UpperSycCyn1B
UpperClarkCynA1
UpperClarkCynA1
UpperSycCyn5A
UpperSyc5CynB



Legend

Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

- Category 2
- Category 3

Model Categories

- Low Similarity (0 - 0.24)
- Low to Moderate Similarity (0.24 - 0.49)
- High Similarity (0.49 - 0.74)
- Very High Similarity (0.74 - 1.00)

N

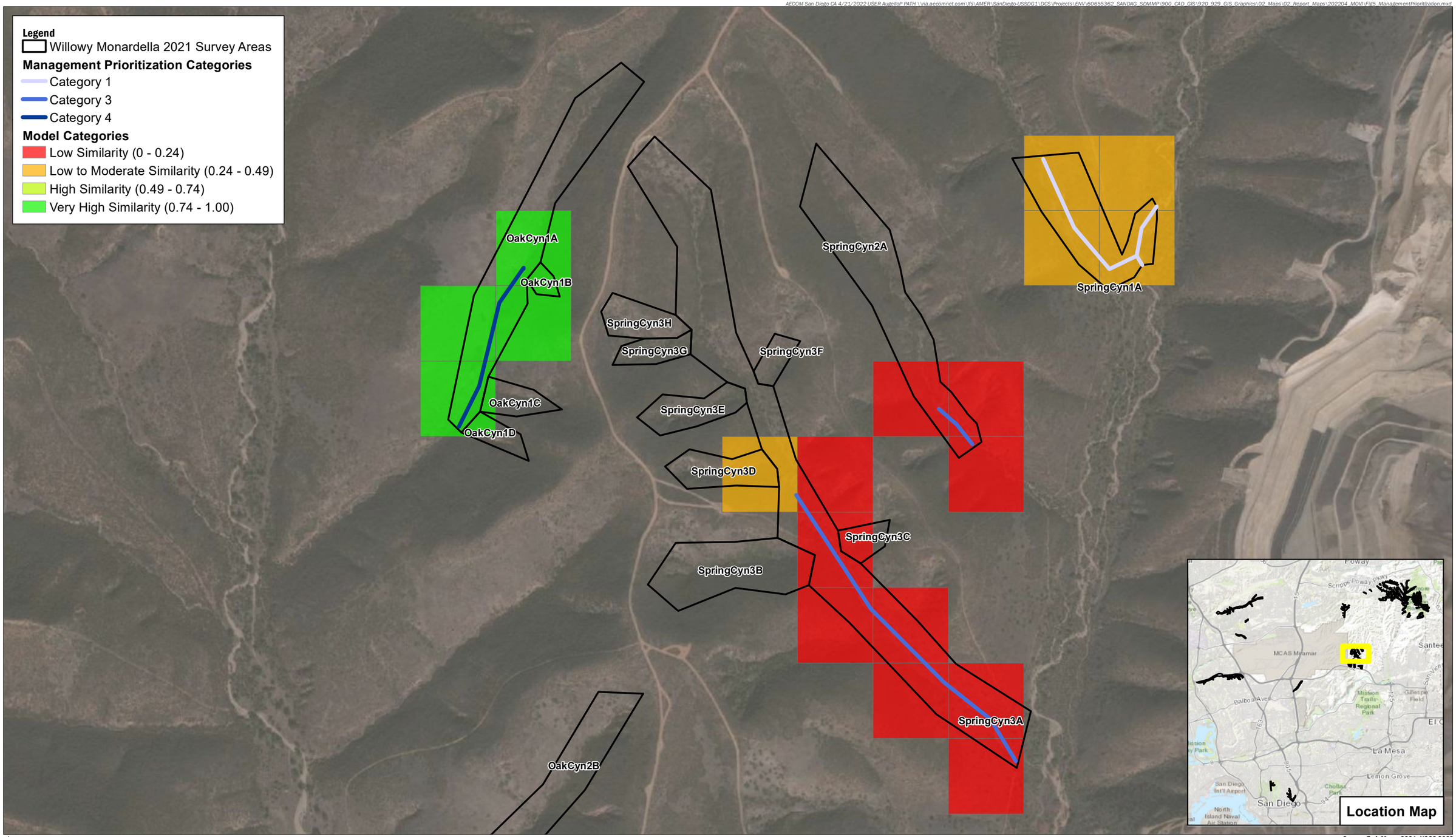
0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM
SDMMP
Willowy Monardella Report

FIGURE 5H MANAGEMENT PRIORITIZATION AND MODELED HABITAT



Source: Esri, Maxar 2021; USGS 2022

AECOM

SDMMP

Willowy Monardella Report

FIGURE 5I MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Legend

Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

- Category 3
- Category 4

Model Categories

- Low Similarity (0 - 0.24)
- Low to Moderate Similarity (0.24 - 0.49)
- High Similarity (0.49 - 0.74)
- Very High Similarity (0.74 - 1.00)

OakCyn2B

OakCyn2C

OakCyn2A

OakCyn2D

SpringCyn4A

SpringCyn3A

SpringCyn5B

SpringCyn5A

52

Sycamore Landfill Rd

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

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Willowy Monardella Report

FIGURE 5J MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Source: Esri, Maxar 2021; USGS 2022

AECOM
SDMMP
Willowy Monardella Report

FIGURE 5K MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Legend

- Willowy Monardella 2021 Survey Areas

Management Prioritization Categories

- Category 4

Model Categories

- Low Similarity (0 - 0.24)
- Low to Moderate Similarity (0.24 - 0.49)
- High Similarity (0.49 - 0.74)
- Very High Similarity (0.74 - 1.00)

34thStCynB
34thStCynA
34thStCynH
34thStCynI
34thStCynJ
34thStCynL

Location Map

N

0 600

Feet

Source: Esri, Maxar 2021; USGS 2022

AECOM

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Willowy Monardella Report

FIGURE 5L MANAGEMENT PRIORITIZATION AND MODELED HABITAT

Appendix B

Data Collection Form

Willowy Monardella Data Form

Survey Information

Survey Area ID (dropdown or surveyors to type in, depending on lead time provided to Emily [AECOM still needs to split up Survey Areas and assign IDs])
Surveyors Drop down
Affiliation: AECOM
Land Owner (fill out post-field survey, via desktop)
Management Unit (fill out post-field survey, via desktop)
Date (auto-populate with option to edit)
Time Start (auto-populate with option to edit)
Does the Survey Area contain habitat suitable for MOVI? Y/N; Not Evaluated

If Not Evaluated, notes for why (access constraints, etc.)

***If No*, Why is the Survey Area Unsuitable?** (select all that apply, but checking one would disqualify the Survey Area as Suitable)

- Unsuitable substrate (no cobbles or sand)
- No open/wide/or braided channel *and* No sandy/alluvial benches present
- Other
    - Option for comments

***If Yes*, fill** out data below:

Photographs of Unoccupied Suitable Habitat (Option for up to 8 Photo Points)

If MOVI is present in Survey Area, IMG monitoring photos will be taken separately.

Photo Point X
Take point/GPS coordinates

- Photo filename (can photos be attached in Survey123?)
    - SurveyAreaID_PhotoPointx_202106xx
- Direction of Photograph (bearing, 0 to 360 degrees)

Hydrology and Habitat Assessment

Channel Information

Drainage type (dropdown options for Primary, Secondary, Tertiary, other [if other, option for comments])

Drainage incline (incline of flow) (fill out post-field survey, via desktop, %age or ratio of horizontal/vertical, only a subset potentially)

Approximate Average depth of channel from OHWM (centimeters)

Approximate Maximum depth of channel from OHWM (centimeters)

Approximate Average Width of Drainage Channel (meters)

Drainage substrate within Channel
- Boulder (>300 mm) (%)
- Cobble (64 - 300 mm) (%)
- Gravel (4 - 64 mm) (%)
- Sand (0.1 - 4 mm) (%)
- Fines (<0.1 mm) (%)

Water Present at Time of Survey (Pick all that apply)
- None
- Flowing
- Standing
- Wet sand/mud

Dominant plant species in channel (drop down) (>20% relative cover)
- Total Native Plant Cover (%)
- Total Non-native Plant Cover (%)
- Other cover (%)
    - Other cover notes (describe, i.e. thatch, litter, cryptogrammic crust, woody debris, etc.)

<u>Alluvial Bench Information</u>

Approximate Average Width of Alluvial Bench (meters, include combined width of benches on either side of channel. Average width should be calculated using portions of drainage with benches only [i.e., do not factor in areas of Survey Area/canyon with bench width = 0])

Drainage Substrate on Alluvial Benches:
- Boulder (>300 mm) (%)
- Cobble (64 - 300 mm) (%)
- Gravel (4 - 64 mm) (%)
- Sand (0.1 - 4 mm) (%)
- Fines (<0.1 mm) (%)

Dominant plant species on bench (drop down) (>20% relative cover)
- Total Native Plant Cover (%)
- Total Non-native Plant Cover (%)

- Other cover (%)
    - Other cover notes (describe, i.e. thatch, litter, cryptogrammic crust, woody debris, etc.)

Ratio of Alluvial Benches to Stream Channel Automatic calculation of *Approximate Average Width of Alluvial Bench*/*Approximate Average Width of Drainage Channel*

Drainage Stability indicators (adapted from CRAM episodic streams module) (Check all that apply)

Indicators of Natural Processes

- There are distinct soil texture and grain size differences between different parts of the drainage.
- Channel contains embedded woody debris of the size and amount consistent with the adjacent area.
- Channel bars consist of well sorted bed material (Smaller size on the top and downstream end of the bar, larger grain size along the margins and upstream end of the bar)
- Channel characteristics (check all that apply)
  - Well defined channel OR
  - braided compound channels OR
  - high density of channels

Indicators of Altered Sediment Transport

- The channel is characterized by steep or undercut banks.
- An obvious historical floodplain has recently been abandoned.
- The channel is scoured to bedrock or dense clay in places.
- Soil texture and grain size differences between the low flow channel and floodplain are not evident or distinct
- The channel is ill defined.
- Several previously distinct channels have coalesced.
- Channel bed and bars (if present) are not well sorted, rather a homogenized mix of grains sizes.

Based on indicators, drainage is (pick one)
- Stable.
- Undergoing erosion.
- Undergoing sedimentation.

Factors Altering Natural Hydrology (Pick all that apply)
- Urbanization in surrounding area.
- Culverts emptying into the drainage.
- Channelization or water control features.
- Upstream dams.
- Dredged Areas.

Threat Assessment

Surrounding Land Use (text field)

Threat Categories (also include comments option for each disturbance type)
0 = No sign of disturbance in suitable habitat or 100m buffer.

1 = No sign of disturbance in suitable habitat but disturbance occurs in 100m buffer.
2 = Disturbance present in >0% to <5% of suitable habitat.
3 = Disturbance present in >5% to <15% of suitable habitat.
4 = Disturbance present in >15% to <30% of suitable habitat.
5 = Disturbance present in >30% to <50% of suitable habitat.
6 = Disturbance present in >50% to <75% of suitable habitat.
7 = Disturbance present in >75% of suitable habitat.

Fossorial Mammal Species Activity
Non-native Forbs
Non-native Grasses
Non-native Woody Plants
Competitive Native Plants
Dumping/Trash
Floodborne Debris
Encampments
Trampling
Vandalism
Altered Hydrology
Erosion
Urban Runoff
Slope Movement
Soil Compaction
Fuel Modification Zone/Fire Break
Road Construction/Maintenance
Vegetation Clearing
ORV Activity
Evidence of Recent Fire
Authorized Trails
Unauthorized Trails
Other Disturbances

Potential for Disturbance from Upstream Influence outside 100m buffer? (text field, include notes on disturbance type and potential)

Potential for future Hydrological Instability? (text field, include notes on why potential for future hydrological instability was identified, level of potential [low, moderate, high], and potential impact to suitable habitat)

Summary

Is MOVI Present in the Survey Area? Y/N; Not Evaluated, (discovery surveys not possible due to access)

- *If No,* No further info on this topic needed.

- *If Yes*, Is it an existing occurrence (i.e. are the plants found within 0.25 mile of a Current Mapped Extent of an existing occurrence)? Y/N
    - *If No*, Did AECOM establish a new IMG monitoring Sample Plot? Y/N (should always be Yes)
    - *If Yes*:
        - Occurrence ID (dropdown with all existing occurrence IDs for MOVI)
        - Entity which completed/will complete IMG monitoring at Sample Plot(s) in 2021? (text field – AECOM, City of San Diego, etc.)
        - Did AECOM find additional extent if new plants were found within 0.25 mile of Current Maximum Extent? Y/N
            - Was the additional extent mapped? Y/N (should always be Yes)
            - Was an additional Sample Plot established? Y/N

Overall Quality Rating (dropdown)
- Not Suitable
- Low
- Moderate
- High
- Not Evaluated

Management Ranking (dropdown)
- Not applicable – habitat not suitable or not evaluated
- No management needed
- Medium level of management needed
- High level of management needed

Management Recommendations (text field; describe management recommendations to manage threats for existing occurrences or management that would be needed to enhance unoccupied suitable habitat; include recommendations to reduce impacts of flooding and erosion to sensitive natural resources and surrounding habitat. Examples include invasive species control, prevent public access, soil manipulation including stabilization of the channel bank, expand population to additional suitable habitat areas within the Survey Area, etc.)

Management Actions in Last Year (text field)
CNDDB Species Detected (text field)
Other Notes (text field)
Time End (auto-populate with option to edit)

Willowy Monardella Survey Protocol

Suitable habitat definition
High Quality habitat:

a. Supports a wide bench above the main flow channel, and/or
b. Supports a braided open channel with seasonal or intermittent flow
c. Soil is sandy and alluvial with some cobbles but not solid rock

d. Bench contains some suitable areas not prone to erosion.
e. Vegetation is open scrub habitat or sycamore alluvial woodland

All or most of the categories above would be met to be considered High quality. Moderate quality habitat may simply include presence of a bench of habitat out of the water flow area that lacks other features and moisture situation, or one or more degraded features.

Field Protocol

AECOM Ecologists and Botanists will survey each Survey Area (to be derived from splitting overall survey areas provided by SDMMP into sub-survey areas by individual drainage) and collect data as outlined above in 1 form per Survey Area. The data form includes embedded guidance on how to complete data fields, as needed.

Suitable habitat will be mapped in Collector by drawing lines along the center of the canyon along the length of suitable habitat areas. Lines of suitable habitat can be drawn from stationary locations while reviewing the landscape and aerials in Collector (with additional field verification along the length of the suitable habitat) or by walking the distance of the suitable habitat while Collector draws/streams the line.

When canyons with existing occurrences are surveyed, AECOM will perform IMG monitoring where the occurrences aren't otherwise being monitored by another entity. If monitoring is being performed by another entity but AECOM finds additional extent outside the Current Mapped Extent, we will assume that it is not likely to be mapped by the other entity, and AECOM will map additional extent. Upon completion of field work, AECOM will work with SDMMP to ensure extent polygons are archived as a single feature per each occurrence.

Where new occurrences are found, AECOM will perform IMG monitoring by establishing a new plot and mapping the extent.

Discovery Surveys for willowy monardella will be documented by collection of spatial data. Suitable unoccupied habitat photo points, suitable habitat lines, and IMG data will document that surveyors were at that location and surveyed for willowy monardella. Discovery Survey Points will be collected, as needed, to document areas surveyed where other features listed prior are not adequate to show the area surveyed.

Should Survey Areas not be accessible, surveyors will select "Not Evaluated" at the beginning of the form. Should Survey Areas be evaluated from vantage points, Surveyors will select "Not Evaluated" for "**Is MOVI Present in the Survey Area?"**. Surveyors should rely on the Other Notes section to describe any nuances for the Survey Area (i.e., this is where a surveyor could note that a canyon was assessed from a vantage point rather than walked, etc.).

Appendix C (Electronic Attachment)

Survey Data

Appendix D

Representative Photographs

Appendix D
Representative Photographs

Photograph 1. Representative photo of Very High quality occupied habitat in UpperClarkCynA1. This canyon represents the highest scored habitat and is representative of wide channel and alluvial benches with coarse substrates in combination with sparse native shrubs and lack of non-native grasses and forbs.

Photograph 2. Representative photo of Very High quality occupied habitat in LopezCynA. This canyon shows Very High quality habitat on scarecely vegetated alluvial benches with coarse substates. Photo represents areas of Very High quality with minor reductions in suitability due to periods of non-cotiguous benches.

Photograph 3. Representative photo of Very High quality habitat in UpperSycCyn5A. This canyon shows Very High quality habitat with high threat scores resulting from dense non-native grass and forb cover which may contribute to lack of occupancy.

Photograph 4. Representative photo of Very High quality habitat in SpringCyn3A. This canyon was the one of two unoccupied canyons scoring as Very High and is representative of wide, contiguous, alluvial benches in combination with coarse channel substrates and a relatively stable channel.

Photograph 5. Representative photo of High quality occupied habitat in LopezCynM. This photo represents charateriztics of high quality habitat generally reduced by higher composition of fine substrates within the channel and alluvial bench.

Photograph 6. Representative photo of High quality habitat in BeelerCyn1U. Habitat quality within this canyon was high due to wide, contiguous, alluvial benches. Photo illustrates observed threats from non-native grasses and forbs.

Photograph 7. Representative photo of High quality habitat in FloridaCyn2A. Habitat quality within this canyon was high due to channel stability, wide channel contiguous alluvial bench, despite narrower bench widths.

Photograph 8. Representative photo of High quality habitat in MarianBearA. Photo is representative of coarse alluvial bench substrates and wide benches which provide high quality habitat for willowy monardella.

Photograph 9. Representative photo of Moderate quality occupied habitat in Private Q. Photo is representative of interface of secondary canyons adjoining canyons with higher quality occupied habitat which results in habitat with lower scoring also supporting willowy monardella

Photograph 10. Representative photo of Moderate quality habitat in 34thStCynL. Photo is representative of reduced habitat quality due to absence of a defined bench along most of the channel.

Photograph 11. Representative photo of Moderate quality habitat in Private O. Photo is representative of general conditions resulting in more marginal habitat score, such as steeper channels, narrower channel and bench widths, and reduced channel stability.

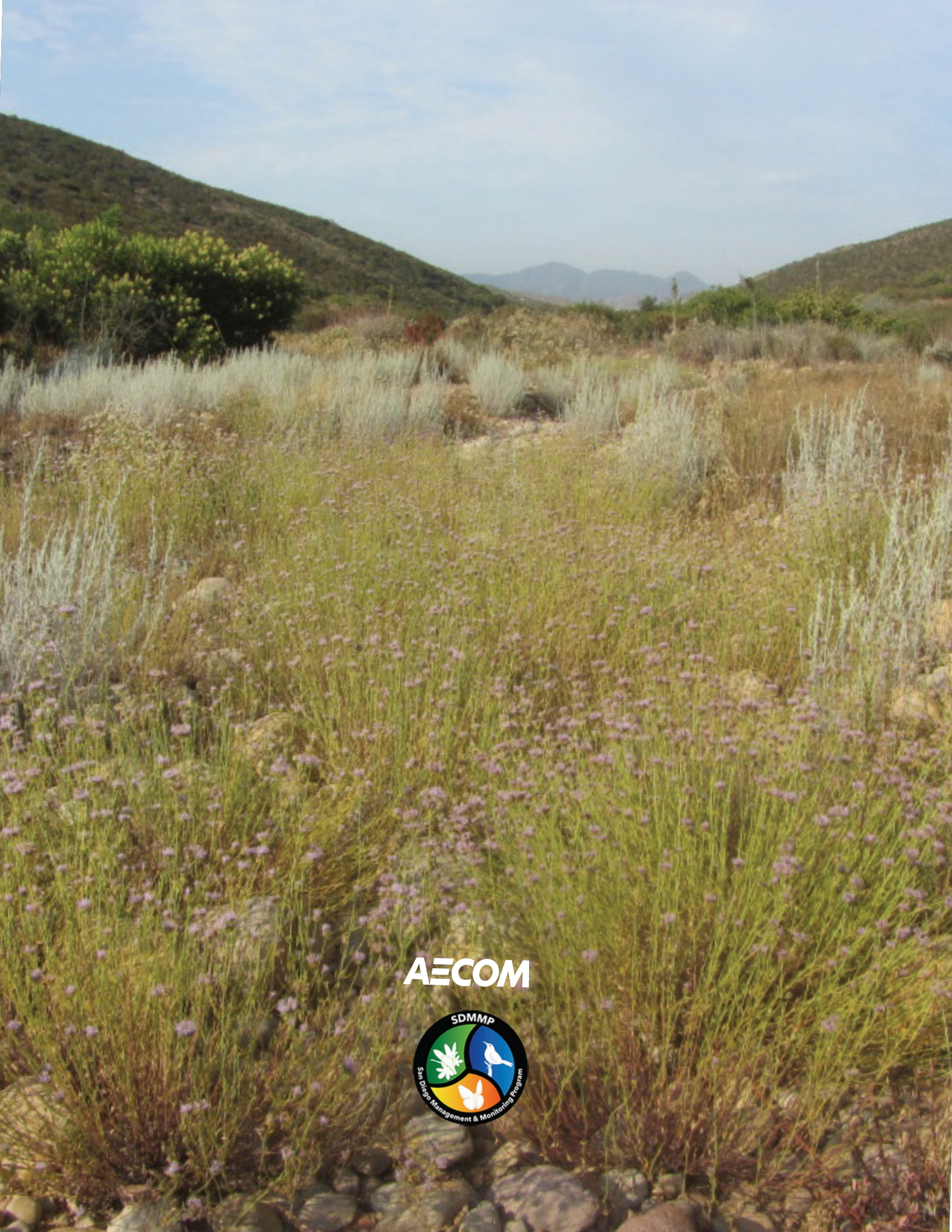
Photograph 12. Representative photo of Moderate quality habitat in UpperSycCyn4I. Photo is representative of reduced habitat quality due to reduction in presence of alluvial bench due to a steep channel wall along 50-percent of the channel. Habitat within this canyon was similarly reduced by low channel stability.

Photograph 13. Representative photo of Low quality habitat in OakCyn1A (low quality). The most common factor in canyons with low habitat scores was the general absence of an alluvial bench despite generally exhibiting channel and vegetation characteristics of willowy monardella habitat.

Photograph 14. Representative photo of Low quality habitat in SpringCyn1A. Photo shows the general lack of alluvial bench typical of most low quality habitat surveyed.

Photograph 15. Representative photo of Low quality habitat in UpperSycCyn4Z. Photo shows the lack of native vegetation cover and fine substrates in both the bench and channel.

Photograph 16. Representative photo of Very Low quality habitat in UpperSycCyn4U. Very Low quality habitat was generally indicated by narrow channel widths and lack of alluvial benches.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