

**Long-Term Monitoring Plan and Baseline Survey
of Willowy Monardella (*Monardella viminea*) at
Marine Corps Air Station Miramar
San Diego, California
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Executive Summary

The San Diego Natural History Museum signed a Cooperative Letter of Agreement with Marine Corps Air Station (MCAS) Miramar through Southwest Division Naval Facilities Engineering Command to provide a long-term monitoring plan and baseline survey for the endangered species willow monardella (*Monardella viminea*). This project provides a comprehensive population census in all appropriate Station habitat, creates a method to track the status of willow monardella on MCAS Miramar, develops a methodology for monitoring population trends, and reports potential plant specific management needs. The monitoring protocols outlined here will provide consistent data collection, data evaluation, and assessment of this taxon's status on the Station.

Willow monardella is typically a low-growing shrub (typically 30-50 centimeters in height) that can reportedly reach a height of about one meter (this project observation). This species lacks a central stem, but instead has multiple stems growing from a centralized root system. The plant is a perennial that flowers each spring.

A recent taxonomic study looked at the known populations of willow monardella within San Diego County and reclassified them. This taxonomic re-evaluation of willow monardella has created a new species (located in the southern part of San Diego County) that is now recognized as *Monardella stoneana*. The MCAS Miramar willow monardella populations have been elevated to species status (previously the subspecies *Monardella linoides* ssp. *viminea*) identified as *Monardella viminea*. Willow monardella is found in coastal San Diego County from Elanus Canyon in the south to Penasquitos Canyon in the north. It occurs within flood plains of canyons and most frequently is located in close proximity to ephemeral drainages.

There is little documentation regarding the life history and ecology of willow monardella. The observations from this project provide new information and a more detailed interpretation of the natural history and biology of this species (though much is yet needed). Evidence, thus far, appears to indicate a direct competition between willow monardella and naturalized exotic plant species, particularly exotic grasses with heavy thatching (dense intergrowth of grass leaves and culm/seed stalks).

The Cedar Fire burned most of the species-occupied habitat on MCAS Miramar in October 2003. Project-established monitoring sites were revisited after the fire and revealed that at least some of the plants have been able to crown sprout (regrow from the roots). A baseline plant census was completed prior to the fire and will permit plant fire response evaluation.

All Station willow monardella occurrences were mapped using Axis 3 Global Positioning System equipment to sub-meter specificity per MCAS Miramar standards. Such specific measurement will allow for more accurate population evaluations and population trend analysis over time.

The baseline surveys located occurrences of willowy monardella in seven watersheds on the Station. In total, an estimated 3,379 individuals were located across 393 occurrences.

The data from the baseline survey was used to develop a monitoring protocol which focused on the following questions:

1. Are the populations of willowy monardella at MCAS Miramar declining, increasing, or remaining stable?
2. Is recruitment (adding new individuals to existing populations) occurring for this species and in what form does it occur (episodic or continual)?
3. Is the life stage structure (proportion of plants at each stage in the life cycle) of populations stable or unstable?
4. What potential threats to this species currently exist?
5. What actions or management directives could prove beneficial for this species?
6. What is the natural history and ecology of this species?

Fifteen monitoring sites were established in 2003 for long-term data collection. Establishment of the monitoring sites was determined by population locations, cost of repeated monitoring surveys, and expected statistical value. Initial results of the test plots found that there is a high amount of variance in the population numbers of willowy monardella.

While little is known about many aspects of willowy monardella, this project has been designed as the first step in assessing the extent of MCAS Miramar's populations, providing a long-term monitoring plan for continued assessment, presenting information for species management, and evaluating the species status on the Station. Continued use of this monitoring protocol, in the absence of catastrophic events, should offer valid census data, plant ecology insight, and guidance for best management practices to maintain the species.

Introduction

In September of 2001, Southwest Division Naval Facilities Engineering Command, on behalf of Marine Corps Air Station (MCAS) Miramar, entered into a Cooperative Letter of Agreement (Agreement) with the San Diego Natural History Museum to provide a baseline survey and a long-term willowy monardella (*Monardella viminea*) monitoring plan for MCAS Miramar. Willowy monardella is a Federal and State of California listed endangered species which occurs only at MCAS Miramar and nearby off-station watersheds. This plan includes a review of current scientific and gray literatures, knowledge of the ecology and life history of this endangered species, and a comprehensive survey for the species in the Station's watersheds. The information gathered has been used to develop a methodology for monitoring the Station's population trends and potential management needs specific to this species.

Located in San Diego County, California, MCAS Miramar is thirteen miles north of downtown San Diego and four miles east of the Pacific Ocean (Dames and Moore, 2000). The Station consists of 23,116 acres (Dames and Moore, 2000), a portion of which has been developed as an airfield and associated military support facilities.

The Station is physically situated between Interstate (I)-805 on the west and Sycamore Canyon on the east, a distance of approximately 12 miles in length. The Station is about four miles in width at its widest point on a north-south orientation. The general topography is composed of coastal mesas between I-805 and I-15 (western Miramar) and foothills that extend from I-15 to the eastern boundary of the Station (eastern Miramar).

The coastal mesas are dissected by four major canyons and their smaller tributaries: Rose Canyon in the north, San Clemente Canyon through much of the southern and the central portions, and Elanus Canyon and Murphy Canyon in the southern portion. The eastern portion of the Station is a steep cobbled network of canyons and hills. Except for San Clemente Canyon, there are several distinct watersheds in this portion of the Station, which eventually drain into the San Diego River. The major canyons are Sycamore Canyon, on the extreme eastern edge of the Station running north to south; West Sycamore Canyon, just west of Sycamore Canyon running north to south; and San Clemente Canyon that extends west to east from the coastal mesas into the foothills. The San Clemente Canyon drainage eventually becomes channelized off Station and enters Mission Bay. Along the southern edge of the Station are several smaller canyons collectively referred to as the finger canyons. Spring Canyon is the largest finger canyon with Quail, Little Sycamore and several unnamed canyons draining to the south and eventually linking to the San Diego River. Murphy, Elanus, Sycamore, and West Sycamore canyons are part of the larger San Diego River watershed, and refer to distinct localities on the Station, representing separate watersheds within the Station. This distinction of local watersheds on the Station is important for the implementation of management and monitoring activities.

The Station consists of eight watersheds representing portions of three different larger San Diego County drainage systems. These watersheds are associated with the San Diego River (terminus San Diego River Channel), San Clemente Canyon (terminus Mission Bay), and Rose Canyon (terminus Los Penasquitos Estuary). Miramar's watersheds are particularly relevant to this project as they are the largest defining factor for the presence of willowy monardella populations.

Description

Taxonomy

Monardellas are in the mint family (Lamiaceae). There are approximately 30 species of *monardella* in the genus. All are found naturally in the western parts of North America. In 1912 Abrams divided the genera into two subgenera (Macranthae and Pycnanthae) distinguished by the size and density of the flower heads (Abrams, 1912). Willowy monardella is a perennial in the subgenus Pycnanthae.

In 1902, willowy monardella was first described as a species and assigned to the taxon *Monardella viminea* by Edward L. Greene, (1902). Subsequently, this taxon was revised and recognized as *Monardella linoides* var. *viminea* (Munz, 1935). Abrams (1951) also conducted taxonomic work on this taxon and transferred it to *Monardella linoides* ssp. *viminea*. In 2003, willowy monardella was again studied taxonomically in an article (Elvin and Sanders, 2003) published in the scientific journal *Novon*. This most recent article looked at "willowy" monardella growing in the mountains of northern Baja California and southern San Diego County. It compared that to populations in central San Diego County (in and around MCAS Miramar). The authors found that there were significant differences in morphology and habitat.

This taxonomic re-evaluation of willowy monardella found the differences to be sufficient to justify recognizing a new species for the populations in the south San Diego County and Baja California, which are now considered to be *Monardella stoneana*. In addition, the central San Diego County populations were elevated from the level of subspecies to species, as *Monardella viminea*, which includes all of the populations found on and around MCAS Miramar.

This change in taxonomic treatment is significant since it relates to the special status of willowy monardella as a Federal listed Endangered species. The taxonomic status change reduces the overall distributional range for this species and decreases the number of known occurrences. This reclassification means that MCAS Miramar now has the largest number of known *Monardella viminea* individuals.

Appearance

Willowy monardella (*Monardella viminea*)

is typically a low growing shrub that can reach a height of roughly one meter (based on field observations during this project). This species has multiple stems growing from a root system. Willowy monardella plants often grow in dense clusters called clumps where it is difficult to determine where one plant stops and another begins. These clumps can often be several meters across.

Willowy Monardella along Drainage



The Jepson Manual (Hickman, 1993) reports that willowy monardella has a tap root, but from field observations by Keith Greer and Cindy Burrascano (Kelly and Burrascano, 2001), it appears that willowy monardella may have rhizomatous roots located just below ground level establishing connections between seemingly different plants (Kelly and Burrascano, 2001). This is further corroborated by the observations of Mark Elvin who has grown the species in greenhouses (Mark Elvin, Pers. Communication 2005). Without significantly impacting individuals of this rare species, it is difficult to know whether one or both root types are present.

The plant's general morphology usually appears as a roughly hemispherical subshrub with grayish green foliage. It often resembles a small plant of flat-topped buckwheat (*Eriogonum fasciculatum*) to the untrained observer. The tubular flowers are typically light lilac or white in coloration. The entire plant has a strong minty aroma, especially during flowering time. Willowy monardella typically flowers from May to August, but blooming time is dependent, at least in part, on rainfall within a given year.

Hydrology and Habitat Characteristics

Willowy monardella is found in coastal San Diego County from Elanus Canyon in the south to Carroll Canyon in the north. Willowy monardella is primarily known to occur within flood plains of canyons, and most frequently, is located in close proximity to seasonal drainages. There are three typical habitat requirements for willowy monardella: (1) The size of the canyon's flood plain, (2) the hydrology of the sites, and (3) the climate.

- (1) In smaller canyons (roughly 50 meters or less across) with very flat flood plains, willowy monardella is found immediately adjacent to or within the seasonal drainages. These drainages typically consist of a cobbled bottom (cobbles vary in size with most around 10 centimeters [4 inches] across) and eroded banks. On MCAS Miramar, these drainages meander greatly, often crossing the flood plain

areas several times over relatively short distances. Willowy monardella appears to be most abundant at the bends in the meandering drainages, though it can be found anywhere along these drainages. Willowy monardella plants will also grow quite abundantly on low benches that are adjacent to the streambed but somewhat lower (approximately 1 foot [30 cm]) than the surrounding terrain. Secondary channels often have willow monardella individuals growing densely along their bottoms and edges. The typical willow monardella habitat suggests that this species appears to prefer a seasonal sheet flow (slow shallow moving water). Another observation is that the willow monardella always seems to drop out of the flora when the canyon becomes steeper, which may be caused by an increase in velocity of the water.

The soil of the flood plains is typically from eroding marine terraces and is full of cobble and sediments. The US Department of agriculture predominantly maps the soils where willow monardella occurs at MCAS Miramar as the following soil series: Stony Land, Redding Gravelly Loam, Visalia Sandy Loam, and Riverwash.

Typical Habitat in Smaller Canyons



Overview of Habitats in Smaller Canyons



In larger canyons with greater water flows in the drainages, willowy monardella is most often found on cobbly, alluvial bench areas and along tertiary drainages. The cobbled bench areas are usually flat areas that probably only flood periodically. These benches can be near the drainage or quite separate, but typically are outside or higher in elevation than the riparian/wetland habitat that occurs along the lower parts of the primary drainages of these wetter canyons.

Typical Habitat in Larger Canyons



(2) Willowy monardella's hydrological preferences appear to be associated with seasonal surface water flow within a specialized microhabitat. The most abundant populations of willowy monardella occur in the following types of hydrological regimes:

- At the bends in meandering drainages where the drainage is often widest so that the energy of the ephemeral water flow would be most dispersed.
- Low benches along streambeds where ephemeral streams might overflow their banks and would be likely to spill a portion of the surface water flow.

- Within a drainage where the banks are low and the drainage is wide, or on small “islands” (discrete higher areas amid the streambed) that receive water through absorption of ground water or slower flow.
- Secondary channels (less defined drainages) where water flow is shallow and slow.
- In larger drainages where plants are typically found further from the streambed center along secondary swales or higher alluvial benches that generally inundate only in very heavy storm events.

The characteristics that all of these localities have in common is a reduced flow mechanism that probably has a shallower, slower water flow (sheetflow) as compared to the rest of the drainage. Why these areas are favored by the plant is speculative at present, but it may have to do with water availability or germination requirements of the species. Individual plants are sometimes located in other types of hydrological systems, but these areas may have originally met the above conditions only to be eroded into something else or there may be a very small piece of microhabitat remaining that reflects the above environmental conditions.

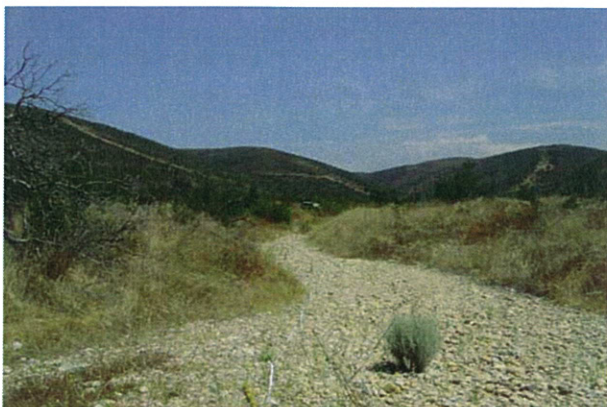
Willow Monardella in a Streambed that widens and is without Banks



An Alluvial Bench on Right of Photo



Willow Monardella hydrological setting



Bend in Meandering Drainage Where Willow Monardella Likes to Grow



(3) The climate, which controls the habitat's hydrology, is typically arid with an average rainfall of around 10.6 inches annually, although coastal fog provides the scrubland with additional moisture. MCAS Miramar and surrounding areas are located in an arid climate. Traditional rainfall patterns occur predominantly during late fall, winter and early spring (November-April). The heaviest period of rainfall is February and March. These periods of seasonal inundation, then dry out with the hottest months of August – October, when temperatures can exceed 100 degrees Fahrenheit.

The vegetation associated with willowy monardella is varied in composition ranging from riparian oak woodlands to non-native grasslands. The most common willowy monardella habitat is coastal sage scrub with a heavier than normal presence of broom baccharis (*Baccharis sarathroides*). In addition, several types of chaparral (ie. scrub oak chapparral, chamise chapparral, southern mixed chapparral) can be associated with populations of willowy monardella. In all cases, the microhabitats are fairly open, without dense vegetation at any level (herb, shrub, or tree layer). A comprehensive list of plant species observed at the sample study sites done in 2003 is provided in Appendix 2.

Distribution

The recent taxonomic split of willowy monardella (*Monardella viminea*) from Jennifer's monardella (*Monardella stoneana*) has greatly reduced the known range for the species. The entire known historical range of willowy monardella is within coastal San Diego County, and consists of very specific habitats within this region, specifically flood plain areas with appropriate hydrology and cobbled soil. The majority of the extant distribution for willowy monardella is on MCAS Miramar.

The California Department of Fish and Game Natural Diversity Database (CNDDB) reported populations of willowy monardella occurring in the watershed/canyon systems north of MCAS Miramar, which include Lopez, Cemetery, and Carroll canyons. There are also reports of the species from San Clemente and Sycamore canyons, both on and off MCAS Miramar property (State of California, 2004). Only seven occurrences off MCAS Miramar have been confirmed by the CNDDB within the last ten years, and at least two of these have been showing a decline in numbers. The CNDDB reported populations in the Otay area and Baja California, but these now appear to be the newly described Jennifer's monardella (Elvin and Sanders, 2003). There are no specimens of willowy monardella from Baja California the San Diego Natural History Museum's Herbarium.

Historical populations occurred along portions of I-15 in Murphy Canyon and along State Route 52 (State of California, 2004). Other populations include an industrial park north of MCAS Miramar along Frontage Road, (State of California, 2004) Switzer Canyon in the north park subdivision of the City of San Diego (Kelly and Burrascano, 2001), and Carroll Canyon at a newly constructed Business Park. There were lawsuits filed against

the U.S. Fish and Wildlife Service (USFWS) and the City of San Diego regarding these impacts by the Center for Southwest Biological Diversity and California Native Plant Society. Many of the plants from these impacted populations have been salvaged and were scheduled to be replanted in the spring of 2004. The replanting was delayed and is now expected to occur in 2005.

The population distribution at MCAS Miramar prior to this project was believed to be 80% of U.S. population for this species (USFWS, 1998). With recent losses of populations in Carroll and Lopez canyons (State of California, 2004; Kelly and Burrascano, 2001) combined with the taxonomic split separating the occurrences in the southern portion of the range into a different species (Elvin and Sanders, 2003), the MCAS Miramar population appears to have an even higher percentage of the remaining populations of this species. Previous studies/surveys of this species have provided conflicting and unverifiable numbers for the locations and occurrences on MCAS Miramar. The baseline Station-wide census portion of this project uses a consistent methodology to reconcile those issues and creates a baseline of what occurred on the Station in 2002.

Life History and Ecology

Very little is known about the life history and ecology of willowy monardella. This species is known to be a perennial of an indeterminate life span (though it's been reported to live over ten years [Elvin, Pers. Comm., 2005]), which can produce viable seed (Kelly and Burrascano, 2001). The number of flowers per individual and duration of flowering time varies each year depending upon rainfall, but it was observed during the 2003 project plant census to flower typically from May to August with some individuals still flowering as late as September. The peak flowering period is early June to mid July. The habitat and distribution of the species is discussed below, including observations made during this project's data collection.

Pollinators

Prior projects have reported European honeybees (*Apis mellifera*) as being frequent visitors to willowy monardella flowers (Kelly and Burrascano, 2001). The same report states that three different insects were collected at MCAS Miramar by Mark Dodero. Two of them were wasps in the family Bembicinae and most likely of the genus *Bembix*. The other species reported was a solitary bee tentatively identified as an Andrenid bee.



During this project, several possible pollinators were observed visiting the willowy monardella flowers in the summer of 2003. The most common visitors were bumblebees and a wasp similar to a yellowjacket. Two butterfly species were also observed, a painted lady visited in the earlier part of the season and a Behr's metalmark was observed, very late in the season in late August. The Behr's metalmark as an important pollinator for willowy monardella is unlikely since the metalmarks were not observed visiting the monardella flowers until nearly all other plant species had stopped flowering, and then only in one instance. The metalmarks were abundant throughout the area during much of the blooming season. An unidentified bumblebee species and a yellowjacket-like wasp were frequent and common visitors to the willowy monardella flowers throughout most of the summer. Notably, no hummingbirds were observed visiting willowy monardella flowers.

Painted Lady Visiting Monardella Flowers



Predators

No species were observed directly eating or otherwise preying on willowy monardella. An hemipteran insect was observed on one individual plant. Hemipteran species typically consume plant phloem, however the insect was only observed on the plant (not feeding) and may have simply stopped there on its

Unidentified Visitor to a Monardella Seedhead



way to another plant species. A nectar robber (Dipteran species) was observed on another individual willowy monardella and evidence of nectar robbery (holes at the base of the petals) were seen on a few willowy monardella flowers.

Competition

Two canyons, which are both tributaries of West Sycamore Canyon, are separated by a single ridge and have dramatically different numbers of willowy monardella plants. The southern canyon has an estimated 363 plants and the northern canyon has none, despite the fact that the canyons are approximately the same dimensions. The most striking difference between these two canyons is that the northern one is dominated by exotic grasses and the southern one is primarily native shrubs.

Canyon with Willowy Monardella



Adjacent Canyon without Willowy Monardella (The light brown are exotic grasses)



In several places on the Station, it was observed that willow monardella appeared to be physically “smothered” by exotic, annual grasses. In fact, exotic grasses were observed during this project growing within willow monardella clumps. The thatching process, which is common for exotic grasses, prevents most other plant species from being able to establish and compete in shared areas by “smothering” the seedlings and in some cases even the adult plants. It is plausible that the thatching of exotic grasses is negatively impacting willow monardella. This is supported by observations of occurrences within areas with high densities of exotic grasses.

In some areas natural erosion processes appear to be undercutting some adult willow monardella plants. While this would be expected with any species that lives along drainages, it is especially detrimental when combined with the exotic grass thatching which is probably reducing new recruitment and diminishing available habitat. Thus the two effects are reducing the species abundance, reproductive capabilities, and viability in the more heavily infested areas. Simply stated, new growth areas are being “smothered”, while old growth is being eroded.

In some areas, it appeared that other exotic plant species such as windmill pink (*Silene gallica*) and filaree (*Erodium botrys*) were outcompeting the exotic grasses. In areas dominated by these non-grass exotics containing appropriate habitat, willow monardella seemed to persist. Whether these exotic species were providing a refuge for the willow monardella, by out-competing the exotic grasses or simply having less of an impact on the willow monardella than the grasses, is unclear.

Examples of Willowy Monardella Being Engulfed by Exotic Grasses



There is sufficient visitation by native species of insects to assume that pollination is occurring (see pollination section in this document). This project did not look directly at the question of seed viability. There is an obvious absence of many seedling and juvenile plants seen during the field observations. In fact in 2003, Sycamore Canyon had the only one occurrence of multiple juvenile plants. The juveniles were growing in an area saturated with oak duff. The lack of recruitment in the willow monardella populations may be due to one or a combination of several potential possibilities:

- Lack of seed viability
- Competition with exotic plants is depressing the recruitment for the species.
- Pollinators have been reduced, resulting in low numbers of viable seed set.
- Conditions for reproduction and establishment are episodic (requires specific events such as fire, flood, or other event).
- Conditions for recruitment are no longer available (habitat has changed over the time and only older plants persist).
- This plant species' normal life cycle involves very low natural recruitment, i.e., long lived individuals with a low reproductive rate and high survivorship of offspring).

One idea, based upon repeated observations in the field, is that juvenile plants originate and grow within the older, dead adult structures (branch and stem remnants). This site specific form of recruitment (within the canopy/spread of the parent plant) is unusual in the plant kingdom. However, this is one method that a plant species might maintain site availability. Documentation of this recruitment observation would require impacting the species. It would require digging up young plants and determining if they are new juveniles or rhizomatous clones.

After the Cedar fire in October 2003, all established willow monardella monitoring sites were revisited. It appears that an estimated 63% of the plants have been able to resprout or be replaced and were often coming back in the same locations as previously observed.

Post Fire Ecological Data

In October 2003, the Cedar Fire burned the majority of occupied willowy monardella habitats at MCAS Miramar. Monitoring efforts in the spring of 2004 revealed that willowy monardella is capable of crown sprouting from a persistent root structure. Not all individuals have regenerated at the time of this report writing. Many of the resprouts appear to be young but they are growing out of old root structures or in the exact location of previously mapped individuals. It is unknown how many individuals may have been lost due to the fire. Monitoring efforts in spring 2004 revisited the 15 monitoring plots which also burned. There was a noticeable decline in the average number of plants from a 2003 average of 57 plants per site to a 2004 average of 36 plants per site. (The data is available in Appendix 2) The extreme variability between sites and years meant this difference was not determined to be statistically significant during the analysis using the protocols explained later.

Due to the fire it was possible to determine that the larger clumps definitely consisted of multiple individuals. Whether these individuals are linked by rhizomes (underground stems) is still unclear, but they are at least separate ramets (Individual units capable of surviving on their own, but may be genetically identical to other ramets.). As of this writing, the fire does not appear to be a factor in the germination of new monardella plants as no noticeable influx of seedlings appeared in 2004.

Weather and Streamflow Information

San Diego County is considered an arid environment with an average rainfall of approximately nine inches per year (SD Lindbergh field). Precipitation data collected at MCAS Miramar airfield from 1949-1995 shows a slightly higher average annual precipitation of 10.6 inches per year. No stream flow data is available for any watersheds on the station. A streamflow data collection device was observed in San Clemente canyon, but no data could be located for it, and it is believed to be out of service. No data collectors were observed in any of the other watersheds.

A local biological hypothesis postulates that too much water created by increased urban run off from development is eroding the banks (City of San Diego, 2001) and/or saturating the willowy monardella drainages (high flows hypothesis). This increase in water both directly erodes the willowy monardella and changes the habitat to a wetland. This is thought to be one of the primary factors for decline of the species.

Observational project evidence supports some of these conclusions but differs in the mechanisms of impacts. Willowy monardella seems to grow best in areas with sheet flow (secondary spillways, wide meandering drainages, and low alluvial benches). Volume and velocity of the water may not be as important as maintaining periodic sheet flow across the areas where the plants occur. Thus, increases in volume is not itself the

upstream conversion of a naturally meandering waterway into a single channel by development. When a drainage is channelized, the channel becomes narrow and deep reducing the frequency of sheetflow events and replacing them with narrower, higher volume, and more erosive channel flows. While it has been observed that erosion of the habitat from direct flows can contribute to the loss of individuals, the observations from this project suggest the lack of sheet flow may be the primary source for decline of the species in areas of altered hydrology (sheet flow hypothesis).

The sheet flow hypothesis is supported by the fact that naturally heavy rains (wet years) are not thought to significantly harm the species in areas of natural drainage patterns. Also, if simple erosion and resulting conversion to riparian habitat was the primary cause for the monardella's decline, it would be expected that the plants would colonize new areas based upon the altered moisture regime in the canyons with increased moisture, rather than disappearing entirely.

The sheet flow hypothesis reflects the observed current distribution patterns. The populations of willowy monardella occur as scattered patches in flat areas within or adjacent to streams and along secondary overflow channels or swales throughout much of the potential habitat area. In areas of higher flows (larger flood plains), willowy monardella would be expected to occur elevationally higher above the drainage bottoms. This occurrence pattern is observed in both the larger floodplains of San Clemente and Sycamore canyons when compared to the other canyons on the Station. However, the willowy monardella is still restricted to appropriate soils.

The occurrence pattern under the high flow hypothesis would expect monardella to occur only within a band of tolerable moisture. One would expect the plants to thrive immediately adjacent to the drainage upstream and to find the plants further from the drainage downstream as the ground water and flows increase. The observed pattern is more consistent with the sheet flow hypothesis; however, neither can be proven with data on record.

Regulatory Status

In 1997, the United States Fish and Wildlife Service (USFWS) issued a Final Rule (USFWS, 1998) designating willowy monardella (*Monardella linoides* ssp. *viminea*) as a Federally endangered species. This entitles it to the strongest protection for plants possible under Federal law. The basis for the decision was the perceived decline of the species, and the clear decline of available habitat area. The recent name changes, if accepted by USFWS, would have no anticipated effect on the protected status of populations at Miramar. The USFWS is currently evaluating critical habitat designations throughout the species range.

The California Department of Fish and Game declared willow monardella a State endangered species in November of 1979. Thus, the plant is protected by The State of California Endangered Species Act and has status under the California Environmental Quality Act. Neither of these regulations apply to Federal lands; however, should any portion of a willow monardella plant be transported off-Station, permits are required from the State of California.

Current Status/Policies at MCAS Miramar

The primary agreement regarding natural resources between the USFWS and MCAS Miramar is the Integrated Natural Resource Plan (INRMP), which was written and approved by both the Station and the USFWS in May 2000. This survey and monitoring plan are part of the Station's efforts to comply with the policies, objectives and planned actions of the INRMP. The Station had specified several planned actions within the INRMP including the following:

- Map locations of unique or rare plant species.
- Initiate Special Status Species monitoring to maintain an up-to-date database in support of Environmental Assessment (EA) actions and Endangered Species Act (ESA) compliance for planning and management for all listed or proposed species.

This project and report supports both of these planned actions as well as the general goals and objectives of the INRMP.

Transplantation/Revegetation/Horticulture

Four previous projects have worked with captively grown monardella by attempting to either transplant plants or reintroduce them to the wild. The oldest project was a California Department of Transportation (Cal Trans) mitigation site for State Route 52. Plants were introduced into San Clemente Canyon as mitigation for impacts by the freeway construction. The plants were planted adjacent to existing wild willow monardella. In 1987, the introduced plants were all dead, but the adjacent wild monardella plants still appeared to be thriving (Reiser, 1994).

The Tree of Life Nursery has successfully been propagating willow monardella for retail sales for some time. These plants are not usually introduced into the wild, though for a science fair project, Jessica Duty, a middle school student, attempted to introduce nursery stock plants to Marian Bear Park in 1999 (Kelly and Burrascano, 2001). There was no plan for monitoring this population over the long term.

A project to reintroduce the plant and bolster populations in Lopez Canyon is currently being undertaken by the Friends of Penasquitos Canyon, though it is too early for any results to be reported (Kelly and Burrascano, 2001).

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The construction of the Carroll Canyon Business Park provided another opportunity to transplant the affected willowy monardella population for mitigation requirements. . These plants were taken to the Ranch Santa Ana Botanical Garden where they are being tended until the reintroduction was/is possible. The willowy monardella was scheduled to be replanted in spring of 2004, but there was difficulty finding a site acceptable to the USFWS and has been delayed until the spring of 2005 (pers. Comm. Kyle Ince, 2005).

Both the Carrol Canyon Business Park project and Jessica Duty's science fair project used cuttings as the method for plant propagation. However, seeds were used for the Lopez Canyon project. Jessica Duty found that cuttings responded favorably to root hormones.

Mark Elvin grows willowy monardella in greenhouses at University of California Irvine (UCI). He has one plant that has been growing in this setting for at least ten years. He grows them in a mixture of sand, pumice, oak duff, and clay.

As yet, there is no record of a successful transplantation or introduction for this species into the wild. The ease with which the plants grow in greenhouses suggests that successful transplantation or reintroduction may one day be a possibility. However, there is very limited available habitat suitable for transplanting and most of that occurs at MCAS Miramar and nearby areas. The lack of habitat is caused by a combination of extensive development in the coastal terraces and flood control measures that alter the hydrology of the canyons.

Baseline Survey/Information

Purpose

The baseline survey was conducted to more accurately assess population trends for this endangered taxon as well as support long-term stewardship efforts at MCAS Miramar . The baseline survey is a verifiable survey using consistent methodology and mapping that documents, to the greatest extent possible, all occurrences of willowy monardella at MCAS Miramar. This will provide a comparison for future surveys and monitoring efforts on MCAS Miramar. Previous assessments had been made during the 1990's but none were systematic, Station-wide, or sufficiently detailed in their mapping to provide a reliable baseline for willowy monardella populations on MCAS Miramar.

Survey Areas

Willow monardella has a specialized habitat and grows along ephemeral drainages, perennial drainages, or within associated flood plains areas. All survey efforts were focused within appropriate flood plain habitats.

The areas surveyed were defined in the field by the survey team. All flood plains were visited and surveys typically originated at the downstream end of the canyon and included all tributary canyons. Surveys were conducted until it was determined that the probability of locating willow monardella was virtually zero. Survey boundaries for the upstream edge were determined by several factors: lack of flood plains, associated vegetation, high density of annual grasses, steepness of canyon bottom, narrowness of floodplains, Station boundaries, shape of streambed, and distance from any prior willow monardella observations.

As the surveyors proceeded along each canyon they periodically marked the edge of the survey area with datapoints taken on a submeter global positioning system (GPS). Both the upstream and the edges of the flood plains or potential habitats within the flood plains were demarcated in the field. Later, global information system (GIS) technicians used these points to recreate the areas surveyed as shown in Figure 1. The surveyed areas are equivalent to the potential habitats for this species on MCAS Miramar.

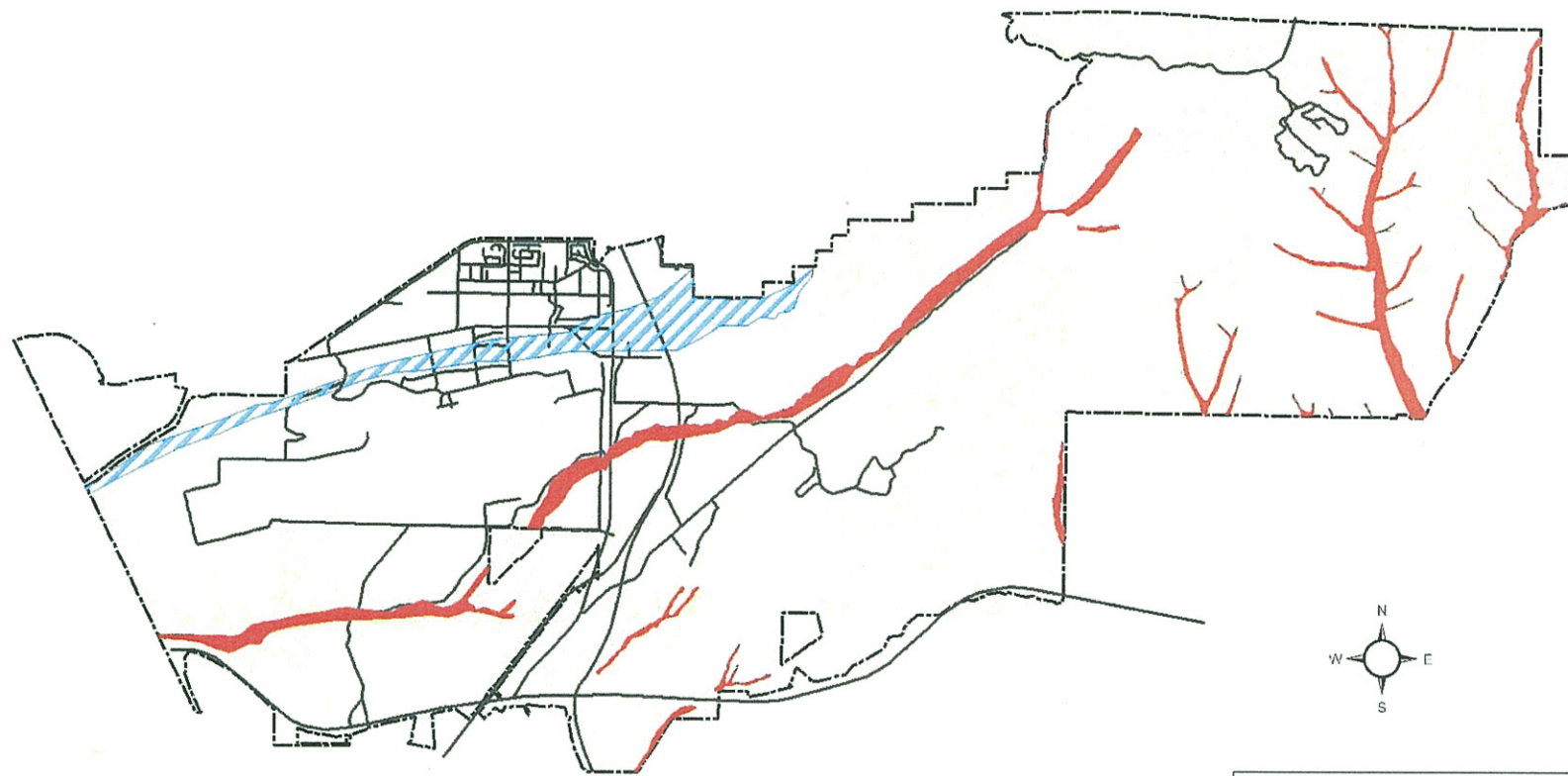
Methodology

The baseline survey was conducted on MCAS Miramar from May to July 2002 during willow monardella's normal flowering time and most vegetatively developed period. The surveys were conducted in the following watersheds: West Sycamore, Sycamore, Clark, Spring, Oak, Elanus, Murphy, San Clemente, Quail, and Little Sycamore canyons. All canyon bottoms, flood plains, and tributary drainages were surveyed for potential appropriate habitat.

When a population or individual of willow monardella was encountered, it was mapped using Axis 3 Global Positioning System (GPS) equipment. Data required for the MCAS Miramar botanical database were recorded for each occurrence. Notes were taken using a hand-held computer (personal digital assistant) in conjunction with the GPS equipment. This information was then downloaded, compiled, and formatted by the San Diego Natural History Museum's Global Information System (GIS) specialist, Jim Barry (Attached CD).

In each watershed, two willow monardella voucher specimens were collected from each population of sufficient size and health so that no individual plants were significantly impacted. All specimens have been mounted on herbarium sheets and labeled per the herbarium standards of the San Diego Natural History Museum's Department of Botany. Additionally, a total of two specimens were collected from the Station's populations to be used for training by the MCAS Miramar, Environmental Management Department. All specimens, except those retained for training, have been deposited in the SD Herbarium and have become the property of the San Diego Natural History Museum

Areas Surveyed for Willow Monardella Baseline Survey



Key to Features

-  Contractor Surveyed Areas
-  Surveyed by MCAS Staff

Survey Date : 2002

Figure 1

Produced by the San Diego Natural History Museum
Survey Date : 2002
Jim Barry 2004

Results

The baseline survey located willow monardella in seven watersheds on the Station. However, in Murphy Canyon only three dead plants were located; therefore, only six watersheds had active populations. In total, an estimated 3,379 individuals were located across 393 occurrences. An individual is a single plant, and occurrence is a single undivided mapped group. A population is a grouping of occurrences and individuals within reasonable vicinity of each other. The distribution of the plants across the watersheds is given in Table 1, followed by a description of the typical habitat and populations within each watershed.

Table 1: 2002 Baseline Distribution of Willowy Monardella at MCAS Miramar by Watershed

Watershed	Estimated Number of Individuals	Number of Occurrences	Occurrence(single map unit) with the Largest Estimated Number of Individuals
West Sycamore Canyon	1792	153	332
San Clemente Canyon	574	103	63
Spring Canyon	549	80	38
Sycamore Canyon	446	51	35
Elanus Canyon	16	3	12
Rose Canyon	2	2	1
Murphy Canyon	0	1	0

West Sycamore Canyon

This watershed contains the largest number of individuals. The majority of these plants are in two unnamed side canyons with 799 of the individuals occurring in a single side canyon. This side canyon is east of the main floodplain and south of fuel break NS-06. This population is the densest at MCAS Miramar and provides the best glimpse of the growing patterns before the arrival of exotic species and alterations to the drainages due to the canyon's isolation. The second densest population is estimated to be 363 individuals scattered along a small meandering drainage in an unnamed tributary canyon, west of the main floodplain and roughly opposite of the largest population.

At the upstream end of West Sycamore Canyon, the canyon forks into three smaller unnamed finger canyons. Within each of these tributary canyons are scattered populations of willowy monardella. The main floodplain of West Sycamore Canyon below the convergence of the three finger canyons has several medium to large occurrences of willowy monardella. This area is the most densely populated portion of the main floodplain in this canyon. The frequency of occurrences drops dramatically from this point as one moves downstream. There is a notable occurrence near Santee Lakes. This population had an estimated seven individuals in 2002, four of which were noted as being in a powerline easement. During 2003, the four individuals within the powerline easement were not located. Five total individuals were counted at the same site, but none were in the powerline easement. The increase from three to five remaining individuals was most likely due to the changed counting method used in 2003.

All of the occurrences were within open coastal sage scrub/chaparral habitat with riparian influence. There were rarely any willows (*Salix* spp.), mulefat (*Baccharis salicifolia*) or other wetland species in the areas where the willowy monardella occurred but flat-topped buckwheat (*Eriogonum fasciculatum*), holly-leaved cherry (*Prunus ilicifolia*), coastal mountain mahogany (*Cercocarpus minutiflorus*), broom baccharis (*Baccharis sarothroides*) and other species common to the drier flood plains at MCAS Miramar were usually present. Also, there was a large amount of exotic grasses (wild oats [*Avena* spp.] and bromes [*Bromus* spp.]) in some areas of this canyon.

San Clemente Canyon

Due to the presence of an established riparian habitat along the primary drainage/stream, the occurrences in San Clemente Canyon and Sycamore Canyon were notably different. In the MCAS Miramar portion of San Clemente Canyon, riparian habitat occurs from the intersection of Rifle Range Road and fire road R-29 downstream to the point where San Clemente Canyon leaves MCAS Miramar. As this drainage steadily gets more wet, the amount of riparian habitat increases.

North of the rifle range the canyon is dominated by a tall, mature chaparral consisting primarily of chamise (*Adenostoma fasciculatum*), coastal mountain mahogany (*Cercocarpus minutiflorus*) and Ramona lilac (*Ceanothus tomentosus*). The population occurrences in this area usually occur along stream banks of the drainage, but the surrounding chaparral habitat is taller and thicker than other Station sites where willowy monardella was located.

In the wetter riparian areas, willowy monardella occurred less often along the stream banks and more frequently on alluvial benches/flats, secondary overflow channels, and tributary swales throughout the watershed. This canyon had the second largest number of individuals, but the occurrences were spread out over a greater distance than in the other canyons surveyed.

Spring Canyon

The populations in Spring Canyon are some of the least disturbed on the Station. They are fairly dense and occur along the meandering main drainages of the three canyons that make up this watershed. The most dense populations in this canyon are on low benches adjacent to the drainages and on the inside edge of the curves in the meandering drainages. Patches of willowy monardella are also found in some secondary swales. Occurrences are throughout the entire watershed except in the uppermost reaches of the tributary canyons where the canyons narrow and have more dense vegetation.

The habitat for willowy monardella throughout Spring Canyon is coastal sage scrub with some intermixing of chaparral species. There is also a large amount of broom baccharis on the sites where willowy monardella occurs.

Sycamore Canyon

According to the CNDDB and the USFWS, the occurrences in Sycamore Canyon extend beyond the edge of the Station's property. There are several Sycamore Canyon populations that occur within oak woodlands, which is very different habitat than any other population. Particularly notable is that the largest of these occurrences (Appendix 1, Map 1, Label 6) has the highest density of young willowy monardella plants that appear to be newly recruited within the population. In most other areas, only adult plants were observed with very rare recruitment being observed.

Monardella populations occurred in Sycamore Canyon in two microhabitats; along the main drainages, and on sparsely vegetated alluvial benches dominated with coastal sage scrub. The localities of the plant occurrences in this canyon resembled the distribution in San Clemente Canyon more than any of the other watersheds. This is probably due to the presence of mature riparian habitats along the streams in these canyons.

Elanus Canyon

Elanus Canyon is primarily located within the area referred to as the Tea Cup Parcel (a portion of the Station east of I-15 and south of State Route 52). It is much smaller than most of the other watersheds mentioned above, but is a tributary to the larger Murphy Canyon. A single occurrence was located just north of State Route 52, outside of the Tea Cup Parcel, but still within Elanus Canyon. Two occurrences were noted within the Tea Cup Parcel. All occurrences were found in a coastal sage scrub type, flood plain habitat dominated by broom baccharis.

Rose Canyon

Rose Canyon was initially surveyed by MCAS Miramar Environmental Management Department personnel who located a single individual in 2002. This individual plant was quite peculiar as it was not growing in the traditional flood plain habitat, but rather in a drainage on a mesa top habitat near the easternmost edge of the Station. However, this locality is along a tributary of the primary drainage that eventually flows into Rose Canyon. A second individual plant was observed in 2003 farther west by a separate survey group. This single plant was located near the intersection of Kearny Villa Road and Miramar Way, just west of the south bound onramp from Miramar Way to Kearny Villa Road. The habitat at this locality is an alluvial bench and overflow area adjacent to the main drainage, a habitat typical of other monardella populations.

Murphy Canyon

Three dead plants were found near the western edge of Murphy Canyon just east of I-15. These plants were checked both in 2002 and 2003, so it is unlikely they were dormant during the time of the surveys. This was the only occurrence of willowy monardella found in this watershed on the Station. They were located in coastal sage scrub dominated by broom baccharis. The cause of their mortality is not known.

Long-Term Monitoring Plan

Purpose

The purpose of these protocols and the long-term monitoring is to support stewardship efforts at MCAS Miramar for willowy monardella and to enable more accurate assessments of population trends for this endangered taxon. Very little is currently known about the natural history and ecology of willowy monardella, but the protocols outlined here will provide a consistent methodology for collecting and evaluating data, and creating long-term monitoring sites for assessing the status of this taxon.

Methodology

No single methodology will answer all of the possible questions that can be asked regarding this species. In order to focus the monitoring and increase the usefulness of information obtained, the methodology established here is designed to address the following questions; listed in order of priority:

1. Are the populations of willowy monardella at MCAS Miramar declining, increasing, or remaining stable?
2. Is recruitment (adding new individuals to existing populations) occurring for this species and in what form does it occur (episodic or continual)?

3. Is the life stage structure (proportion of plants at each stage in the life cycle) of populations stable or unstable?
4. What potential threats to this species currently exist?
5. What actions or management directives could prove beneficial for this species?
6. What is the natural history and ecology of this species?

The first three questions and part of question six can be answered exclusively with demographic data, therefore the collection of demographic data has been given the most time and attention in these protocols. For management purposes, demographic information is the most urgent within the current regulatory framework. If the populations of willowy monardella are not shown to be declining, there may be no need for additional management actions (passive management), but if a decline is found to be occurring or imminent over time then questions four through six become crucial in order to determine how to stop or reverse such trends.

Framework

The overall framework for these protocols needs to be as flexible and simple as possible to allow for shifting budgets and staffing priorities over the years. The protocols in this report will strengthen over time as the amount of data accumulates and trends can be observed. These protocols can be phased in slowly or rapidly depending on need and priority.

The basic structure of the data to be collected will be taken from a series of permanent study sites located within the Station's watersheds. Additional watersheds and sites can be added or phased in to accommodate budget, however this should be done carefully as removing sites is not recommended if consistent data analysis is to be maintained. It is more efficient use of personnel and fiscal resources to have more sites in the watersheds where willowy monardella is currently abundant and focus on the other watersheds when/if funds become available. Initially fifteen sites were established in the spring of 2003. All are located in the West Sycamore Canyon watershed (Figure 2)

The monitoring protocols proposed by this project initially measure the number of individuals (N) at a given study site. This process is expanded to evaluate the life stage of the individuals present. The protocol's primary response variable (a measurable quantity which may change over time or with perturbations) is the change in population size (ΔN). By focusing on this variable the need for control plots will be eliminated because the analysis will primarily be based upon degree of change in population at a study site and/or differences in population size within study sites, when compared to other study sites growing under different circumstances. More simply stated trends (correlation and ANOVA [Analysis of Variance]) will be observed and analyzed based upon differences in existing field conditions. For example, if it is found that some populations occur within oak woodlands and others are found in coastal sage scrub, the recruitment levels can be compared statistically to determine whether there are significant differences in recruitment between the two habitats. Other comparisons can be made based upon stream morphology, presence or absence of exotics (non-native plant species

that may be out-competing native species), and population dynamics. The amount of variability within and between the study plots and the number of study plots determines what degree of change can be assessed.

Depending upon the analysis used, data can be evaluated for each watershed separately or all areas can be combined. Generally speaking, questions not concerning watershed specific hydrology will be able to use a larger dataset as cross watershed comparisons will be permissible (increasing the power of the analysis).

Fieldwork

Initial study sites have been established for this long-term monitoring effort. The number and locations of study sites were selected using the following criteria:

- Watershed location- having many sites within a single watershed allows for a closer study of a given hydrology and watershed specific issues, whereas sites in many watersheds can look at differences between watersheds, but may make some comparisons more difficult.
- Presence of willowy monardella- all study sites will initially have some willowy monardella present.
- Variance of populations in studied plots- if data shows that there is a high variability between plots then more study sites will be needed to detect differences between plots or only larger differences will be observable.
- Number of occurrences within a given watershed- watersheds with greater populations may initially yield more information and can support more study sites.
- Upstream activity- if development is occurring upstream there may be a management/regulatory interest in how it is or is not affecting populations downstream.
- Proximity to other sites- generally, the more separated the study sites are within a watershed, the better for data analyses, because there will be fewer common influences at more disparate sites.

The initial trial study found the variability between study sites in West Sycamore Canyon to be very high. The variability in the study sites and the suggested numbers of sites is addressed below in the section on power of the statistics. Fifteen sites will not be enough with the current amount of variability.

Each site consists of a portion of drainage (reach) approximately 50 meters in length, as the water flows. A reach is determined by the center of the drainage width closest to an occurrence of willowy monardella, and then following the drainage from the upstream end of the occurrence for 50 m. The occurrences chosen were the upstream ends of clusters of occurrences and spread out as much across the watershed as possible to maximize the independence of the data. The total area of the study site consists of the potential habitat within the flood plain as qualitatively assessed by botanists using the

characteristics described in the habitat description of this document. The flood plain from edge to edge for the length of the reach will be mapped using GPS coordinates for future assessments. Not all sites will be of equal size, however all sites will be of a fixed known area, such that differences in dimensions can be controlled when necessary for data analysis

An Example of a Stream Reach (2003)



The data collected at each study site can be broken down as follows:

Study information

Relevant sampling information for tracking and monitoring will include dates of sampling efforts, GIS locality of reach and boundary, name of assessor and site label. Each study site will have a unique designation for long-term

tracking. The designation will consist of an abbreviation for the watershed, a cycle number (1-3), the year it was first assessed, and a letter of the alphabet respectively. For example WSYC12003C indicates that this site is in West Sycamore Canyon (WSYC) and is assessed during 1st measurement cycle (1). Furthermore, this site example was first assessed in 2003 (2003), and is site C (C) within the West Sycamore Canyon watershed.

Demographic data

The location of all individuals of willowy monardella will be mapped in some study sites as specifically as possible using a submeter GPS unit. In some situations, due to population density, it may not be possible to map individuals so clusters will be mapped and described by the surveyor. It also may not be possible to separate individuals which appear as multiple plants due to rhizomous underground connections. All counts are based on the estimated surface individuals (aka:ramets) not the absolute number of genetically unique individuals(aka:genets) The number of individuals will be estimated within these clusters by measuring the length and width in meters of the cluster at their longest/widest points. These two measurements will be multiplied together and divided by the value 0.785 square meters. This value was derived as the largest surface area a willowy monardella is likely to occupy. A single large willowy monardella was observed during the 2002 surveys and measured to be just over a meter across. Using that as a guideline, the ground cover area of one large circular monardella plant with a diameter of 1 Meter was calculated. This number should conservatively estimates the populations since most plants are expected to be smaller than 1 meter in diameter.

At least 10 detailed study sites were initially mapped for tracking. Based upon the results and the amount of time it takes to map these detailed sites, additional detailed sites can be added. These sites provide information on specific individuals over time. At every study site the following data needs to be collected:

1. number of individuals,
2. each individual's current phenology,
3. each individual's stage of growth (Seedling, Juvenile, Mature, Adult)
4. each individual's prior presence.

Four growth stages are used for assessing life stage: seedling; juvenile; mature, and adult. Seedlings are defined as individuals less than four inches tall and lacking multiple stems. Juveniles are defined as lacking multiple stems but being over four inches tall. Mature plants are those with twenty or fewer stems. Adult plants will have more than 20 stems and over four inches tall. This type of numerical, demographic data will indicate whether a population is growing, diminishing, or stable but will not examine why it is going in any particular direction.

By assessing the stage of development for each individual plant in the population, the population structure can later be studied, which will provide more in-depth information than census alone? It is expected that the longer the monitoring study continues without interruption, the more accurate demographic assessments and projections will become.

Population Trend Assessment Information

At each site, the following data is collected in order to help assess potentially beneficial and detrimental effects over time:

1. A floristic list of all other plant species at each site is compiled, with an emphasis on exotic species.
2. Percent coverage of each species at the study site is assessed qualitatively.

The boundaries of each associated drainage channel are mapped only within the detailed study sites and the edges of the drainages are established using a submeter GPS unit. During the course of collecting data over the years, botanists should describe in their notes, any potential changes in the hydrology of the site. At all study sites habitat quality/conditions are identified by the field personnel and assessed qualitatively. Field personnel will estimate percent cover of species, note any unusual hydrology and if possible estimate the average width and depth of the channels. If a population change is later found to be significant, additional quantitative analyses or data collection may be necessary.

Data Analysis

The demographic data collected during site assessments can be analyzed using multiple methodologies. For the demographic data affecting management questions, methods of analysis are provided below. First is a simple analysis that may not be statistically or scientifically valid, but will provide an idea of what is happening on the study sites for

quick management assessments. Additionally, a more detailed/expanded methodology will be used for more extensive statistical analyses and scientific validity. Demographic data can be viewed on a watershed by watershed basis or can be assessed for the entire Station. For questions five and six, the evaluation is dependant upon qualitative information and the results of the data from questions 1-4.

1. Are the populations of willowy monardella at MCAS Miramar declining, increasing, or stable?

Simple

The first question can be answered by looking at the numbers of individuals totaled and compared to prior assessments of the same sites.

Detailed

The Growth/decline rate (λ) of the population can be estimated by looking at current population numbers and dividing by the previous population number. A value equal to one is a stable population; less than one is a declining population and greater than one is an expanding population.

2. Is recruitment occurring for this species and in what form does it occur (episodic or continual)?

Simple

This question may take longer to determine if the recruitment is presently lacking or episodic in nature. Recruitment of individuals into a population can be measured by looking at the density of seedlings or juveniles over time. In a continuous recruitment process, the percentage of the population that are seedlings (percent seedlings) should remain fairly constant from year to year. However, if the seedling plants are responding to wet years, there will be spikes in the percentage of seedlings during those years. This can be analyzed by plotting percent seedling values in populations against the year and looking for obvious spikes.

Detailed

Whether a spike is statistically significant or not can be analyzed using an ANOVA (Analysis of Variance), where the year is the discriminate factor and percentage of seedlings is the response variable. It should be noted that spikes may not be meaningful if the populations being compared are not the same or are not measured at the same time of year. If recruitment remains at or near zero, it will be difficult to distinguish between a failure to recruit new individuals, a low recruitment rate, and an episodic recruitment with long periods of time between successful recruitment events. If recruitment is determined to be significantly lower than mortality rates then the population is in decline.

3. Is the life stage structure of populations stable or unstable?

There is no simple analysis for this question; it will require time and sophisticated analyses to answer. To answer this question, it is necessary to understand the population

dynamics for several generations or many years of study to assess the stability of life stage structures. If the individuals have long lifespans and episodic recruitment occurs with large gaps of time in recruitment events or there is a low survivorship of recruited individuals, then this question may not be answerable within a reasonable period of time. However, the question is integral. For example, a taxon with only populations of 50 year old individuals, and little or no new recruitment observed should be considered to have a higher risk for extinction than a more mixed age structure with the same level of recruitment. The population size could potentially be irrelevant to risk of extinction if the life stage structure is unstable. Although there is no simple way to assess the stability of life stage structure for a species, one scientific way to evaluate the stage structure stability is to build a mathematical matrix (detailed in Appendix 4). The matrix for this monitoring plan will show the average change in each stage with each monitoring effort. By multiplying the matrix out against the existing stage structure, it is possible to see if replacement rates are sufficient to reach an equilibrium level or a point of continuous growth.

If through monitoring of the willowy monardella it is found to have episodic recruitment, the monitoring data evaluation will need to be modified. It will be necessary for the periodicity of the matrix to be calculated in units greater than the estimated periodicity of the recruitment events. For example, if after ten years of monitoring, it is found that willowy monardella is episodic and only has major recruitment during El Nino years, which occur roughly every seven years locally, then it will be necessary to look at data which is separated by nine (multiples of three) years for determining stage structure. Thus, it may be a very long time before an average change for each of the stages is actually observed. By collecting this data in the given format, it will eventually allow such analyses to be made and hopefully reveal any shortcomings that may be encountered in the data.

4. Assessing habitat quality for willowy monardella?

Simple

Once population trends are determined, habitat factors at the sites can be correlated to those trends to determine which factors are most strongly associated with declining or increasing populations. A simple analysis is to examine the study sites with larger populations to see what is present or absent at the sites and compare that information to the sites where willowy monardella is declining or depauperate.

Detailed

Statistically, this is done by using an ANOVA. An ANOVA is a statistical model that focuses on differing treatments of a site (determinants) and correlates them to changes in the variance of a response variable. In this model system, the usual response variable will be changes in population sizes or density. The treatments will be the presence/absence of various species or threats. If a significant effect is found, a regression analysis can sometimes further evaluate the intensity of that effect. These are more complex statistical evaluations, but if declining or unstable populations are found, they will be useful in assessing the potential causes. The qualitative habitat data

collected is not as cumbersome to compile as the demographic data, but may eventually provide a starting point for determining which factors are harming or helping the willowy monardella populations.

5. What actions or management directives could prove beneficial for this species?

This question will be answered indirectly by the results of the monitoring. Subsequently, actions or directives can be implemented if necessary to address problems or enhance populations.

6. What is the natural history and ecology of this species?

This question will be answered, in part, by the collection of demographic and habitat data. Additional observations can be documented and recorded as the project progresses through the years and botanists have the opportunity to interact directly and observe this species in more detail.

Strengths and Weaknesses

The strength of the protocols presented here is the relative speed at which it will be able to assess a growth or decline of willowy monardella at the study sites. After several years, the initial data from the study sites can be assessed with additional data accruing in subsequent years. Analyzing a portion of the sites in different years will be possible to expand the data set and observe the behavior of the willowy monardella each year as it responds to rainfall patterns, while accumulating larger datasets for evaluation over the long-term. The primary weakness of these protocols is that if there is a high variance between study sites, there may be a low margin of detectability as explained below.

Statistical Power

In any statistical test, the margin of detectability is the smallest change that a monitoring process will distinguish as significant (i.e. power of the test). It may be possible to observe smaller changes, but they will not be determined as scientifically significant. With the above monitoring format two factors will have the greatest impact on the margin of detectability: 1.) how much the monitoring sites typically vary between sites, and 2.) the number of monitoring sites. The more monitoring sites assessed the greater sensitivity of the monitoring tests. The less variability between the monitoring sites, the greater the sensitivity and the fewer sites required to detect changes. These issues, in regards to the monitoring project, are primarily financial. The more sites assessed, the greater the sensitivity of the monitoring. However, more monitoring and analysis effort means more expense.

The variability in the initial fifteen test plots is very high. Initially, the margin of detectability was calculated to be a 77% change in the population size. This means that if a population of 100 plants increased or declined, it would need to add or lose 77 individuals in order to have the change be considered significant. This was calculated

using the assumption of a 5% acceptable error. No change could be detected when population size was adjusted for plot size (Zar, 1984; Bonham, 1989).

This is not going to be acceptable for a monitoring program. Further experimentation showed that in order to detect a 20% change in the population size (considered to be mathematically significant), the variance is assumed consistent throughout sites, and the monitoring program will need to have 200 sample sites. Even split over three years, it would require almost 70 sites surveyed/per year. This would be very time consuming. It would be more efficient to simply repeat the baseline survey every few years. A more reasonable approach might be to have sixty sites on the Station, which would mean 20 sites sampled each year. Also, it would be necessary to accept a larger potential for error of 20% (instead of the standard 5%). This number of samples and accepted risk has a minimum detectable difference of 28%. The unfortunately high variance between the sites will result in a high number of necessary sites. The above values are estimated from statistical tests (the standard t-test estimation for power) that have similar dependencies.

The 2004, monitoring efforts allowed for additional data tests to be done. The additional tests showed that the variability in the data between sites was so extreme that hundreds if not thousands of sites will need to be used to get a statistically significant result. The extreme variability may be due to the fact that the entire environment was altered by fire between the 2003 and 2004 surveys. Statistical models seem to be saying that a periodic census of the entire population may be more meaningful than any study sites. The variability would be expected to be reduced in future years with less cataclysmic events, but to date, these are the only data available.

Integration of Protocols into existing Natural Resource Management at MCAS Miramar

The following planned actions are summarized from the Integrated Natural Resources Management Plan for MCAS Miramar (Dames & Moore, 2000):

- Identify and prioritize susceptibility of high value resources located in floodplains and potential options to minimize adverse impacts on both human and natural resources (7-7).
- Initiate Special Status Species Monitoring to maintain an up-to-date database in support of EA Actions and ESA compliance for planning and management for all listed and proposed species (7-37).

The overall monitoring plan and its inherent protocols will contribute to accomplishing each of the above planned actions. These protocols are sufficiently flexible so that existing staff familiar with willowy monardella can be used to implement the study.

Monitoring Results

The following are the results of the data collection from the established monitoring sites for the years 2003 (trial season) and 2004.

Location of Study Areas and Data Collection

Fifteen sites were located in West Sycamore Canyon watershed during the spring and summer of 2003. They were labeled WSYC012003A-O. West Sycamore Canyon was chosen as the trial study area for monitoring the willow monardella due to the abundant populations located during the initial surveys.

Analysis of Data

Trial monitoring efforts were conducted in 2003. Therefore, the first year of monitoring was 2004. The Cedar Fire occurred between the collection of the two sets of data, which has greatly increased the variability and rendered several analyses powerless to detect differences. There are six key topics (bulleted below) this plan intends to address along with the appropriate results for the first year.

- Are the populations of willow monardella at MCAS Miramar declining, increasing or remaining stable?

Fifteen sites were established and counted in 2003 and 2004 (Figure 2, Appendix 2 and 3). They were assessed using the system laid out in this document. In 2003, the average number of individual plants was fifty-seven, ranging from 4 to 375 at any given site. In 2004, the same sites were sampled again with an average of about thirty six individuals per site ranging from 2 to 193. Virtually all of the difference in the mean can be attributed to sites I and F, which combined for a reduction in 296 individuals between the years.

- Is recruitment (adding new individuals to existing populations) occurring for this species and in what form does it take (episodic or continual)?

In the 2003 trial data, a total of nine seedling-sized plants were observed. During 2004, a total of 31 seedlings were recorded. These may have been resprouts from older rootstocks or newly recruited plants. There was a total of 856 individuals in 2003 and 537 individuals in 2004 estimated across all 15 site plots. The proportion of seedlings within the total population is very low when compared to other species of plants that typically have many more seedlings than adults. This does not mean that the populations aren't viable sustainable, but that is one of three possible explanations. There are several potential alternative explanations: an episodic type or reproductive system, naturally low recruitment into a long-lived species, or the species is having problems recruiting for undetermined reasons.

The number of juveniles were slightly less than the seedling stage, with 12 juveniles evident in 2003 and 23 observed in 2004. By combining the seedlings with the juveniles, the youngest plants are only an estimated 2.5 percent of the total population in 2003 and 10.3 percent of the total 2004 population. This is very low when compared to plant species with sustainable population statistics. The 2004 data, due to the fire, may be skewed by including resprouting plants as seedlings or juveniles since there is no way to distinguish the two.

- Is the stage structure (proportion of plants at each stage in the life cycle) of populations stable or unstable?

It would be impossible to answer this question at this time since a baseline life stage structure for this species has just been established. There is not sufficient data for comparison.

- What effects are habitat conditions having on this species?

This question includes both negative habitat effects such as the spread of exotic plant species and positive effects such as increased rainfall. Further discussion is included in the section on management implications. The data to date is still not sufficient to assess threats.

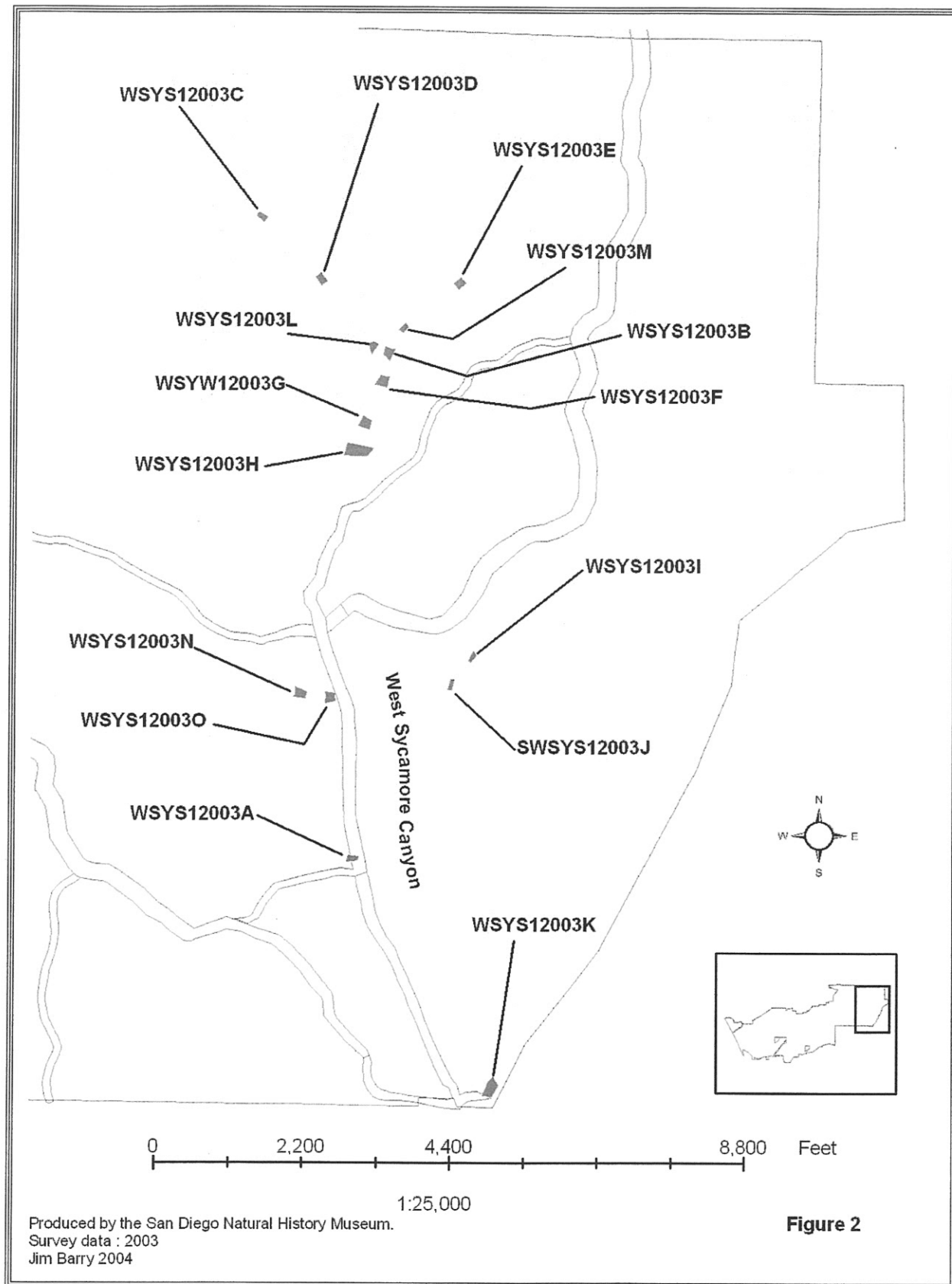
- What actions or management directives could prove beneficial for this species?

While initial observations regarding concerns about changes in drainage hydrology and increases in exotic grasses were noted on the survey sheets, it is unknown at this time which management actions might be more beneficial to the species. Continued monitoring is suggested to assess habitat conditions or changes. Any action that will reduce the number of exotic grasses or preserve the hydrology of these canyons would be expected to benefit the species.

- What is the natural history and ecology of this species?

Several observations were made during the field studies and were described in the natural history discussion earlier in this document.

Locations of Monitoring Sites



Management Implications

Passive management vs. active management

As yet there is no evidence that the species is declining. The apparent low recruitment, presence of exotic grasses, and the recent Cedar Fire have created serious questions about this species viability. Active management and intervention may be recommended. It is unknown whether passive management will be sufficient to prevent this species from declining over time. Continued monitoring is the only methodology that will determine the success and status of this species in the future.

Ecological data

Since there is limited knowledge and documentation regarding willowy monardella's life history and ecology, the initial baseline observations should be considered a starting point for ecological assessments. The life history and ecology will become evident with continued observation and monitoring.

Long-term viability of the monitoring program

The most important element contributing to increased knowledge and management of willowy monardella is repeating the monitoring efforts for an extended period of time. The monitoring design was created to answer significant questions (e.g., population dynamics, ecology, autecology, etc.) regarding MCAS Miramar's willowy monardella populations. Best management practices can be developed with this increased information.

Taxonomic split

The recent taxonomic split has apportioned the majority of the *Monardella viminea* populations upon MCAS Miramar. This has increased the responsibility and role of the Station in management of this species.

Hydrology

The hydrology on the Station appears to be relatively intact and natural, which may be a major reason for the persistence of the willowy monardella on the Station. Those areas, e.g., Rose Canyon, where hydrology has been dramatically altered, no longer support willowy monardella despite the presence of what appears to be potential habitat. However, there are proposed land altering projects adjacent to MCAS Miramar. One such project north of West Sycamore Canyon has already been approved and proposes to reduce the water flow into the canyon. What effects this project may have is unknown, but based upon current knowledge, reduction of water flow is preferable to increases in flow.

Exotic Annual Grasses

Based upon field observations, exotic grass competition appears to be the current potential threat to the species. Wherever the exotic grasses and their impenetrable thatching have dominated the vegetation, willowy monardella was restricted to growing within the drainages or in patches of less thatched exotics such as filaree (*Erodium botrys*). Evaluated on a larger scale, those canyons with higher observed percentage of exotic grasses in their cover had fewer monardella plants.

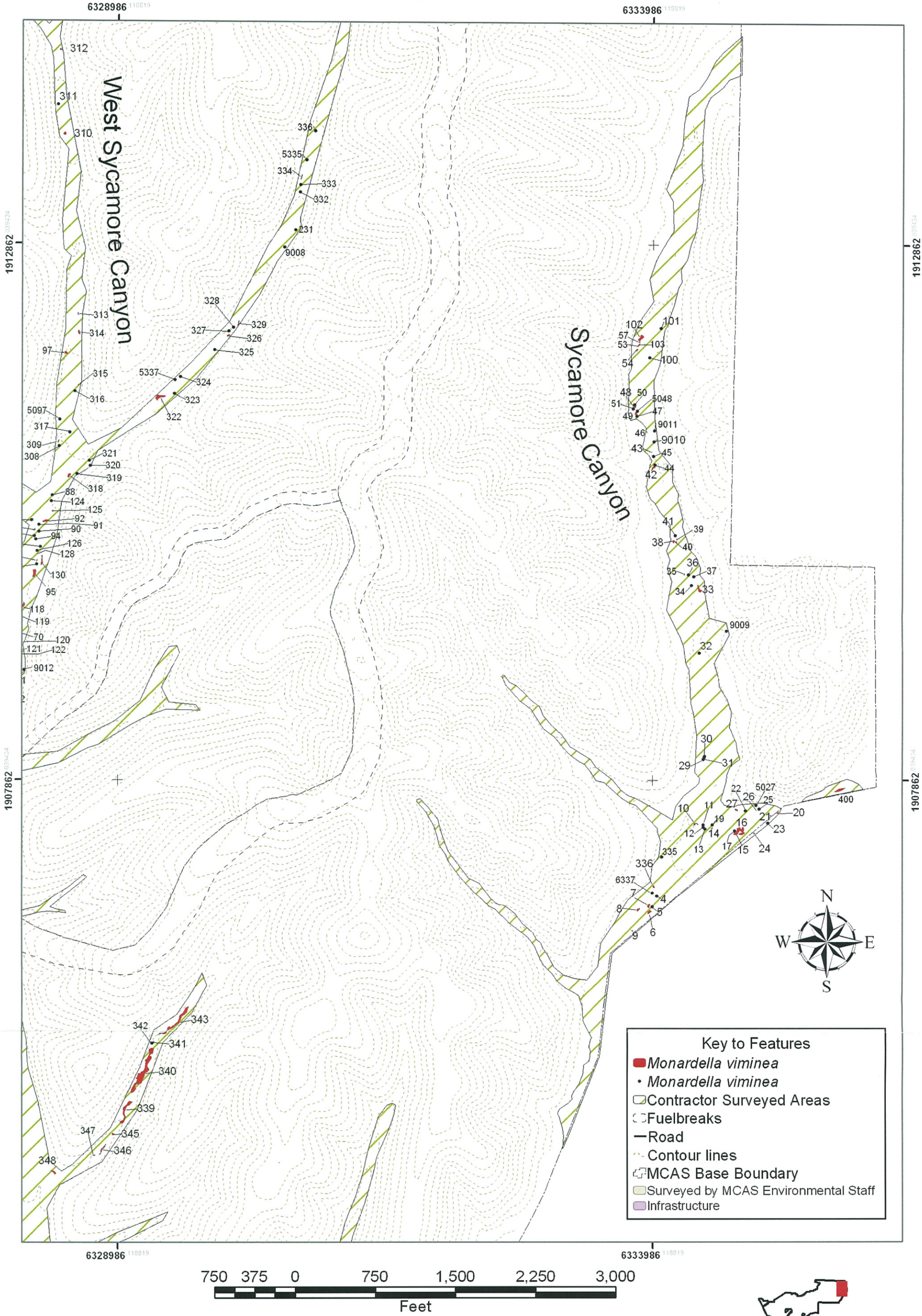
Conclusion

While little is known about many aspects of willowy monardella, this project has been designed as the first step in assessing the extent of MCAS Miramar's species population, providing a long-term monitoring plan for continued assessment, presenting information for species management, and evaluating species status on the Station. Continued use of this monitoring protocol, in the absence of catastrophic events, should offer valid census data, plant ecology insight, and guidance for best management practices to maintain the species.

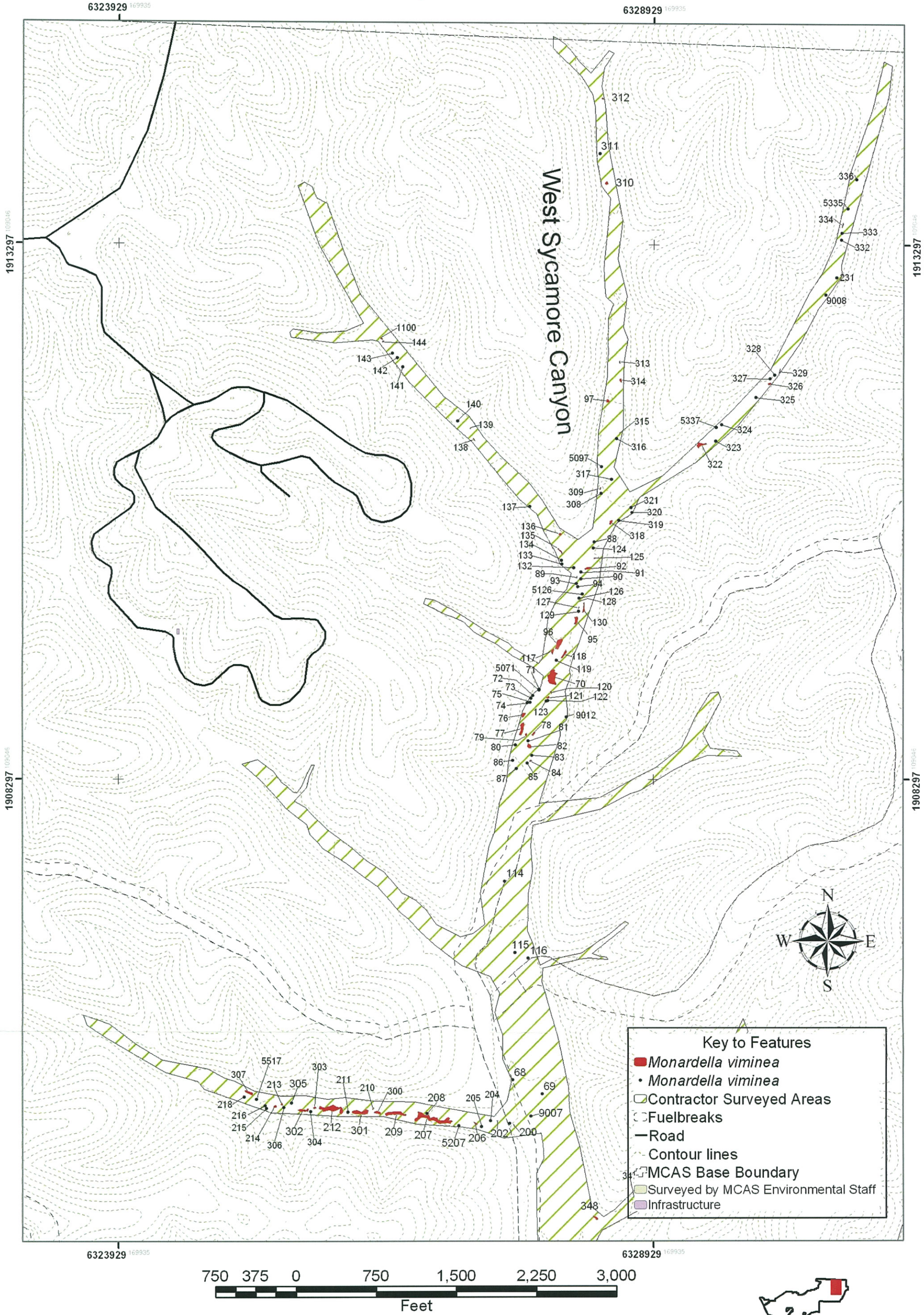
Appendix 1

Data Baseline Study Maps

Baseline Survey for Monitoring Willow Monardella



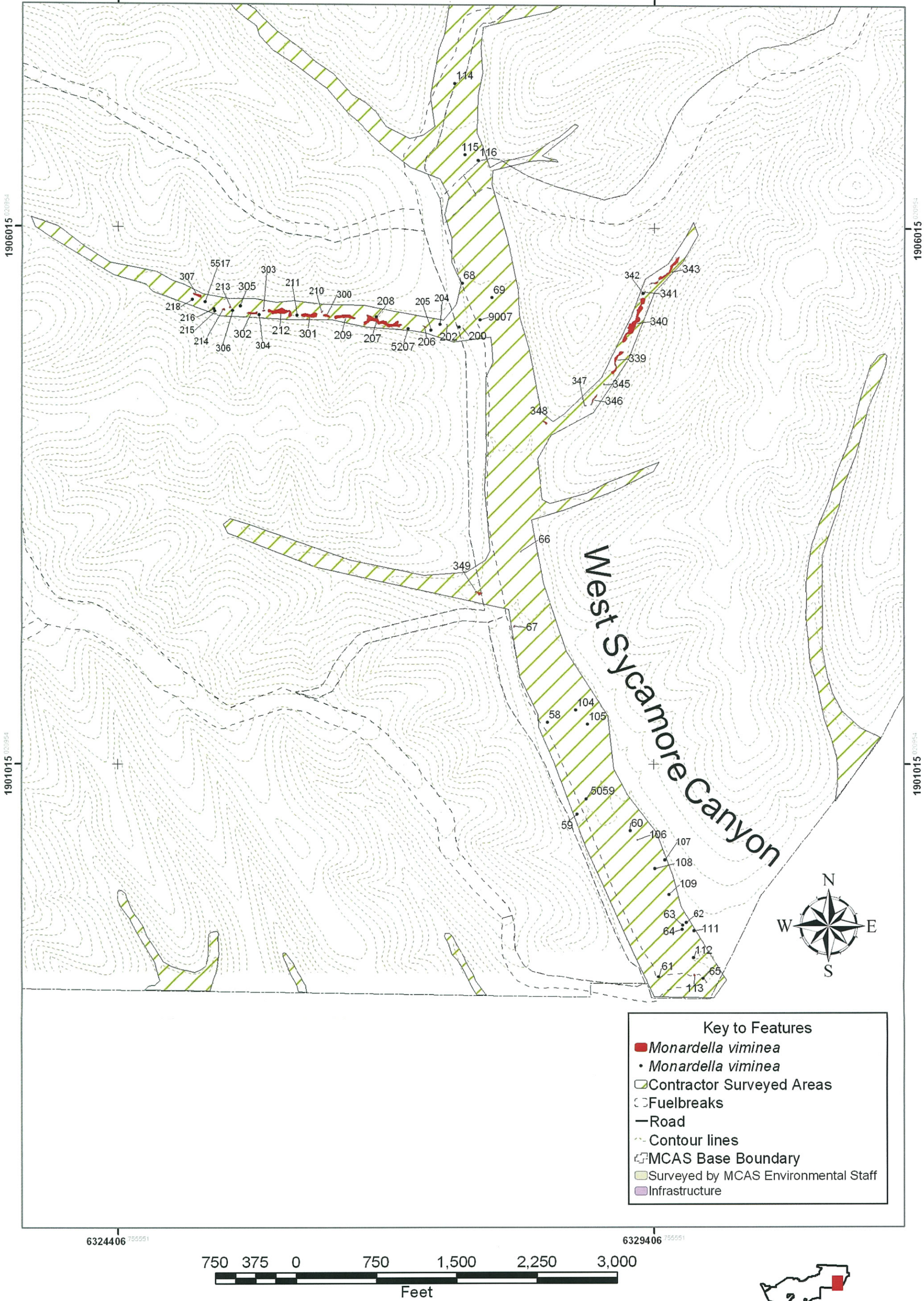
Baseline Survey for Monitoring Willow Monardella



Baseline Survey for Monitoring Willow Monardella

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6329406 755551

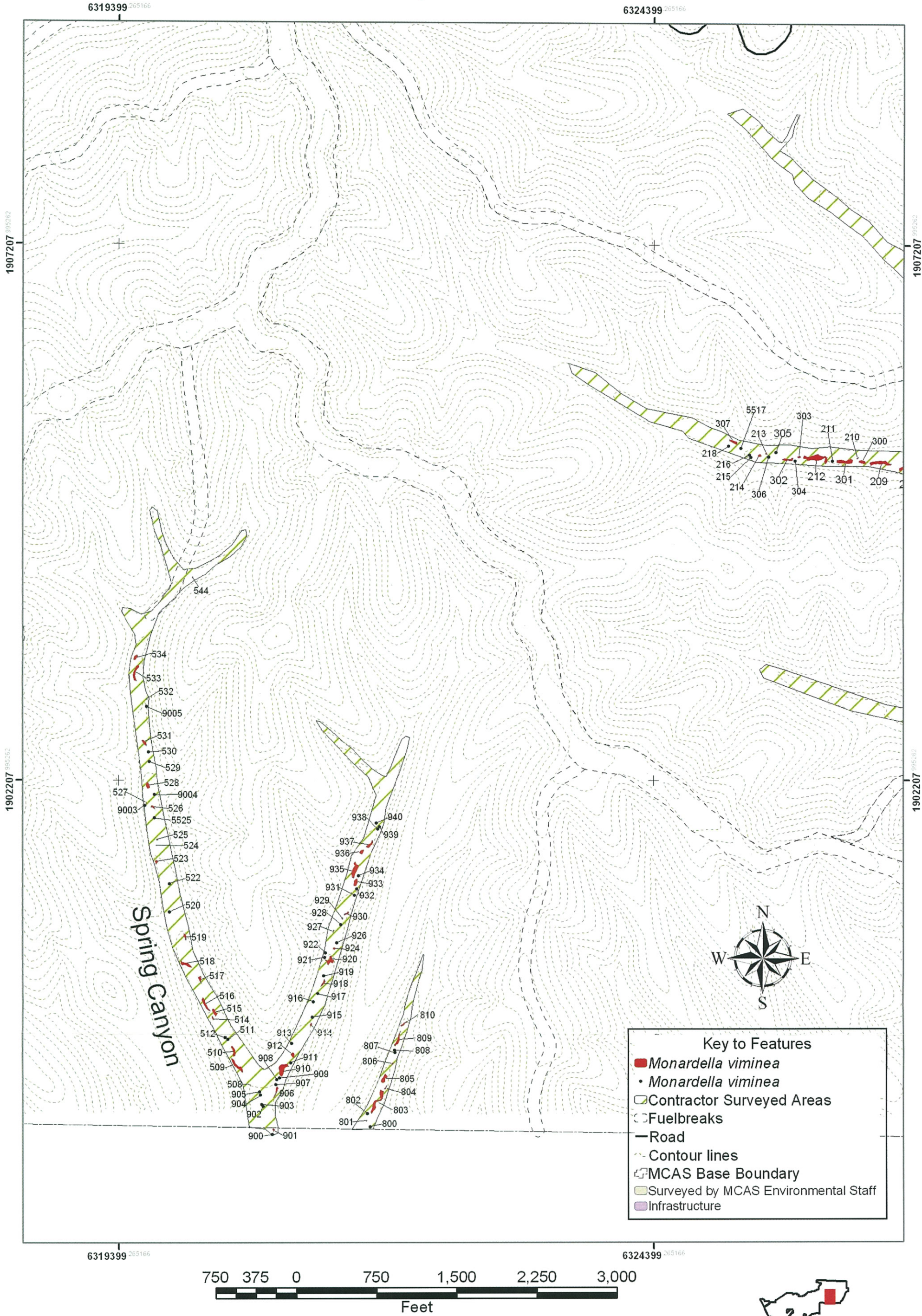


6324406 755551

6329406 755551



Baseline Survey for Monitoring Willow Monardella



Baseline Survey for Monitoring Willow Monardella

6311289 083946

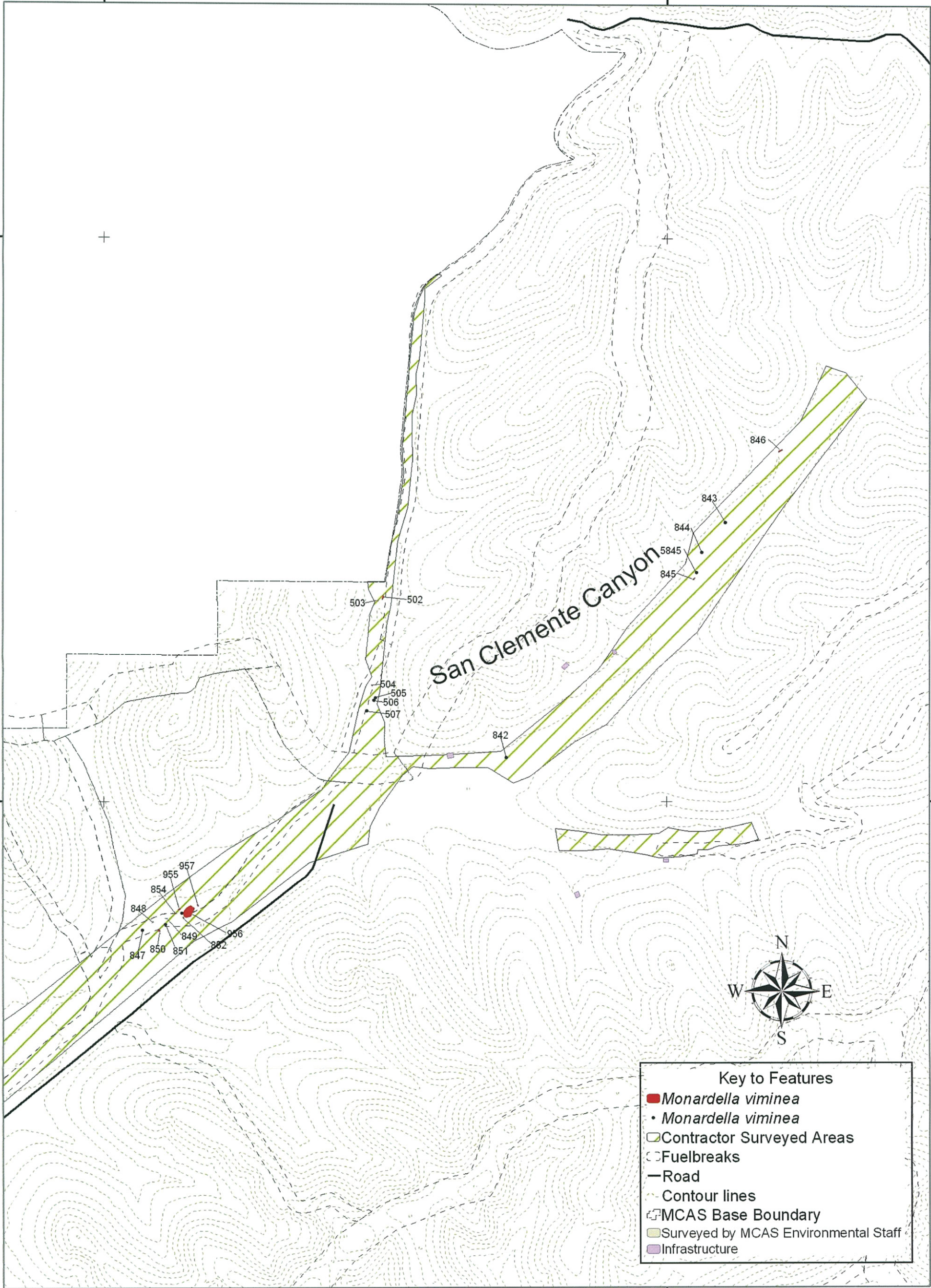
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1907027 477242

1907027 477242



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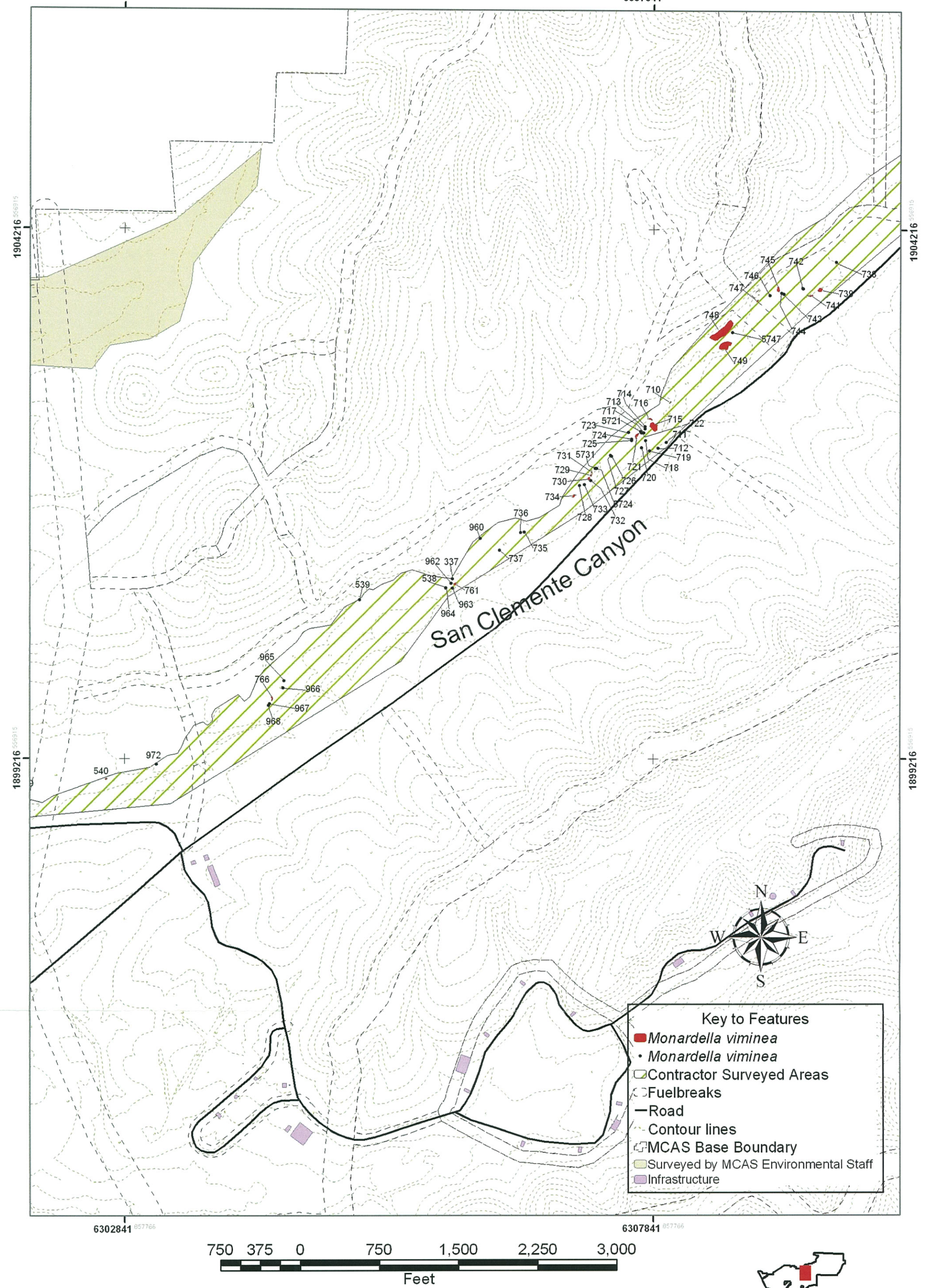
750 375 0 750 1,500 2,250 3,000
Feet



Baseline Survey for Monitoring Willow Monardella

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6307841 857766



6302841 857766

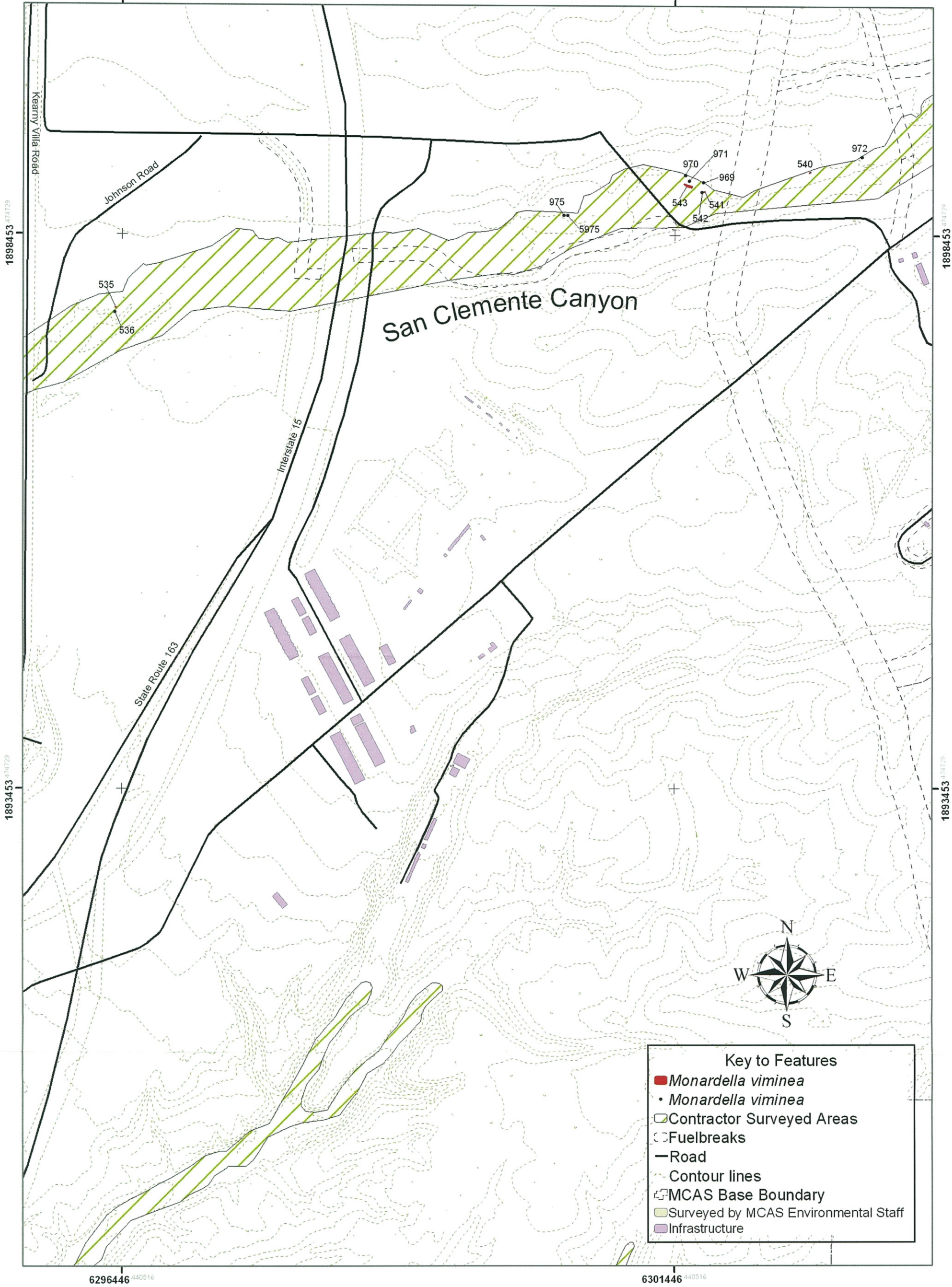
6307841 857766



Baseline Survey for Monitoring Willow Monardella

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6301446 440516

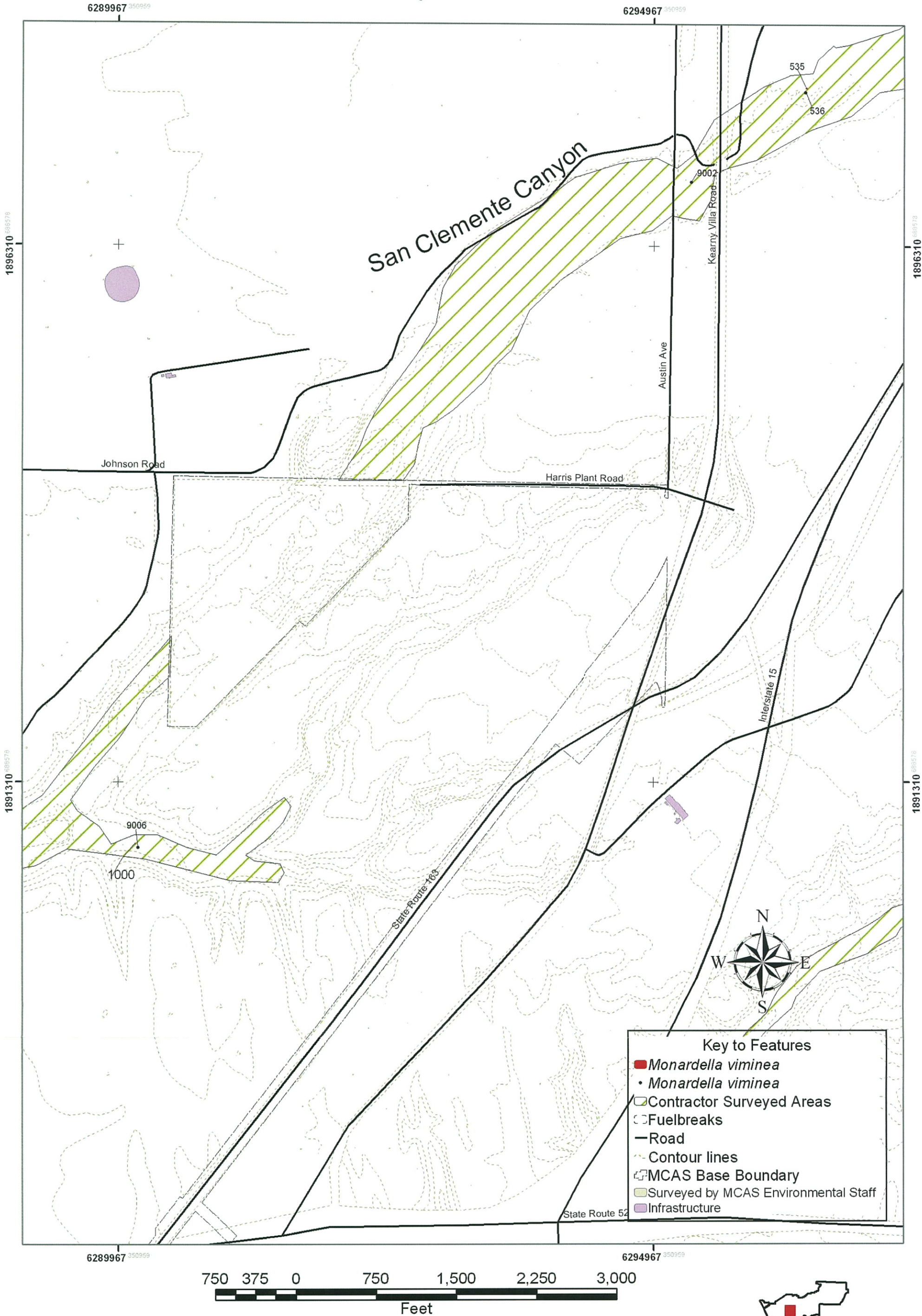


Key to Features

- *Monardella viminea*
- *Monardella viminea*
- ▨ Contractor Surveyed Areas
- Fuelbreaks
- Road
- - - Contour lines
- ▭ MCAS Base Boundary
- ▨ Surveyed by MCAS Environmental Staff
- Infrastructure



Baseline Survey for Monitoring Willow Monardella



Baseline Survey for Monitoring Willow Monardella

6282363 680793

6287363 680793

1893872 166213

1893872 166213

1888872 166213

1888872 166213

6282363 680793

6287363 680793



1:10,000

CONTOUR INTERVAL 20 FEET

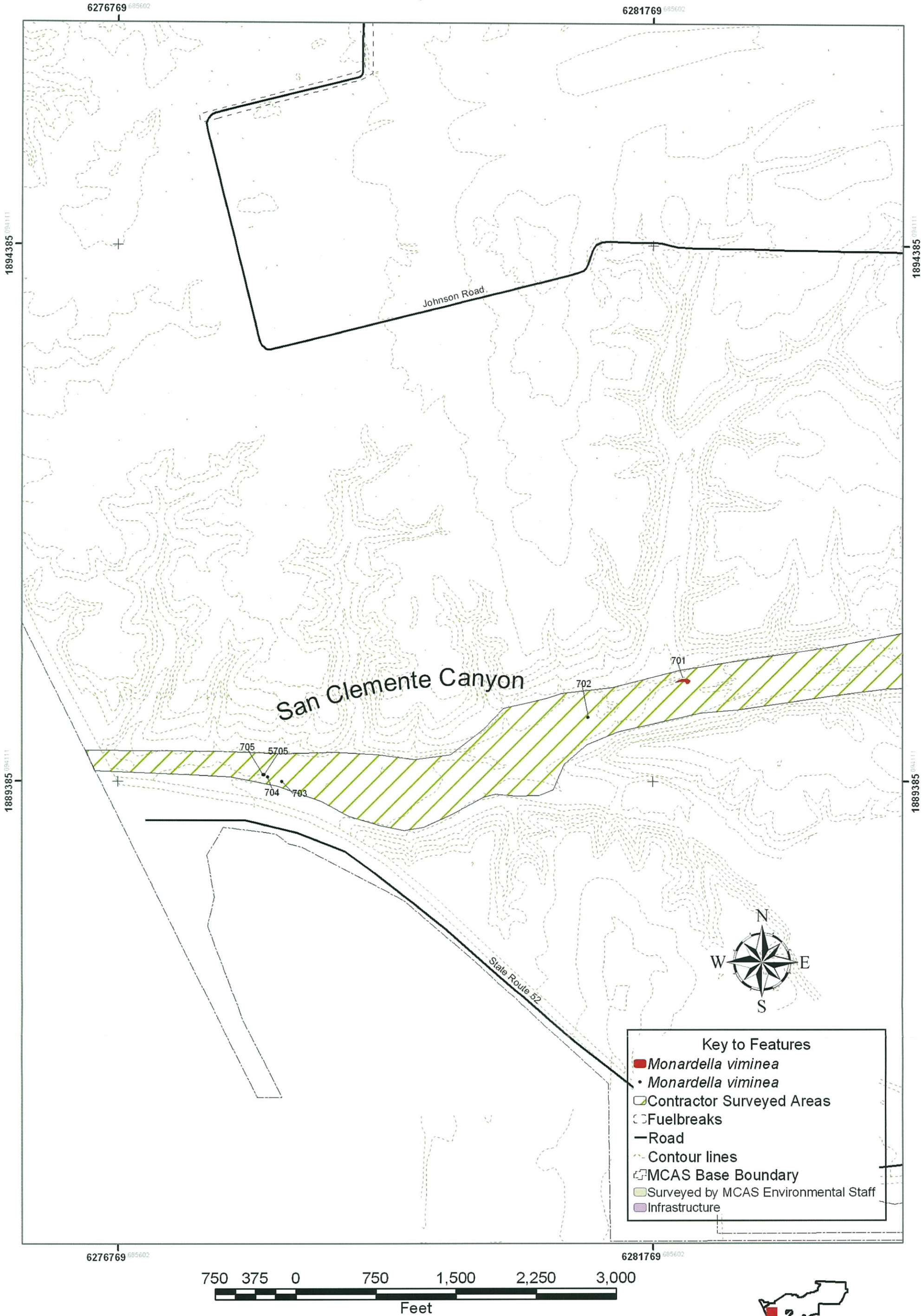


Key to Features

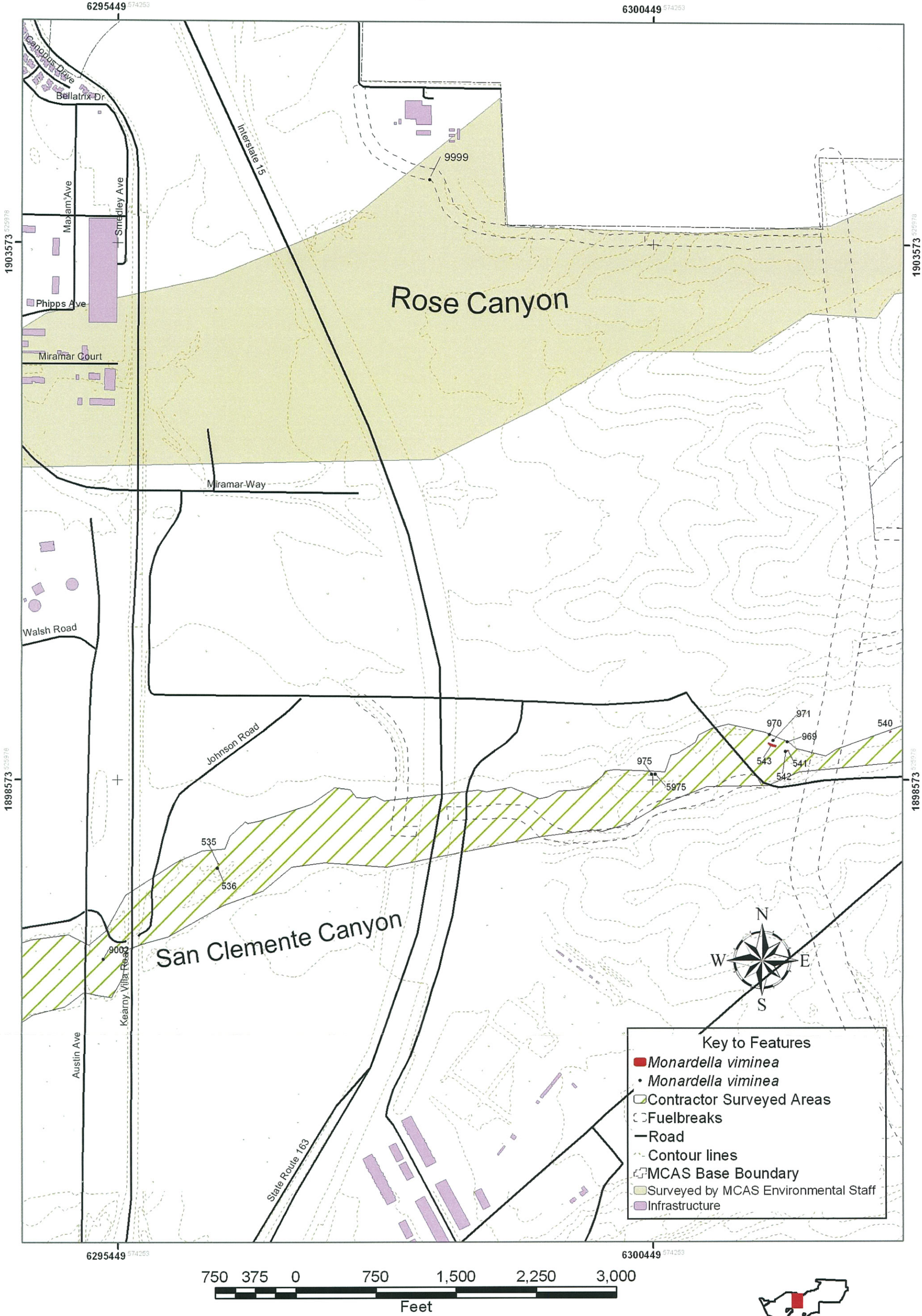
- Monardella viminea*
- Monardella viminea*
- Contractor Surveyed Areas
- Fuelbreaks
- Road
- Contour lines
- MCAS Base Boundary
- Surveyed by MCAS Environmental Staff
- Infrastructure



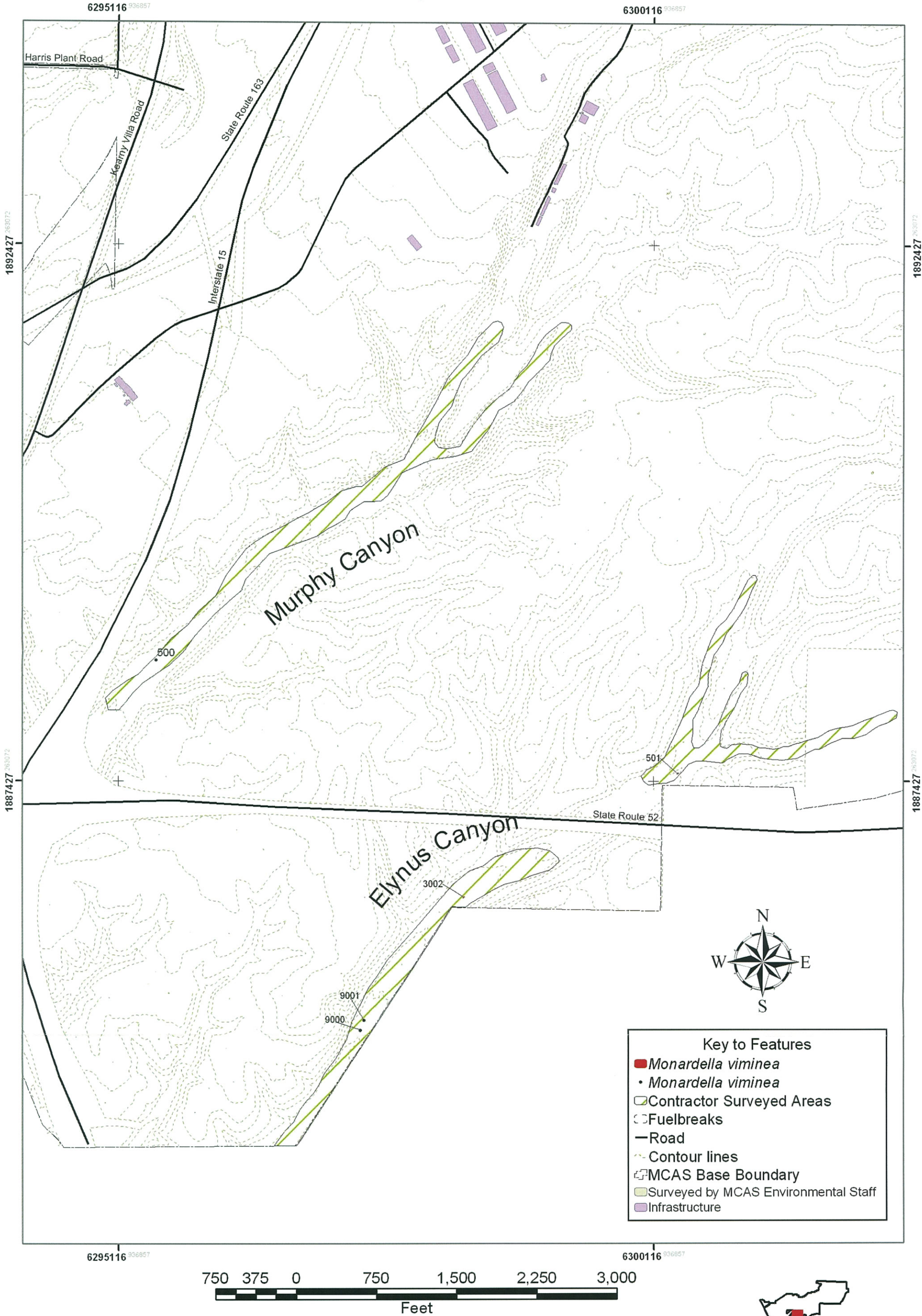
Baseline Survey for Monitoring Willow Monardella



Baseline Survey for Monitoring Willow Monardella



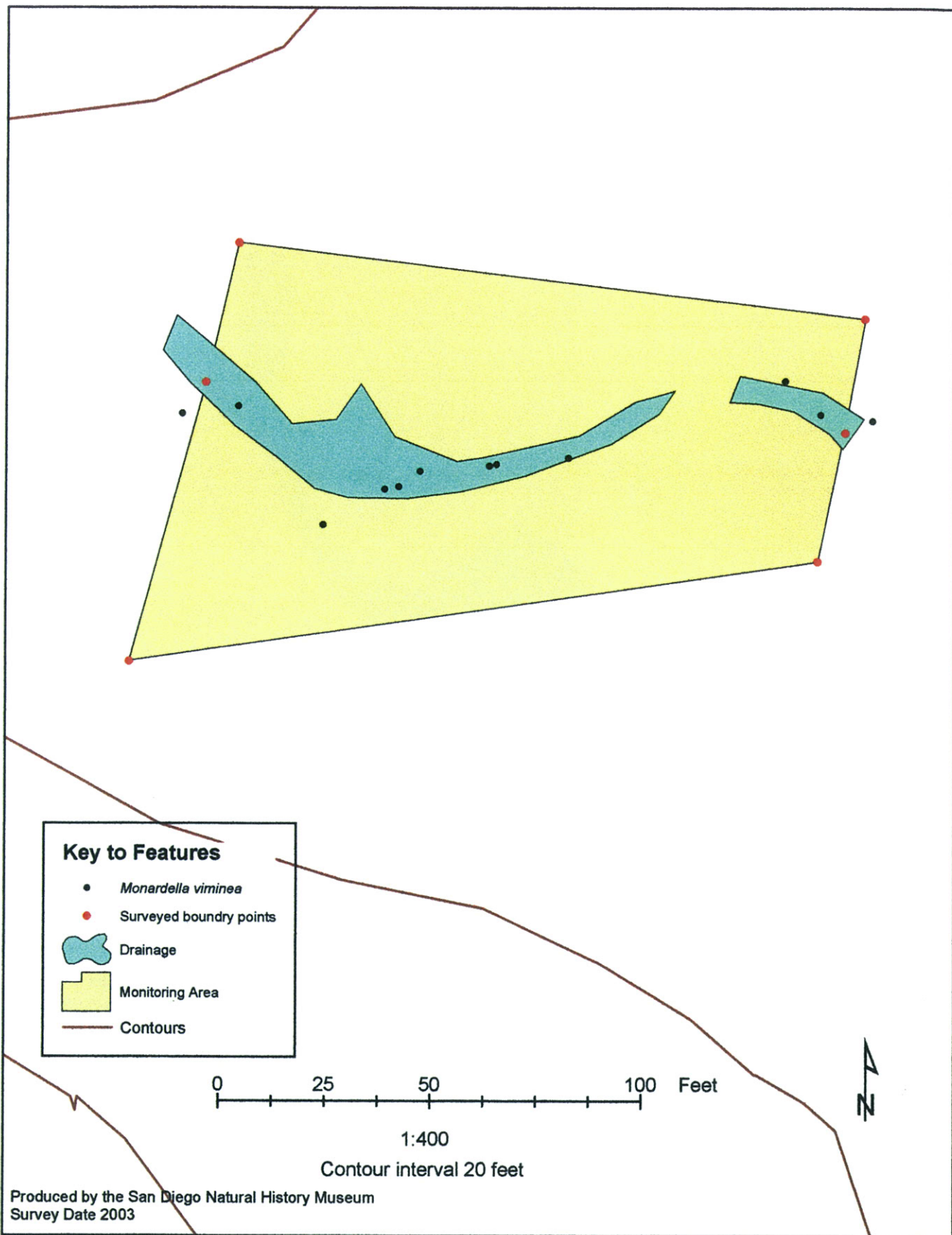
Baseline Survey for Monitoring Willow Monardella



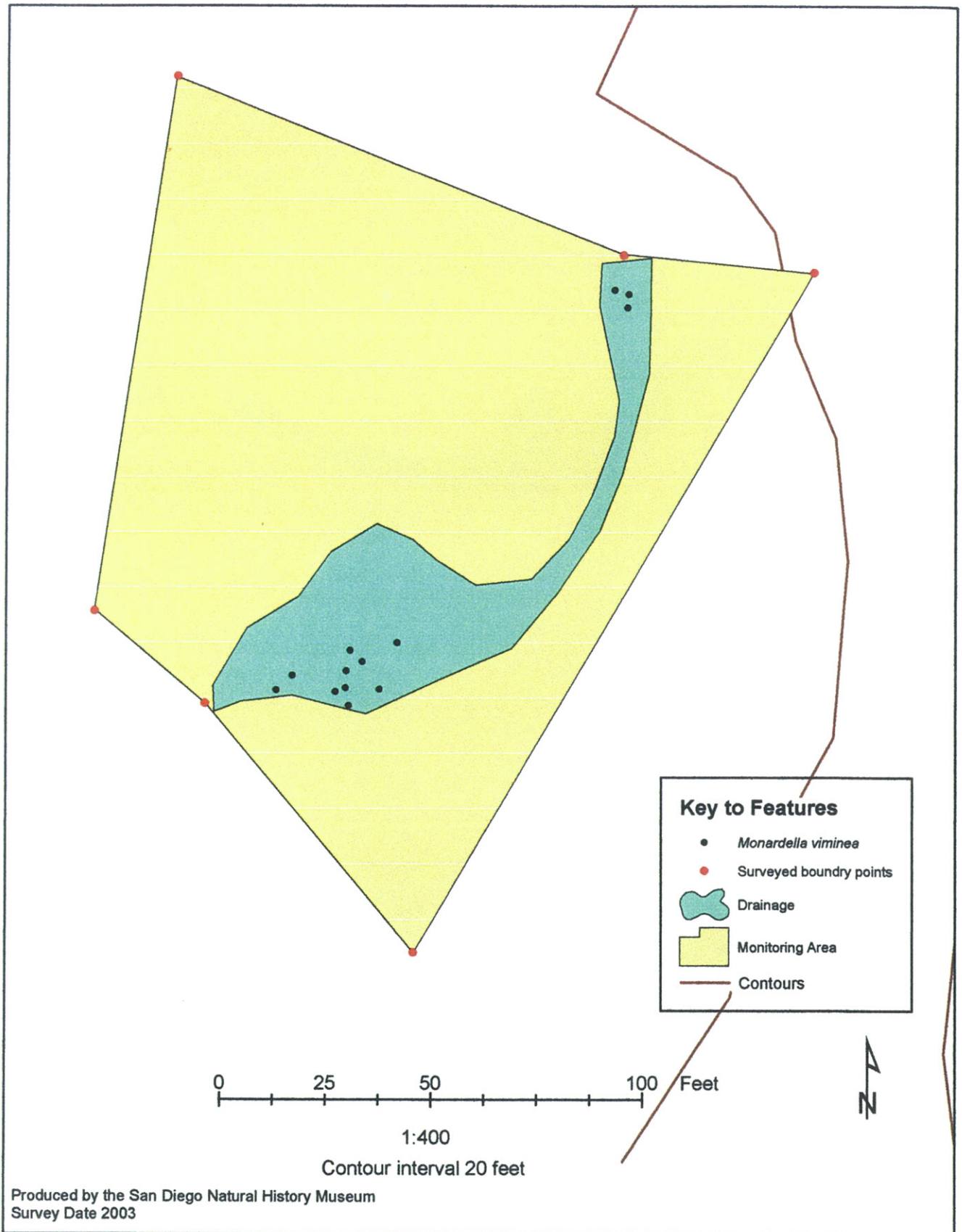
Appendix 2

Data Sample Monitoring Plots Maps and Data Sheets

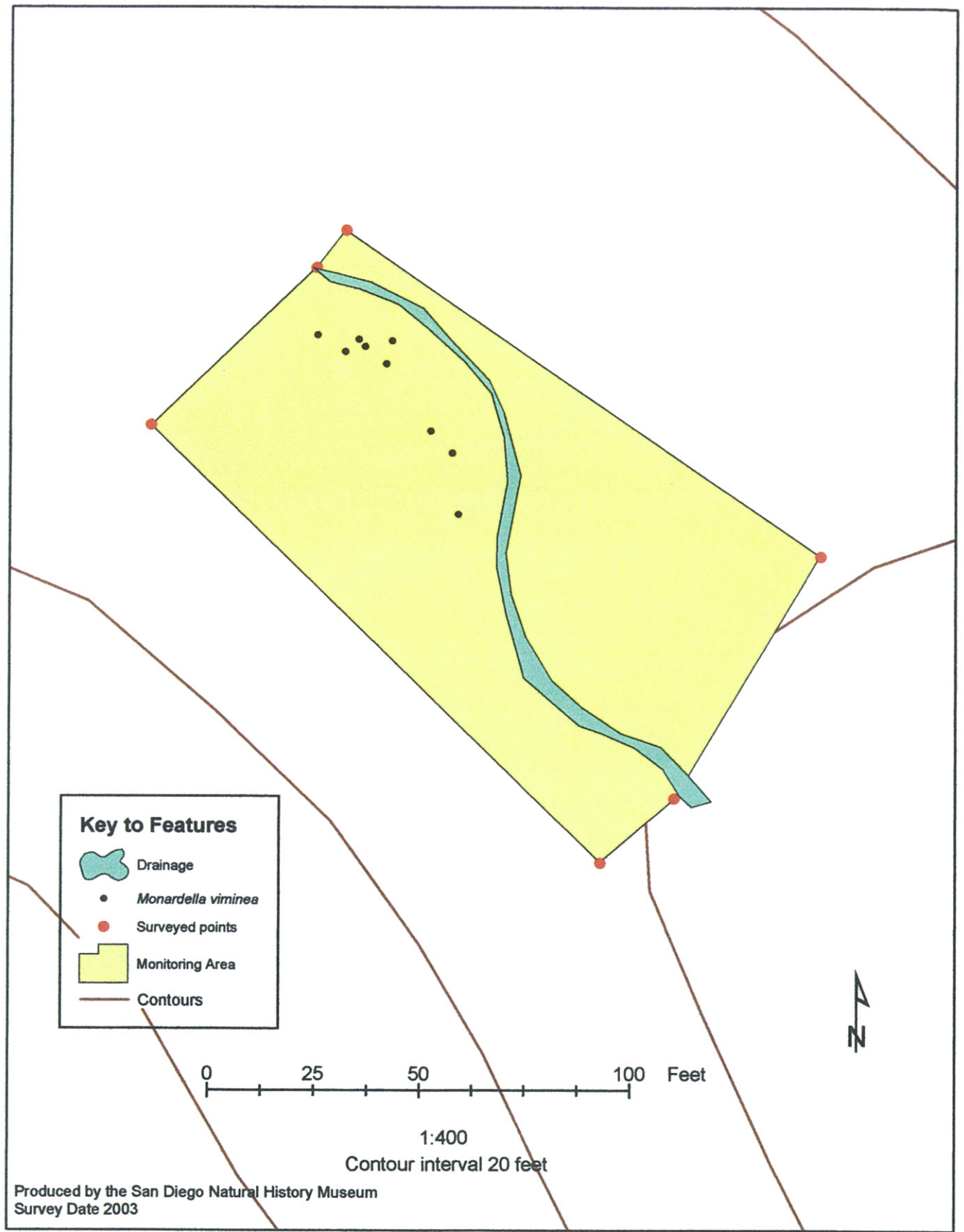
Willowy Monardella Monitoring Site WSYS12003A



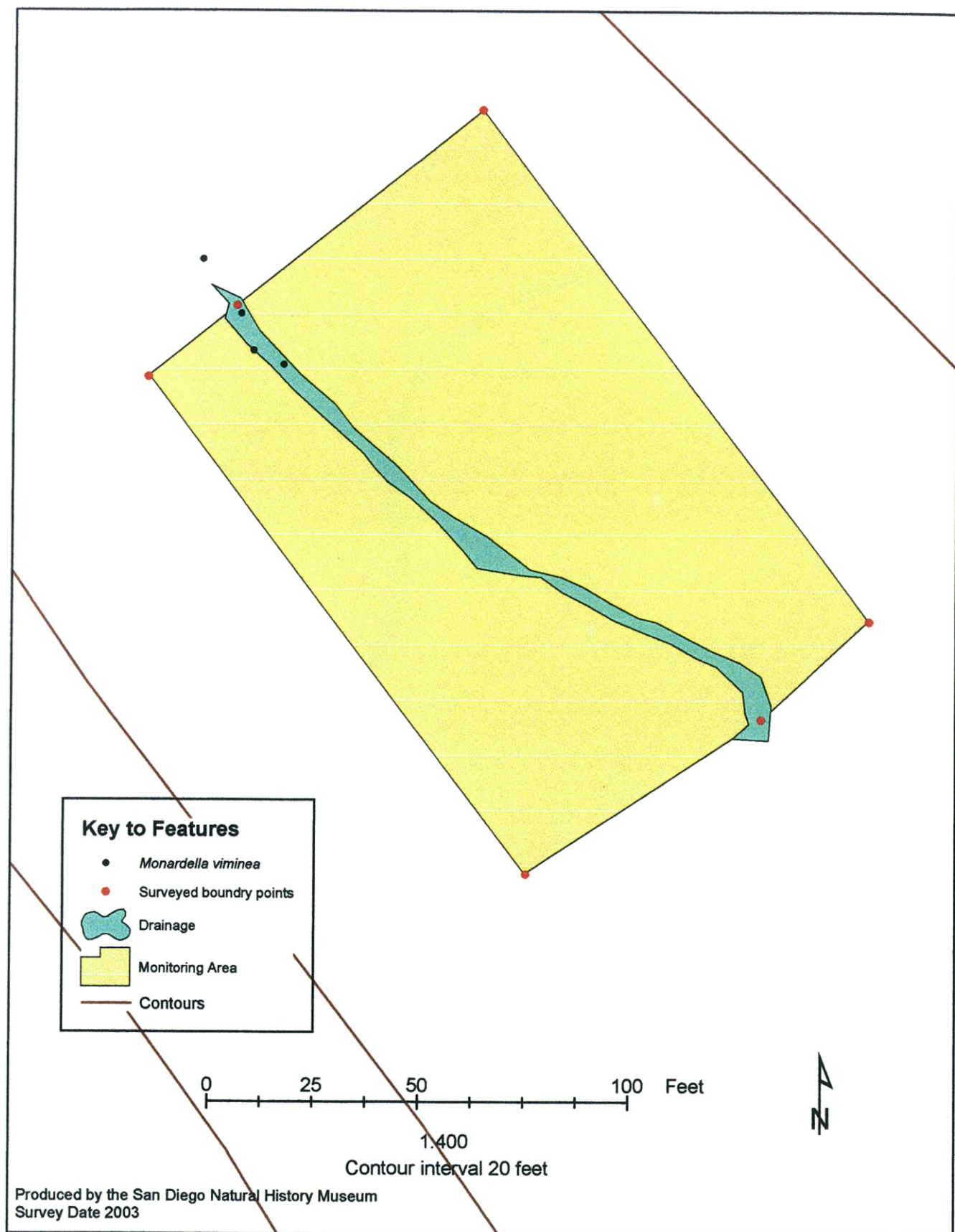
**Willowy Monardella
Monitoring Site WSYS12003B**



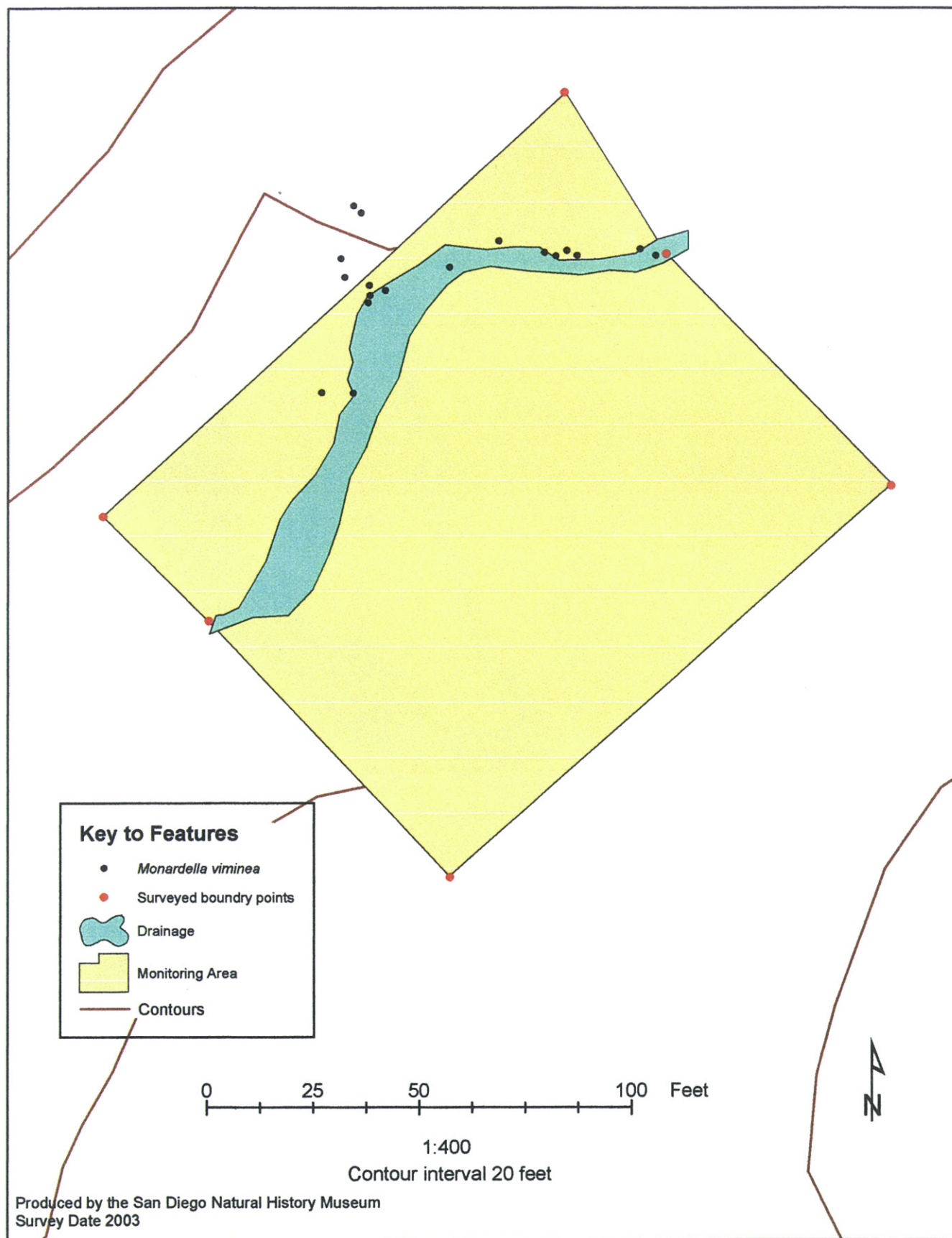
Willowy Monardella Monitoring Site WSYS12003C



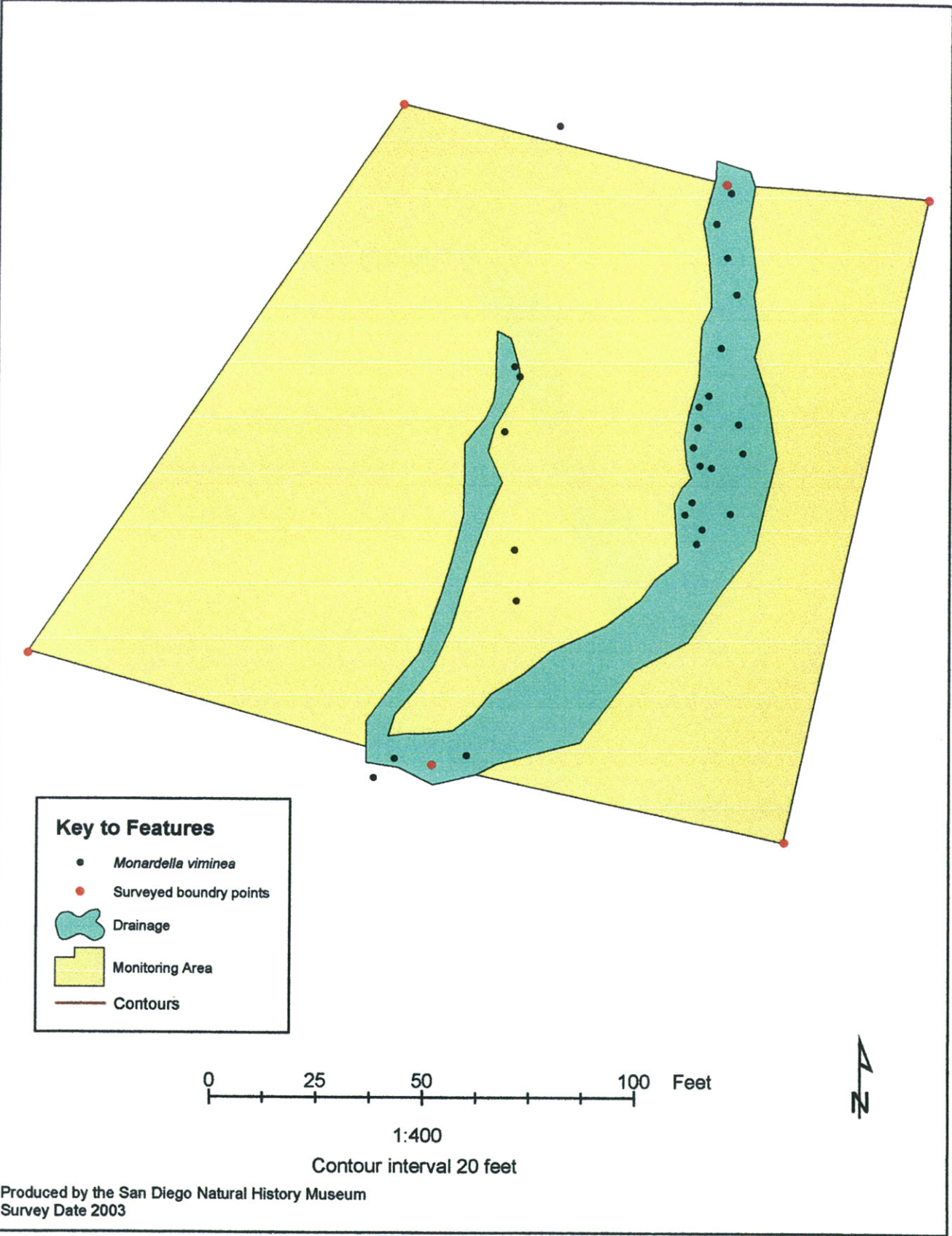
Willowy Monardella Monitoring Site WSYS12003D



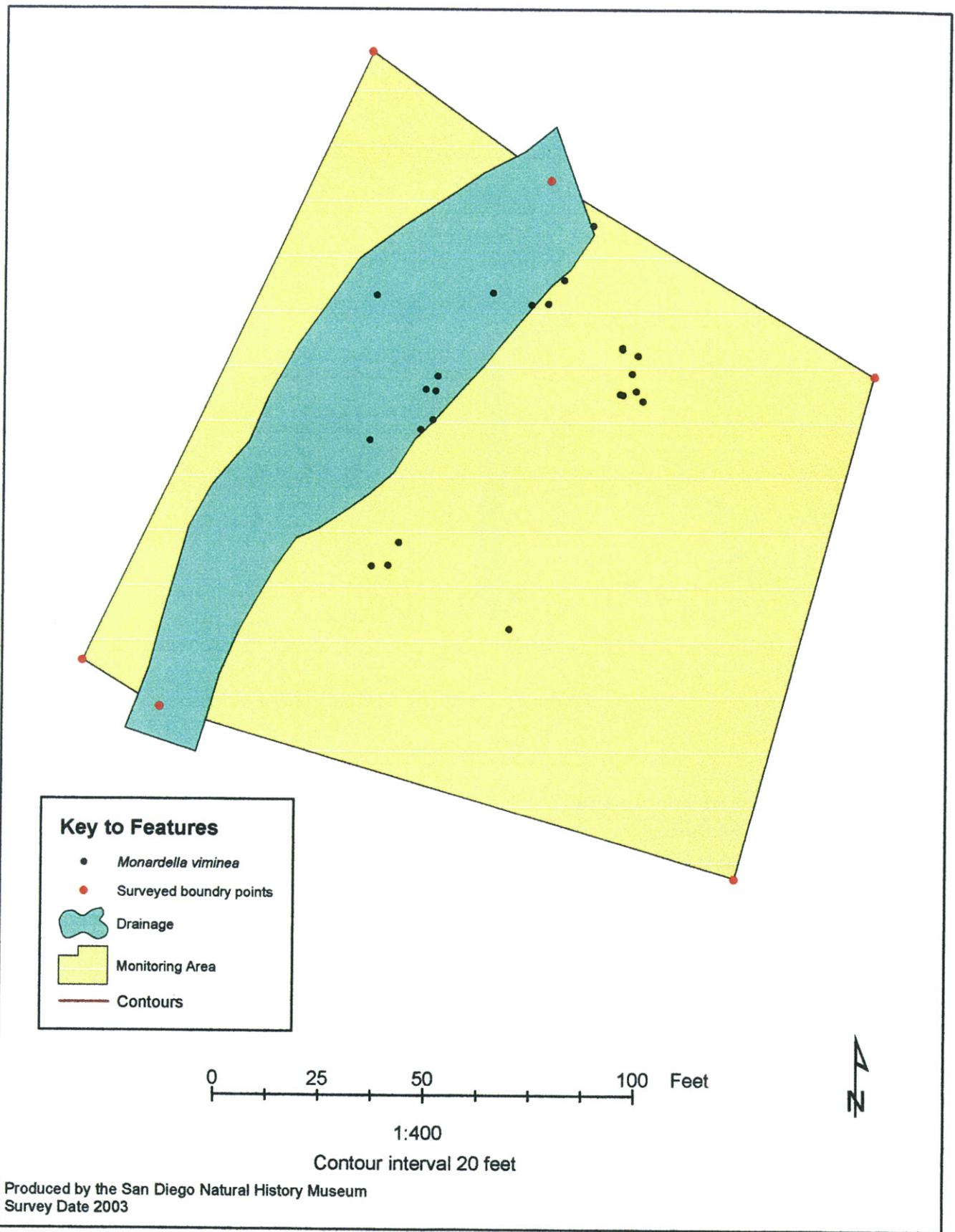
Willow Monardella Monitoring Site WSYS12003E



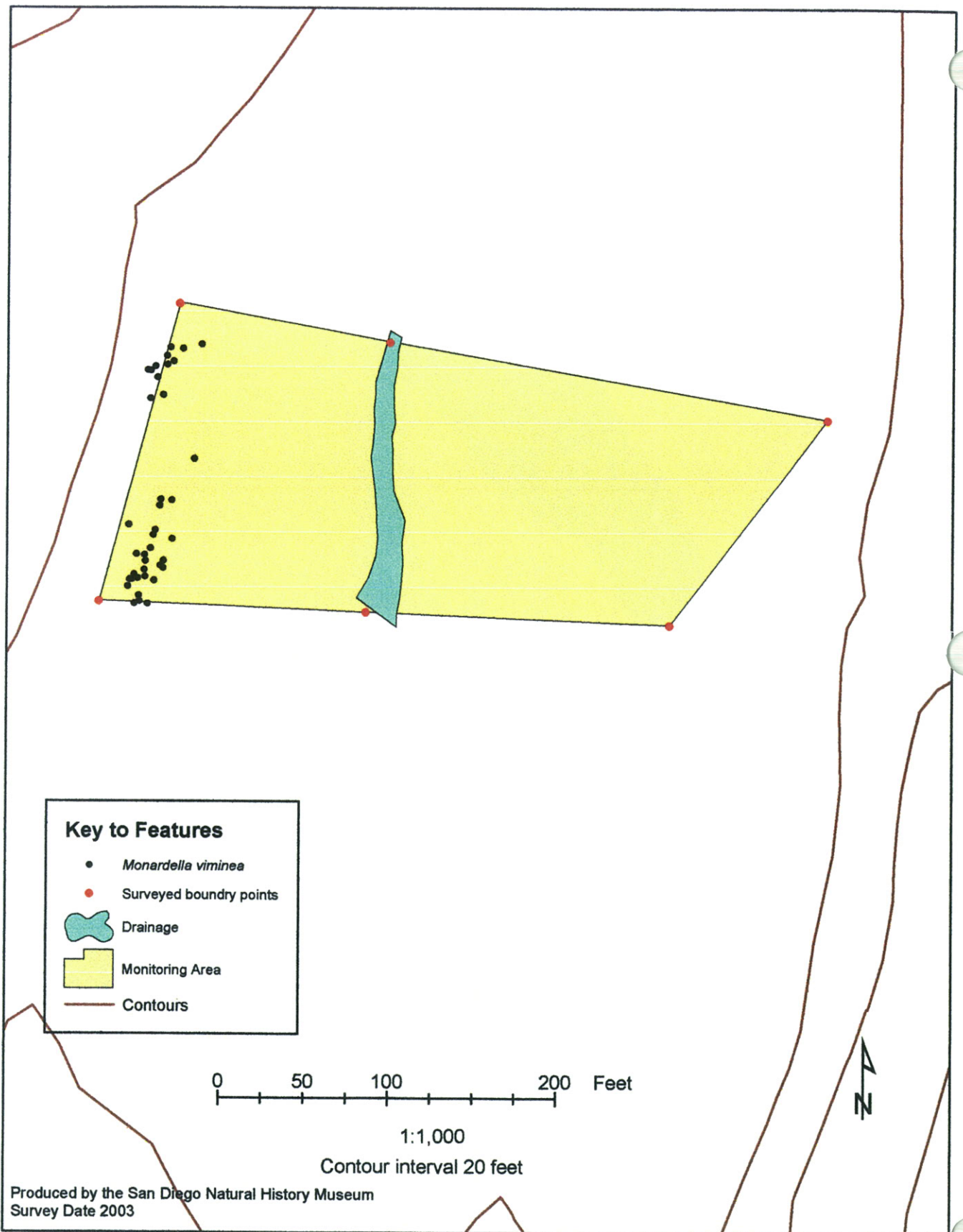
Willowy Monardella
Monitoring Site WSYS12003F



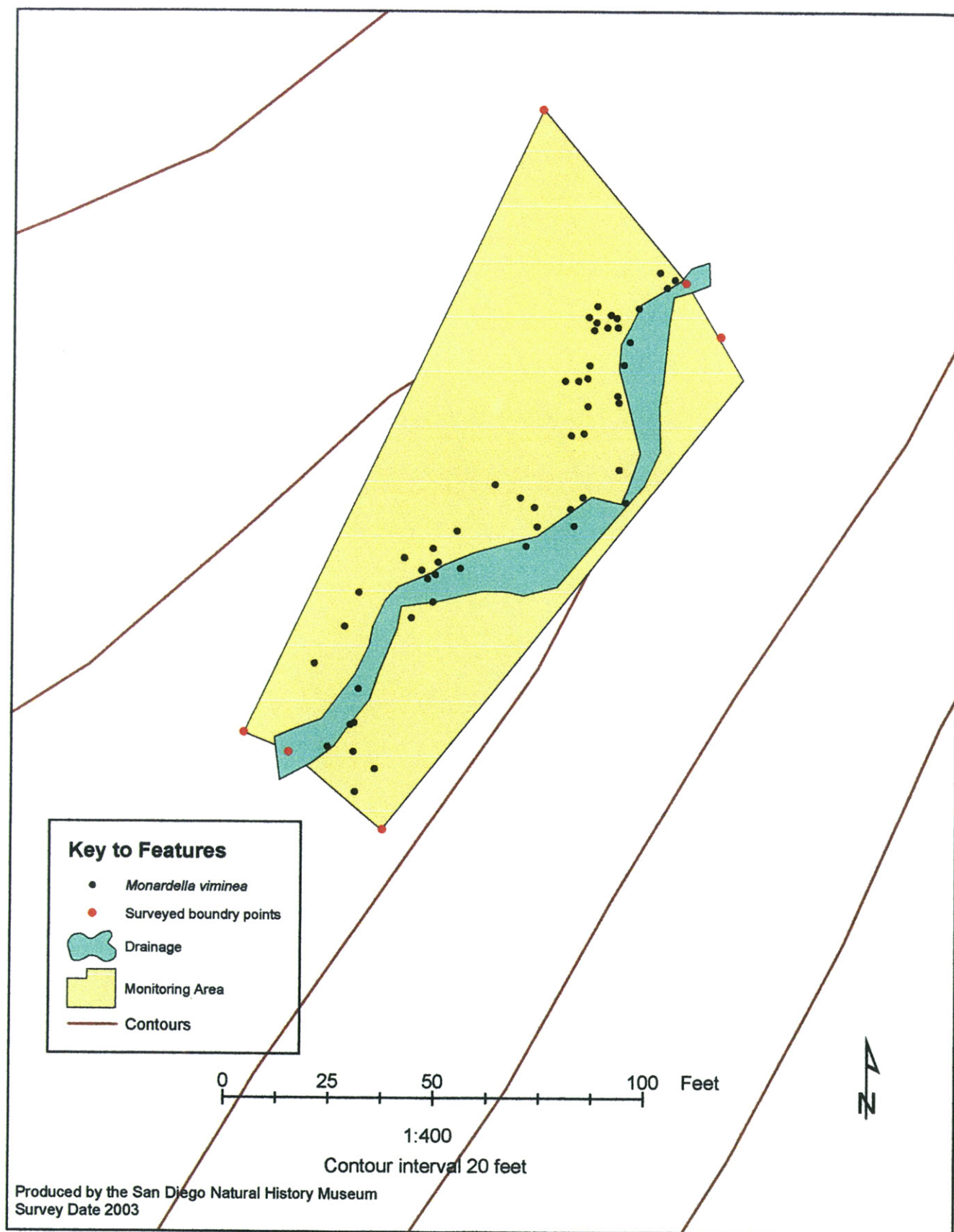
Willowy Monardella Monitoring Site WSYS12003G



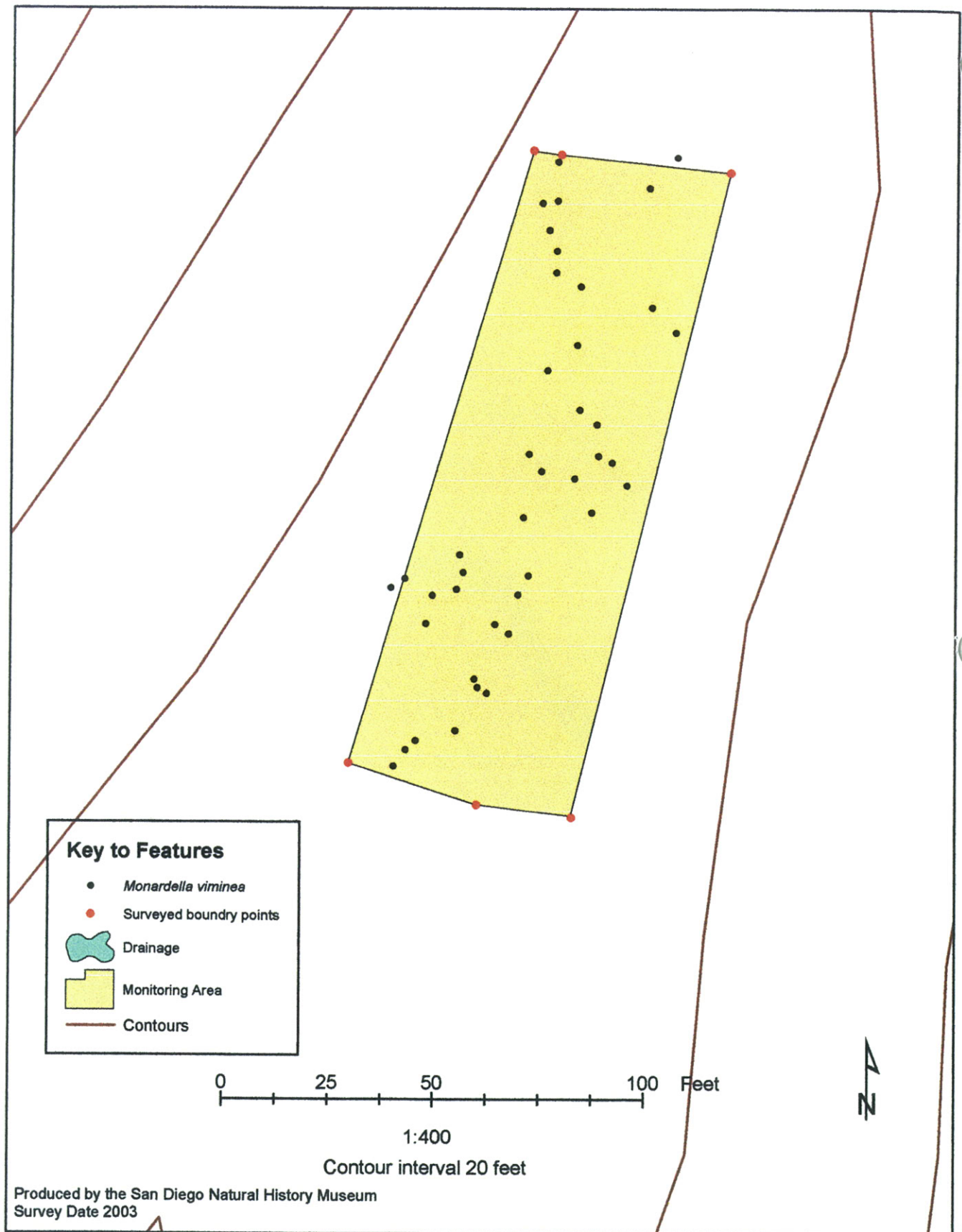
Willowy Monardella Monitoring Site WSYS12003H



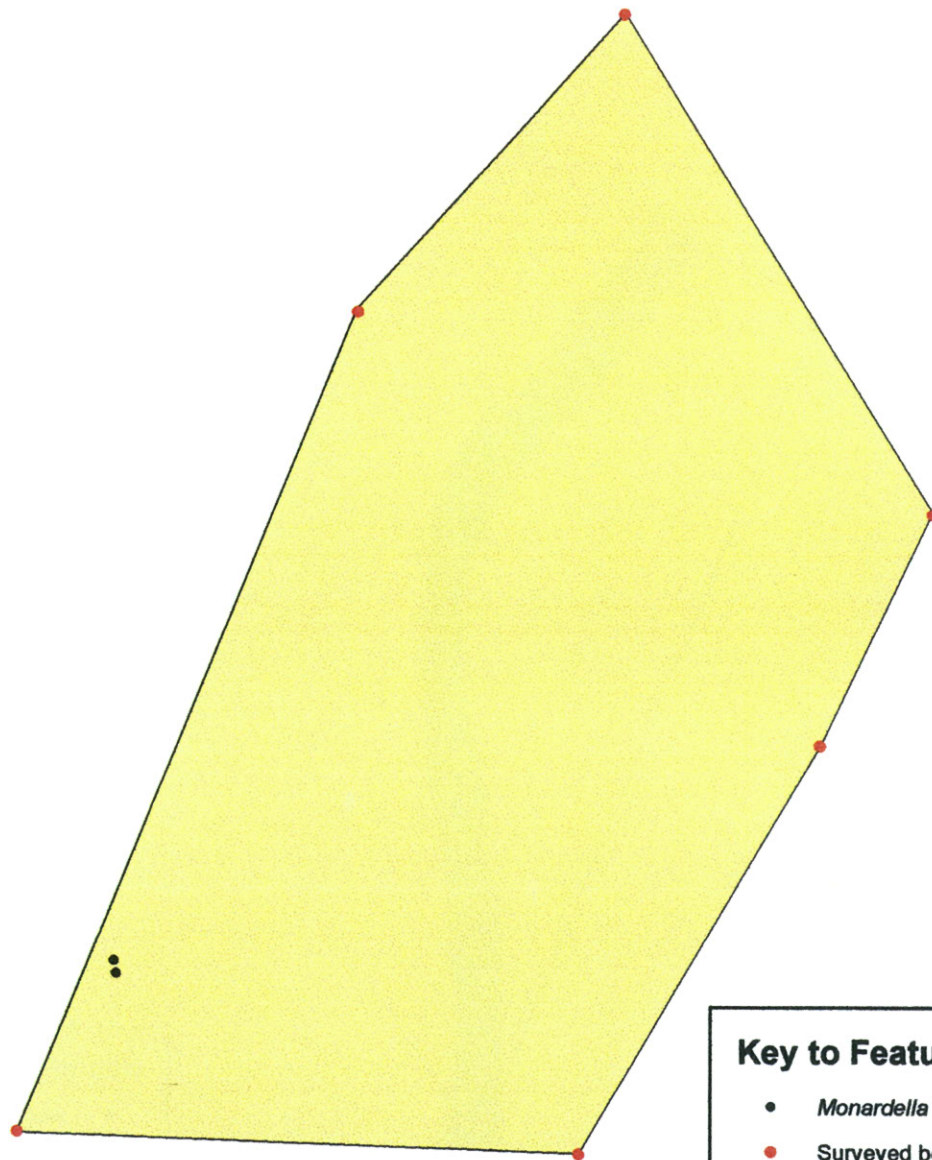
Willow Monardella Monitoring Site WSYS12003I



Willowy Monardella Monitoring Site WSYS12003J



Willowy Monardella
Monitoring Site WSYS12003K



Key to Features

- *Monardella viminea*
- Surveyed boundry points



Drainage



Monitoring Area

0 37.5 75 150 Feet

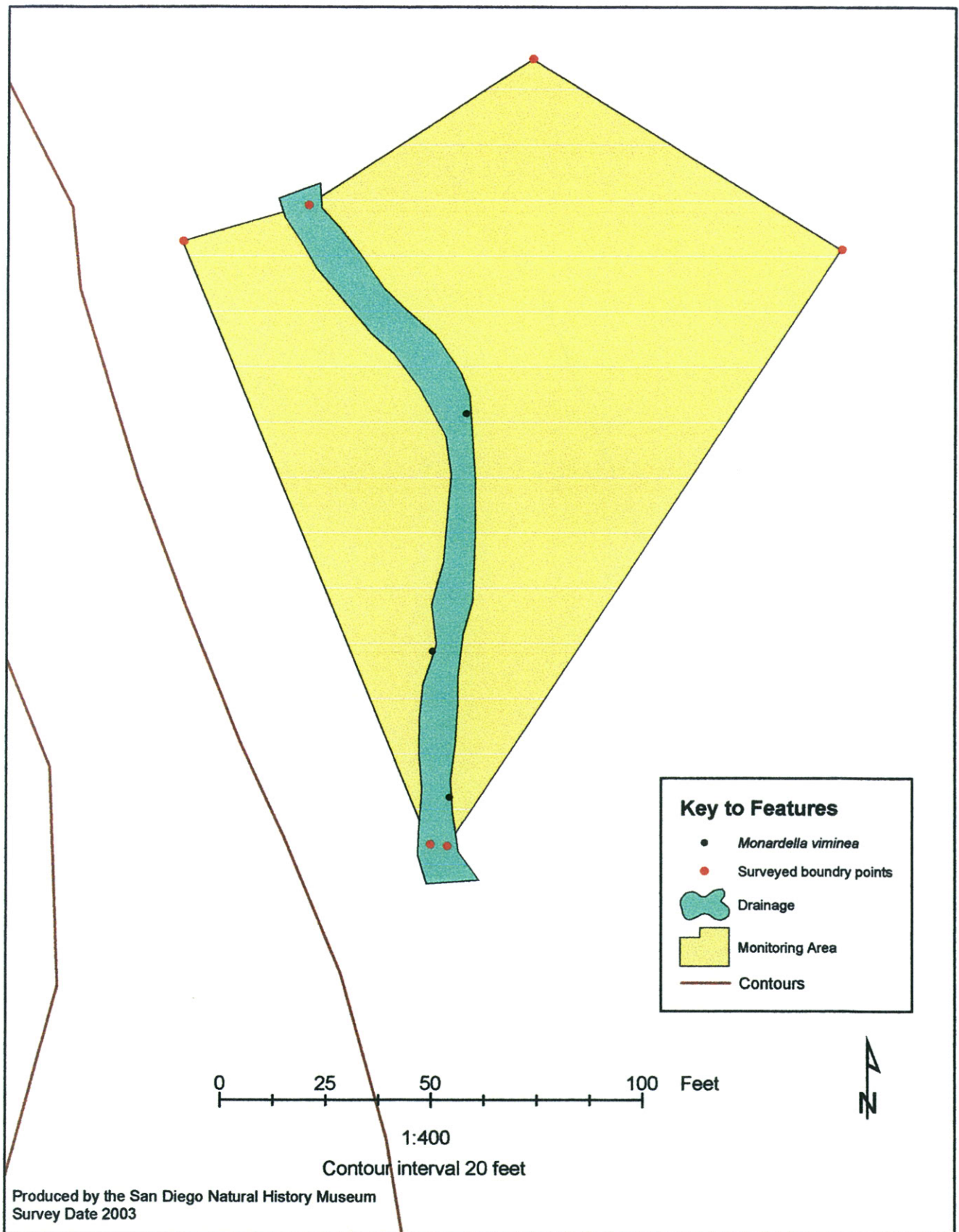
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Contour interval 20 feet

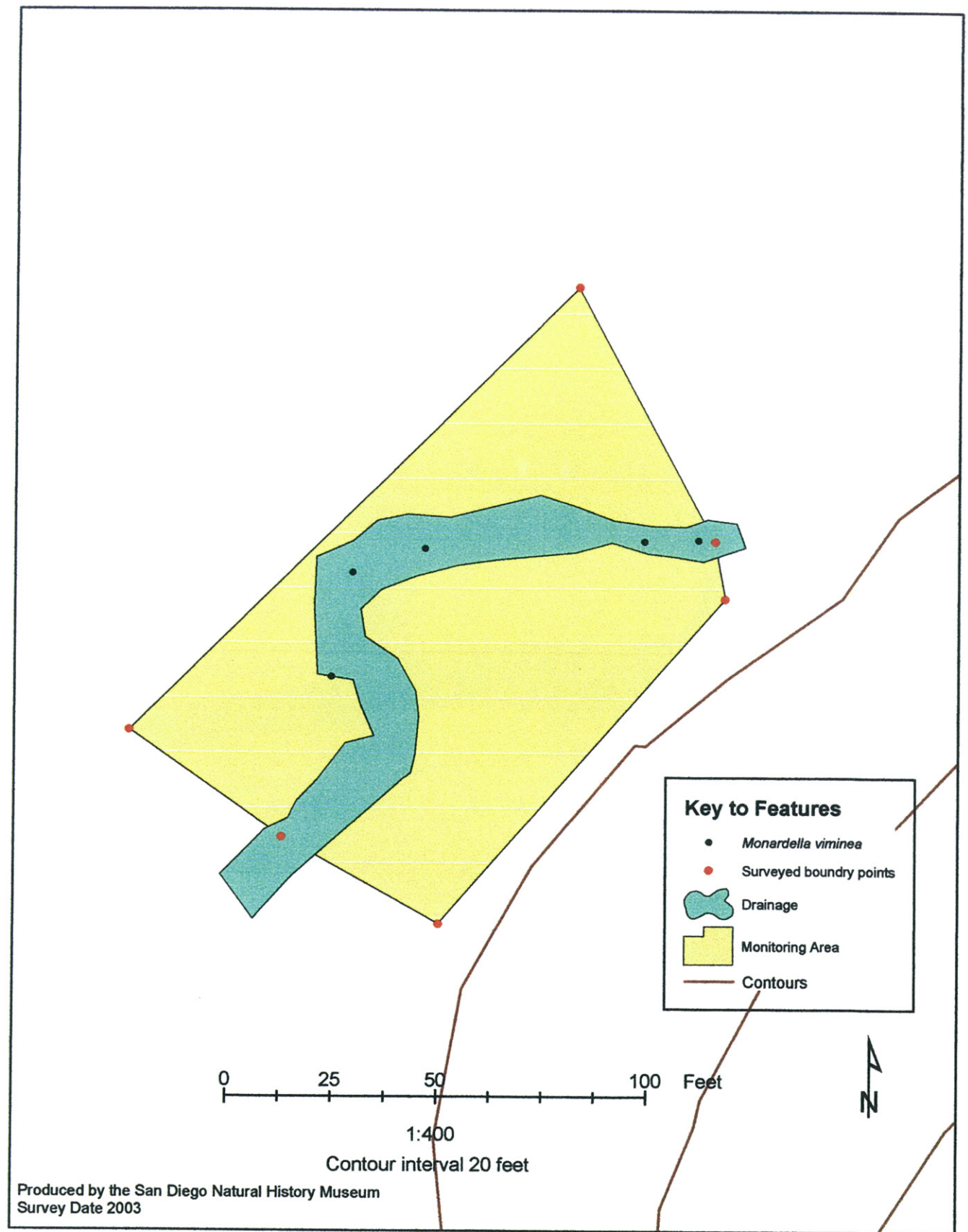


Produced by the San Diego Natural History Museum
Survey Date 2003

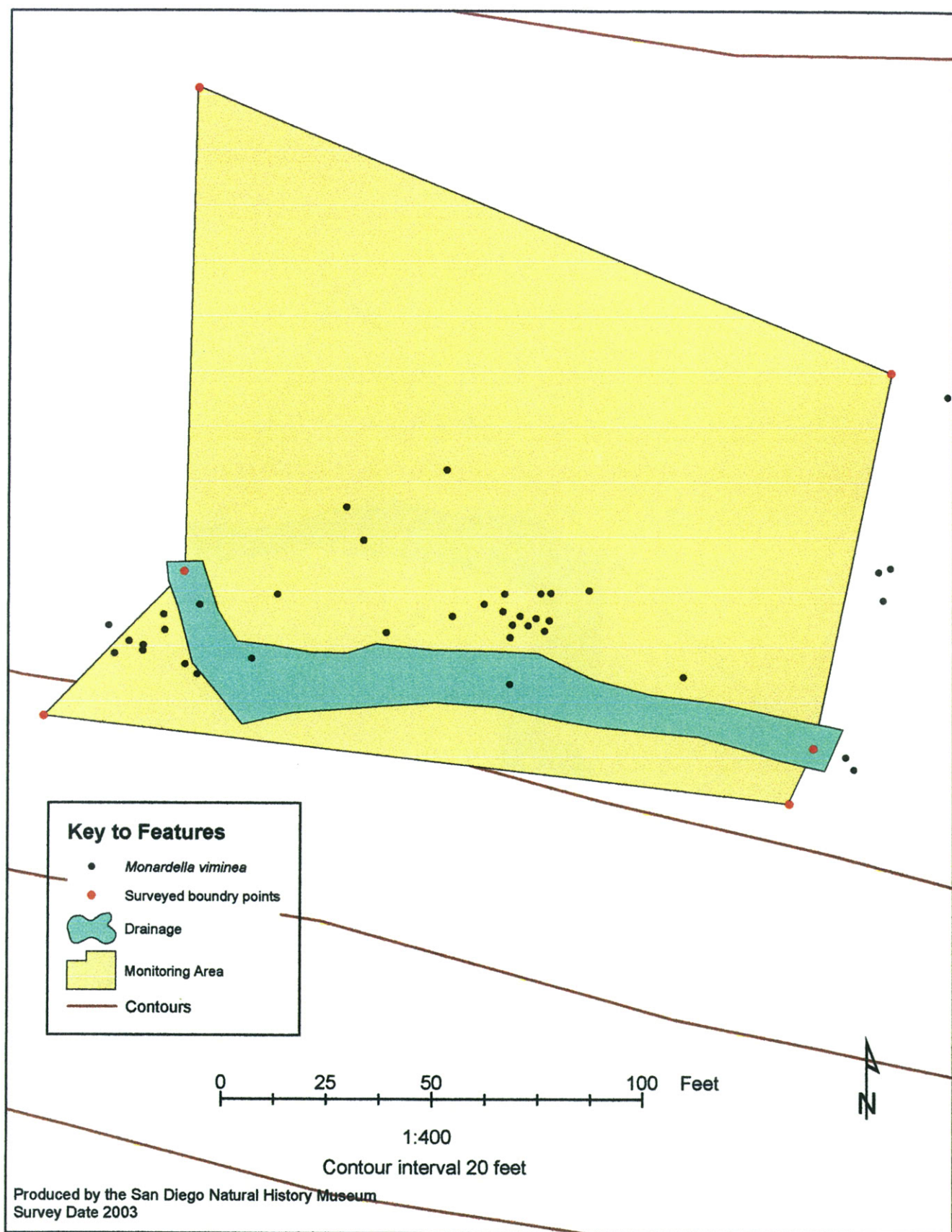
**Willowy Monardella
Monitoring Site WSYS12003L**



Willowy Monardella Monitoring Site WSYS12003M

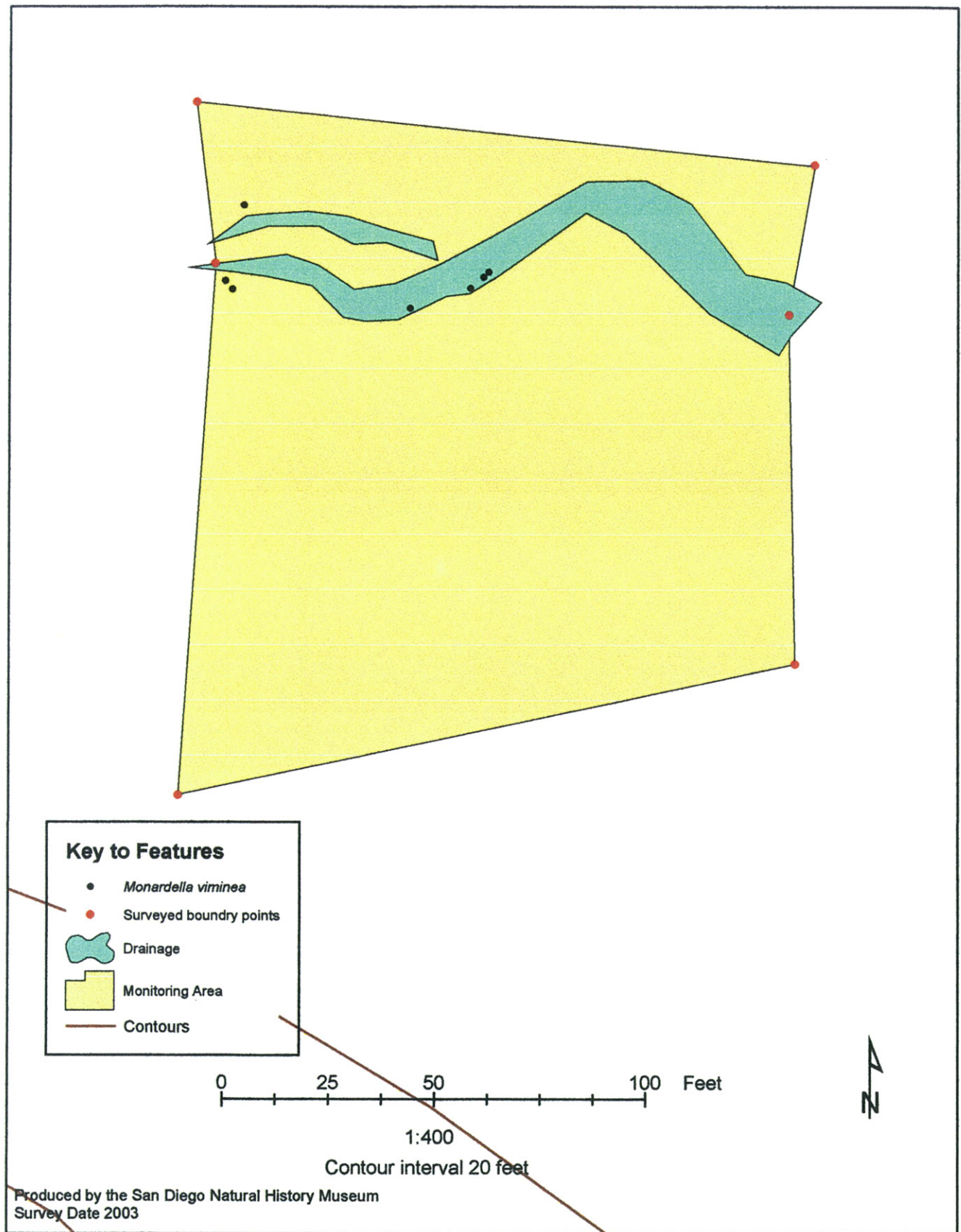


Willowy Monardella Monitoring Site WSYS12003N



Willow Monardella

Monitoring Site WSYS12003O



Site
WSYC012003A
Detail Site
Drainage Mapped

Rod Dossey
7/17/2003

Clumps	10
Estimated N	31
Adults	28
Mature	3
Juveniles	0
Seedling	1
Area in Hectares	0.11494
density number/hectare	269.7068

Native Species	Percent Cover	Exotic Species	Percent Cover
Adenostoma fasciculatum		Avena barbata	0.1
Ambrosia psilostachya		Avena fatua	
Baccharis sarothroides	0.05	Brassica sp.	0.2
Cuscuta sp.		Bromus hordeaceus	
Daucus pusillus		Centaurea melitensis	
Epilobium canum		Gastroidium ventricosum	
Eremocarpus setigerus		Hedypnois cretica	
Eriogonum fasciculatum		Hypochaeris glabra	
Lessingia filaginifolia		Lolium multiflorum	
Lonicera subspicata		Rumex sp.	
Lotus scoparius		Silene gallica	
Lupinus sp.			
Mimulus aurantiacus			
Mimulus guttatus			
Monardella viminea			
Phacelia sp.			
Quercus berberidifolia			
Rhamnus crocea	0.05		
Salvia apiana			
Toxicodendron diversilobum			

Site
WSYC012003B
Detail Site
Drainage Mapped

Rod Dossey
7/17/2003

Clumps	13
Estimated N	21
Adults	18
Mature	2
Juveniles	0
Seedling	0
Area in Hectares	0.179247
density number/hectare	117.1567

Native Species	Percent Cover	Exotic Species	Percent Cover
Baccharis sarothroides		Avena sp.	0.9
Cercocarpus minitiflorus	0.05	Brassica nigra	
Cuscuta sp.		Centaurea melitensis	0.1
Eriogonum fasciculatum		Erodium botrys	
Gnaphalium canescens		Hedypnois cretica	
Deinandra fasciculata		Hypochaeris glabra	
Heteromeles arbutifolia		Rumex crispus	
Monardella viminea			
Phacelia sp.			
Prunus ilicifolia			
Rhamnus crocea			
Toxicodendron diversilobum			

Site
WSYC012003C
Detail Site
Drainage Mapped

Rod Dossey
7/31/2003

Clumps	9
Estimated N	18
Adults	18
Mature	0
Juveniles	0
Seedling	0
Area in Hectares	0.10603
density number/hectare	169.7629

Native Species	Percent Cover	Exotic Species	Percent Cover
Artemisia californica		Avena sp.	
Baccharis sarothroides		Brassica nigra	0.05
Calystegia macrostegia		Bromus diandrus	0.05
Cercocarpus minutiflorus		Bromus hordeaceus	
Dudleya pulverulenta		Centaurea melitensis	
Eriodictyon crassifolium	0.05	Erodium botrys	0.1
Eriogonum fasciculatum	0.1	Filago gallica	
Galium sp.		Hedypnois cretica	
Helianthemum scoparium		Hypochaeris glabra	
Helianthus sp.		Lamarckia aurea	
Heteromeles arbutifolia		Silene gallica	
Lepidium sp.			
Lotus scoparius			
Lupinus ?			
Monardella viminea			
Oxalis albicans			
Pellaea mucronata			
Phacelia sp.			
Prunus ilicifolia			
Rhamnus crocea			
Rhus integrifolia			
Rumex sp.			
Salvia apiana	0.05		
Selaginella cinerascens			
Toxicodendron diversilobum	0.15		
Hesperoyucca whipplei			

Site
WSYC012003D
Detail Site
Drainage Mapped

Rod Dossey
7/31/2003

Clumps	2
Estimated N	4
Adults	1
Mature	3
Juveniles	0
Seedling	0
Area in Hectares	0.146369
density number/hectare	27.32824

Native Species	Percent Cover	Exotic Species	Percent Cover
Artemisia californica		Avena sp.	0.9
Baccharis sarothroides		Brassica nigra	
Ceanothus tomentosus		Bromus hordeaceus	
Eriogonum fasciculatum	0.05	Centaurea melitensis	0.05
Deinandra fasciculata		Erodium botrys	
Lonicera subspicata		Hypochaeris glabra	
Malosma laurina		Silene gallica	0.05
Monardella viminea			
Prunus ilicifolia			
Rumex sp.			
Stephanomeria virgata			
Toxicodendron diversilobu	0.1		

Site
WSYC012003E
Detail Site
Drainage Mapped

Rod Dossey
7/31/2003

Clumps	14
Estimated N	22
Adults	15
Mature	6
Juveniles	1
Seedling	0
Area in Hectares	0.158047
density number/hectare	139.1994

Native Species	Percent Cover	Exotic Species	Percent Cover
Artemisia californica		Avena sp.	
Asclepias fascicularis		Bromus diandrus	0.75
Baccharis sarothroides		Bromus rubens	
Brickellia californica		Centaurea melitensis	
Caulanthus heterophyllus		Erodium botrys	0.25
Ceanothus tomentosus		Filago gallica	
Cercocarpus minutiflorus	0.05	Hedypnois cretica	
Cuscuta sp.		Hypochaeris glabra	
Epilobium canum?		Reseda sp.	
Eriogonum fasciculatum		Rumex sp.	
Galium sp.		Silene gallica	
Deinandra fasciculata			
Isocoma menziesii			
Lepidium sp.			
Lessingia filaginifolia			
Lonicera subspicata			
Malosma laurina			
Monardella viminea			
Phacelia sp.			
Prunus ilicifolia			
Quercus berberidifolia			
Rhamnus crocea			
Rumex sp.			
Salvia apiana			
Solanum parishii			
Stephanomeria virgata			

Site
WSYC012003F
Detail Site
Drainage Mapped

Rod Dossey
7/31/2003

Clumps	24
Estimated N	154
Adults	152
Mature	2
Juveniles	0
Seedling	0
Area in Hectares	0.219864
density number/hectare	700.4319

	Percent		Percent
Native Species	Cover	Exotic Species	Cover
Baccharis sarothroides		Avena sp.	0.25
Cercocarpus minutiflorus	0.05	Brassica nigra	
Epilobium canum?		Bromus diandrus	0.75
Eriogonum fasciculatum		Bromus hordeaceus	
Galium sp.		Centaurea melitensis	0.1
Monardella viminea		Erodium botrys	0.1
Rhamnus crocea		Hedypnois cretica	
Rumex sp.		Hypochaeris glabra	
Toxicodendron diversilobum		Reseda sp.	
		Silene gallica	

Site
WSYC012003G
Detail Site
Drainage Mapped

Rod Dossey
8/1/2003

Clumps	24
Estimated N	25
Adults	21
Mature	3
Juveniles	1
Seedling	0
Area in Hectares	0.204749
density number/hectare	122.1007

Native	Percent Cover	Exotic	Percent Cover
Artemisia californica		Avena sp.	0.05
Baccharis sarothroides		Brachypodium distachyon	
Brickellia californica		Brassica nigra	
Calystegia macrostegia		Bromus diandrus	0.25
Cercocarpus minutiflorus		Bromus hordeaceus	
Chorizanthe fimbriata		Bromus rubens	
Epilobium canum?		Centaurea melitensis	
Erigeron foliosus		Erodium botrys	
Eriogonum fasciculatum	0.05	Filago gallica	
Galium sp.		Hedypnois cretica	
Gnaphalium canescens		Hypochaeris glabra	
Deinandra fasciculata		Lactuca sp.	
Heteromeles arbutifolia		Lamarckia aurea	
Lepidium sp.		Lolium multiflorum	
Lessingia filaginifolia		Reseda sp.	
Lonicera subspicata		Rumex crispus	
Lotus scoparius		Silene gallica	
Lotus strigosus		Spergula arvensis	
Monardella viminea			
Opuntia littorales			
Phacelia sp.			
Quercus berberidifolia			
Rhamnus crocea			
Rumex sp.			
Salvia apiana	0.05		
Selaginella bigelovii			
Selaginella cinerascens			

Site
WSYC012003H
Detail Site
Drainage Mapped

Rod Dossey

8/1/2003

Clumps	32
Estimated N	64
Adults	57
Mature	7
Juveniles	0
Seedling	0
Area in Hectares	0.539544
density number/hectare	118.6188

	Percent Cover		Percent Cover
Native Species		Exotic Species	
Achnatherum corornata		Avena sp.	0.4
Adenostema fasciculatum		Brachypodium distachyon	
Artemisia californica		Brassica nigra	
Baccharis sarothroides		Bromus diandrus	0.7
Brickellia californica		Bromus madritensis	
Calystegia macrostegia		Bromus hordeaceus	
Cercocarpus minutiflorus	0.05	Bromus rubens	
Chamaesyce albomarginata		Centaurea melitensis	
Eremocarpus setigerus		Erodium botrys	0.1
Eriogonum fasciculatum		Filago gallica	
Galium sp.		Hedypnois cretica	
Gnaphalium californicum		Lamarckia aurea	
Gnaphalium canescens		Lolium multiflorum	
Lepidium sp.		Silene gallica	
Lessingia filaginifolia			
Lonicera subspicata			
Lotus strigosus			
Lupinus ?			
Lupinus sp.			
Malosma laurina			
Monardella viminea			
Opuntia littorales			
Oxalis albicans			
Rhamnus crocea			
Rumex sp.			
Salvia apiana			
Selaginella bigelovii			
Selaginella cinerascens			
Toxicodendron diversilobum			
Hesperoyucca whipplei			

Site

WSYC012003I

Rod Dossey

Detail Site

8/18/2003

Drainage Mapped

Clumps	53
Estimated N	375
Adults	304
Mature	68
Juveniles	3
Seedling	0
Area in Hectares	0.075159
density number/hectare	4989.452

Native Species	Percent Cover	Exotic Species	Percent Cover
Artemisia californica		Avena sp.	
Baccharis sarothroides		Bromus diandrus	
Calochortus sp.		Bromus madritensis	
Calystegia macrostegia		Bromus hordeaceus	
Cercocarpus minutiflorus		Centaurea melitensis	0.05
Cuscuta sp.		Erodium botrys	
Daucus pusillus		Filago gallica	
Delphinium parryi		Hedypnois cretica	
Eriodictyon crassifolium	0.05	Hypochaeris glabra	
Eriogonum fasciculatum	0.4	Reseda sp.	
ferocactus vireescens		Silene gallica	0.4
Deinandra fasciculata			
Lessingia filaginifolia			
Lonicera subspicata			
Malosma laurina			
Marah macrocarpus			
Melica imperfecta			
Monardella viminea	0.1		
Nassella pulchra			
Castilleja sp.			
Phacelia sp.			
Prunus ilicifolia			
Rhamnus crocea			
Salvia apiana			
Selaginella cinerascens			
Stephanomeria virgata			
Toxicodendron diversilobum			
Xylococcus bicolor			

Site
WSYC012003J
Standard Site

Rod Dossey
8/18/2003

Clumps	39
Estimated N	54
Adults	45
Mature	8
Juveniles	1
Seedling	0
Area in Hectares	0.074397
density number/hectare	725.8381

	Percent Cover	Exotic Species	Percent Cover
Native Species			
Artemisia californica		Avena sp.	
Baccharis sarothroides		Brassica sp.	
Calystegia macrostegia		Bromus madritensis	
Cercocarpus minutiflorus		Centaurea melitensis	
Cuscuta sp.		Erodium botrys	
Daucus pusillus		Filago gallica	
Dudleya pulverulenta		Gastroidium ventricosum	
Eriodictyon crassifolium		Hedypnois cretica	
Eriogonum fasciculatum	0.25	Hypochaeris glabra	
Galium sp.		Lamarckia aurea	
Deinandra fasciculata		Lathyrus sp.	
Lessingia filaginifolia		Silene gallica	0.45
Lonicera subspicata			
Monardella viminea			
Nassella pulchra			
Castilleja sp.			
Phacelia sp.			
Rhamnus crocea			
Salvia apiana			
Salvia columbariae			
Salvia mellifera			
Selaginella cinerascens			

Site
WSYC012003K
Standard

Rod Dossey
8/21/2003

Clumps	1
Estimated N	5
Adults	0
Mature	5
Juveniles	0
Seedling	0
Area in Hectares	0.356413
density number/hectare	14.02866

Native Species	Percent Cover	Exotic Species	Percent Cover	terrain	Percent Cover
Artemisia californica		Avena sp.		open cobbl	0.35
Baccharis salicifolia		Brassica nigra	0.05	dirt road	0.2
Baccharis sarothroides	0.05	Bromus madritensis			
Brickellia californica	0.05	Erodium botrys			
Camissonia sp.		Filago gallica			
Cardionema ramosissima		Hedypnois cretica			
Chorizanthe fimbriata		Lamarckia aurea			
Cuscuta sp.	0.2	Silene gallica			
Daucus pusillus					
Delphinium parryi					
Epilobium canum?					
Eriodictyon crassifolium					
Eriogonum fasciculatum	0.5				
Eriogonum wrightii					
Galium sp.					
Galium sp. 2					
Gnaphalium californicum					
Gnaphalium canescens					
Gutierrezia sp.					
Lessingia filaginifolia					
Lotus scoparius					
Monardella viminea					
Nassella pulchra					
Pellaea mucronata					
Quercus agrifolia					
Salvia apiana	0.2				
Stylocline gnaphaloides					

Site
WSYC012003L
Detail Site
Drainage Mapped

Rod Dossey
8/21/2003

Clumps	3
Estimated N	5
Adults	5
Mature	0
Juveniles	0
Seedling	0
Area in Hectares	0.13784
density number/hectare	36.27388

Native Species	Percent Cover	Exotic Species	Percent Cover
Artemisia californica		Avena sp.	
Baccharis sarothroides		Brassica nigra	
Ceanothus tomentosus	0.25	Bromus madritensis	0.1
Cuscuta sp.		Bromus hordeaceus	
Daucus pusillus		Centaurea melitensis	0.1
Eriogonum fasciculatum	0.2	Erodium botrys	0.25
Galium sp.		Filago gallica	
Deinandra fasciculata		Hedypnois cretica	
Lotus scoparius		Hypochaeris glabra	
Malacothamnus fasciculatum		Reseda sp.	
Malosma laurina		Silene gallica	
Phacelia sp.			
Prunus ilicifolia			
Quercus berberidifolia	0.05		
Rhamnus crocea			
Ribes indecorum			
Rumex sp.			
Salvia apiana			
Salvia mellifera			
Stephanomeria virgata			
Toxicodendron diversilobum			

Site
WSYC012003M
Detail Site
Drainage Mapped

Rod Dossey
9/5/2003

Clumps	5
Estimated N	5
Adults	1
Mature	4
Juveniles	0
Seedling	0
Area in Hectares	0.098821
density number/hectare	50.59655

Native Species	Percent Cover	Exotic Species	Percent Cover
Asclepias fascicularis		Avena sp.	0.5
Calochortus sp.		Brachypodium distachyon	
Cercocarpus minutiflorus	0.2	Brassica nigra	
Eremocarpus setigerus		Bromus hordeaceus	
Eriogonum fasciculatum		Centaurea melitensis	0.25
Gnaphalium californicum		Erodium botrys	
Deinandra fasciculata		Filago gallica	
Heteromeles arbutifolia		Gastroidium ventricosum	
Lessingia filaginifolia		Hedypnois cretica	
Linaria sp.		Rumex crispus	
Phacelia sp.		Silene gallica	
Quercus berberidifolia			
Rhamnus crocea			
Salvia mellifera			
Stephanomeria virgata			
Toxicodendron diversilobum			

Site
WSYC012003N
Detail Site
Drainage Mapped

Rod Dossey
9/5/2003

Clumps	31
Estimated N	60
Adults	47
Mature	10
Juveniles	2
Seedling	1
Area in Hectares	0.200866
density number/hectare	298.7071

Native Species	Percent Cover	Exotic Species	Percent Cover
Baccharis sarothroides		Avena sp.	
Calystegia macrostegia		Brassica nigra	0.05
Ceanothus tomentosus	0.25	Bromus madritensis	
Cercocarpus minutiflorus		Bromus hordeaceus	
Clarkia purpurea		Centaurea melitensis	
Clematis pauciflora		Erodium botrys	
Cryptantha sp.		Filago gallica	
Cuscuta sp.		Gastroidium ventricosum	
Epilobium canum?		Hedypnois cretica	
Eriodictyon crassifolium		Hypochaeris glabra	
Eriogonum fasciculatum	0.2	Silene gallica	0.1
Galium sp.			
Heteromeles arbutifolia			
Lepidium sp.			
Marah macrocarpus			
Opuntia littorales			
Phacelia sp.			
Rhamnus crocea			
Rhus integrifolia			
Salvia apiana			
Selaginella cinerascens			
Hesperoyucca whipplei			

Site
WSYC0120030
Detail Site
Drainage Mapped

Rod Dossey
9/8/2003

Clumps	7
Estimated N	13
Adults	6
Mature	1
Juveniles	0
Seedling	5
Area in Hectares	0.188138
density number/hectare	69.09823

Native Species	Percent Cover	Exotic Species	Percent Cover
Baccharis sarothroides		Avena sp.	
Ceanothus tomentosus	0.4	Brassica nigra	0.1
Cercocarpus minutiflorus	0.1	Bromus hordeaceus	
Clarkia purpurea		Bromus sp.	0.3
Cuscuta sp.		Centaurea melitensis	
Epilobium canum?		Erodium botrys	
Eriodictyon crassifolium		Hedypnois cretica	
Eriogonum fasciculatum	0.1	Hypochaeris glabra	
Deinandra fasciculata		Lamarckia aurea	
Heteromeles arbutifolia		Silene gallica	
Lessingia filaginifolia			
Lonicera subspicata			
Lotus scoparius			
Malosma laurina			
Opuntia littorales			
Phacelia sp.			
Prunus ilicifolia			
Quercus berberidifolia			
Rumex sp.			
Salvia apiana			
Salvia mellifera			
Stephanomeria virgata			
Toxicodendron diversilobum			

Cumulative Species List for All Sites 2003

Native Species	Number of Sites where found	Exotic Species	Number of Sites where found
<i>Achnatherum coronatum</i>	1	<i>Avena barbata</i>	1
<i>Adenostema fasciculatum</i>	2	<i>Avena fatua</i>	1
<i>Ambrosia psilostachya</i>	1	<i>Avena sp.</i>	14
<i>Artemisia californica</i>	9	<i>Brachypodium distachyon</i>	3
<i>Asclepias fascicularis</i>	2	<i>Brassica nigra</i>	11
<i>Baccharis salicifolia</i>	1	<i>Brassica sp.</i>	13
<i>Baccharis sarothroides</i>	14	<i>Bromus diandrus</i>	6
<i>Brickellia californica</i>	4	<i>Bromus madritensis</i>	6
<i>Calochortus sp.</i>	2	<i>Bromus hordeaceus</i>	11
<i>Calystegia macrostegia</i>	6	<i>Bromus rubens</i>	3
<i>camisonia sp.</i>	1	<i>Centaurea melitensis</i>	14
<i>Cardionema ramosissima</i>	1	<i>Erodium botrys</i>	14
<i>Caulanthus heterophyllus</i>	1	<i>Filago gallica</i>	10
<i>Ceanothus tomentosus</i>	5	<i>Gastrium ventricosum</i>	4
<i>Cercocarpus minutiflorus</i>	11	<i>hedypnois cretica</i>	14
<i>Chamaesyce albomarginata</i>	1	<i>Hypochaeris glabra</i>	12
<i>Chorizanthe fimbriata</i>	2	<i>Lactuca sp.</i>	1
<i>Clarkia purpurea</i>	2	<i>Lamarckia aurea</i>	6
<i>Clematis pauciflora</i>	1	<i>Lolium multiflorum</i>	3
<i>Cryptantha sp.</i>	1	<i>Reseda sp.</i>	5
<i>cuscuta sp.</i>	9	<i>Rumex crispus</i>	3
<i>Daucus pusillus</i>	5	<i>Silene gallica</i>	14
<i>Delphinium parryi</i>	2	<i>Spergula arvensis</i>	1
<i>Dudleya pulverulenta</i>	2		
<i>Epilobium canum?</i>	7		
<i>Eremocarpus setigerus</i>	3		
<i>Erigeron foliosus</i>	1		
<i>Eriodictyon crassifolium</i>	6		
<i>Eriogonum fasciculatum</i>	15		
<i>Eriogonum wrightii</i>	1		
<i>ferocactus vireescens</i>	1		
<i>galium sp.</i>	9		
<i>galium sp. 2</i>	1		
<i>Gnaphalium californicum</i>	3		
<i>Gnaphalium canescens</i>	4		
<i>guttierrezia sp.</i>	1		
<i>Helianthemum scoparium</i>	1		
<i>Helianthus sp.</i>	1		
<i>Deinandra fasciculata</i>	9		
<i>Heteromeles arbutifolia</i>	6		
<i>Isocoma menziesii</i>	1		
<i>Lathyrus sp.</i>	1		
<i>Lepidium sp.</i>	5		
<i>Lessingia filaginifolia</i>	9		
<i>Linaria sp.</i>	1		
<i>Lonicera subspicata</i>	8		
<i>Lotus scoparius</i>	6		

Native Species (continued)	Number of Sites where found
<i>Lotus strigosus</i>	2
<i>Lupinus</i> ?	2
<i>Lupinus</i> sp.	2
<i>Malacothamnus fasciculatum</i>	1
<i>Malosma laurina</i>	6
<i>Marah macrocarpus</i>	2
<i>Melica imperfecta</i>	1
<i>Mimulus aurantiacus</i>	1
<i>Mimulus guttatus</i>	1
<i>Monardella viminea</i>	15
<i>Nassella pulchra</i>	3
<i>Opuntia littorales</i>	4
<i>Castilleja</i> sp.	2
<i>Oxalis albicans</i>	2
<i>Pellaea mucronata</i>	2
<i>Phacelia</i> sp.	11
<i>Platanus racemosa</i>	0
<i>Prunus ilicifolia</i>	7
<i>Quercus agrifolia</i>	1
<i>Quercus berberidifolia</i>	7
<i>Rhamnus crocea</i>	12
<i>Rhus integrifolia</i>	2
<i>Ribes indecorum</i>	1
<i>Rumex</i> sp.	10
<i>Salvia apiana</i>	11
<i>Salvia columbariae</i>	1
<i>Salvia mellifera</i>	4
<i>Selaginella bigelovii</i>	2
<i>Selaginella cinerascens</i>	6
<i>Silene laciniata</i>	0
<i>Solanum parishii</i>	1
<i>stephanomeria virgata</i>	6
<i>Stylocline gnaphaloides</i>	1
<i>Toxicodendron diversilobum</i>	10
<i>Xylococcus bicolor</i>	1
<i>Hesperoyucca whipplei</i>	3

Site	Date:	5/26/2004	
WSYC012004A	Surveyors:	Julie Finzel, JoEllen Kassebaum	
Detail Site (type of Site)		& Dirk Netz	
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)			
Estimated N	13		
Adults	12		
Mature	1		
Juveniles	0		
Seedling	0		
Area in Hectares (area of Site)	0.114942		
Density (number/hectare)	113.101		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Ambrosia psilostachya	0.05	Avena fatua	0.35
Baccharis sarothroides	0.05	Brassica nigra	0.07
Calystegia macrostegia	0.05	Bromus diandrus	0.05
Ceanothus tomentosus	0.05	Bromus madritensis	0.05
Cercocarpus minutiflorus	0.1	Bromus hordeaceus (mollis)	0.05
Deinandra fasciculata	0.05	Centaurea melitensis	0.05
Epilobium canum	0.05	Erodium botrys	0.05
Eriogonum fasciculatum	0.05	Lolium multiflorum	0.05
Eschscholzia californica	0.05	Rumex salicifolia	0.05
Lepidium sp.	0.05	Vulpia myuros	0.05
Lonicera subspicata	0.05		
Malacothamnus fasciculata	0.05		
Quercus berberidifolia	0.05		
Salvia apiana	0.05		
Silene laciniata	0.05		
Solanum parishii	0.05		
Stephanomeria virgata	0.05		
Toxicodendron diversilobum	0.05		

Site	Date:	5/25/2004	
WSYC012004B	Surveyors:	Gary, Bob, Sandy, JoEllen	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)	1		
Estimated N	11		
Adults	7		
Mature	3		
Juveniles	0		
Seedling	0		
Area in Hectares (area of Site)	0.179251		
Density (number/hectare)	61.367		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Baccharis sarathroides	0.05	Avena sp.	0.4
Ceanothus tomentosus	0.1	Brassica nigra	0.05
Cryptantha sp.	0.05	Bromus madritensis	0.35
Deinandra fasciculata	0.05	Centaurea melitensis	0.05
Gnaphalium canescens	0.05	Erodium botrys	0.05
Lepidium sp.	0.05	Reseda luteola	0.05
Lonicera subspicata	0.05		
Monardella viminea	0.05		
Phacelia sp.	0.05		
Prunus ilicifolia	0.1		
Rumex sp.	0.05		
Silene laciniata	0.05		

Site	Date:	5/25/2004	
WSYC012004C	Surveyors:	Chad, Rod, and Julie Finzel	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)	0		
Estimated N	19		
Adults	11		
Mature	8		
Juveniles	1		
Seedling	0		
Area in Hectares (area of Site)	0.106029		
Density (number/hectare)	179.196		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Artemisia californica		Avena sp.	0.2
Calystegia macrostegia		Brassica nigra	
Eriodictyon crassifolium		Bromus diandrus	0.4
Eriogonum fasciculatum		Bromus hordeaceus (mollis)	
Galium sp.		Bromus rubens	
Helianthus sp.		Centaurea melitensis	
Lepidium sp.		Erodium botrys	0.1
Lessingia filaginifolia		Hedypnois cretica	
Lupinus sp.		Lamarckia aurea	
Marah macrocarpus		Silene gallica	
Pellaea mucronata			
Phacelia sp.			
Quercus berberidifolia			
Rhamnus crocea			
Rumex sp.			
Salvia apiana			
Stephanomeria virgata			
Toxicodendron diversilobum			
Hesperoyucca whipplei			

Site	Date:	5/25/2004	
WSYC012004D	Surveyors:	Chad, Rod, and Julie Finzel	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)	0		
Estimated N	2		
Adults	1		
Mature	0		
Juveniles	1		
Seedling	0		
Area in Hectares (area of Site)	0.146367		
Density (number/hectare)	13.664		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Baccharis sarothroides		Avena sp.	0.15
Clematis pauciflora		Bromus diandrus	0.8
Eriogonum fasciculatum		Bromus hordeaceus (mollis)	
Galium sp.		Bromus rubens	
Lepidium sp.		Centaurea melitensis	
Lupinus sp.		Erodium botrys	
Opuntia littorales		Hedypnois cretica	
Phacelia sp.		Hypochaeris glabra	
Prunus ilicifolia	0.05	Lolium multiflorum	0.15
Rumex sp.		Rumex crispus	
Salvia columbariae		Silene gallica	
Solanum parishii			
Stephanomeria virgata			
Hesperoyucca whipplei			

WSYC012003M

Drainage Mapped (was drainage mapped or not)

9/5/2003 (Date)

5

5

Data Missing?

[illegible]

Site	Date	5/25/2004	
WSYC012004F	Surveyors:	Dirk, Derek, Katy and Diane	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)	4		
Estimated N	40		
Adults	38		
Mature	2		
Juveniles	0		
Seedling	0		
Area in Hectares (area of Site)	0.219868		
Density (number/hectare)	181.927		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Artemisia californica	0.05	Avena sp.	0.4
Baccharis sarathroides	0.1	Brachypodium distachyon	
Cercocarpus minutiflorus	0.1	Brassica nigra	0.05
Cryptantha sp.	0.05	Bromus diandrus	0.3
Deinandra fasciculata	0.05	Bromus madritensis	0.05
Epilobium canum	0.05	Centaurea melitensis	0.05
Eschscholzia californica	0.05	Erodium botrys	0.1
Lepidium sp.	0.05	Reseda luteola	0.05
Malacothamnus fasciculatum	0.05	Rumex crispus	0.05
Monardella viminea	0.05	Silene gallica	0.05
Prunus ilicifolia	0.1		
Rumex sp.	0.05		
Solanum parishii	0.05		

Site	Date:	5/25/2004	
WSYC012004G	Surveyors:	Bob Haase, Sandra Baldwin, Julie	
Detail Site (type of Site)		Finzel, Derek Wolfe, Diane Walsh,	
Drainage Mapped (was drainage mapped or not)	Yes	Gary Davis, JoEllen, Rod, and Dirk	
Clumps (number of points taken)	1		
Estimated N	28		
Adults	9		
Mature	13		
Juveniles	6		
Seedling	0		
Area in Hectares (area of Site)	0.204746		
Density (number/hectare)	136.755		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Artemisia californica	0.1	Avena sp.	0.25
Baccharis sarothroides	0.1	Brassica nigra	0.1
Brickellia californica	0.05	Bromus diandrus	0.05
Calystegia macrostegia	0.05	Bromus madritensis	0.25
Cercocarpus minutiflorus	0.05	Erodium botrys	0.75
Chorizanthe fimbriata	0.05	Lamarckia aurea	0.05
Epilobium canum	0.05	Lolium multiflorum	0.05
Eriogonum fasciculatum	0.05		
Galium sp.	0.05		
Lepidium sp.	0.05		
Lonicera subspicata	0.05		
Monardella viminea	0.1		
Opuntia littorales	0.05		
Phacelia sp.	0.1		
Prunus ilicifolia	0.1		
Rumex sp.	0.05		
Salvia apiana	0.1		
Stephanomeria virgata	0.05		
Toxicodendron diversilobum	0.05		

Site	Date:	5/25/2004	
WSYC012004H	Surveyors:	Dirk, Derek, Katy, and Diane	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)	4		
Estimated N	53		
Adults	35		
Mature	16		
Juveniles	2		
Seedling	0		
Area in Hectares (area of Site)	0.539548		
Density (number/hectare)	98.23043		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Baccharis sarothroides	0.05	Avena sp.	0.75
Brickellia californica	0.05	Brassica nigra	0.05
Calystegia macrostegia	0.05	Bromus diandrus	
Caulanthus heterophyllus		Bromus madritensis	
Ceanothus tomentosus	0.05	Centaurea melitensis	0.05
Cercocarpus minutiflorus	0.05	Erodium botrys	0.05
Cryptantha sp.	0.05	Lolium multiflorum	
Epilobium canum	0.05		
Eriogonum fasciculatum	0.05		
Eschscholzia californica	0.05		
Ferocactus vireescens	0.05		
Lepidium sp.	0.05		
Lotus scoparius	0.05		
Monardella viminea	0.05		
Opuntia littorales	0.05		
Phacelia sp.	0.05		
Ribes indecorum	0.05		
Rumex sp.	0.05		
Salvia apiana	0.05		
Silene laciniata	0.05		
Toxicodendron diversilobum	0.05		
Hesperoyucca whipplei	0.05		

Site:	Date:	6/2/2004		
WSYC012004I	Surveyors:	John, Carol, and JoEllen		
Detail Site (type of Site)				
Drainage Mapped (was drainage mapped or not)	Yes			
Clumps (number of points taken)	1			
Estimated N	193			
Adults	94			
Mature	76			
Juveniles	0			
Seedling	23			
Area in Hectares (area of Site)	0.075155			
Density (number/hectare)	2568.038			
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover	
Artemisia californica	0.05	Avena sp.	0.05	
Calystegia macrostegia	0.05	Bromus diandrus		
Cryptantha sp.	0.05	Bromus madritensis	0.4	Total for all
Daucus sp.		Bromus hordeaceus (mollis)		
Eriodictyon crassifolium	0.05	Centaurea melitensis	0.25	
Eschscholzia sp.		Erodium botrys		
Ferocactus vireescens		Reseda luteola	0.25	
Lepidium sp.		Silene gallica		
Linaria sp.		Vulpia sp.		
Lonicera subspicata		Vicia sp.		
Lotus scoparius				
Malacothamnus fasciculatum				
Malosma laurina	0.05			
Marah macrocarpus				
Mirabilis sp.				
Nassella pulchra				
Phacelia sp.				
Prunus ilicifolia	0.05			
Rhamnus crocea	0.05			
Rhus integrifolia				
Salvia apiana				
Salvia columbariae				
Silene laciniata				
Solanum parishii				
Stephnomeria virgata				
Toxicodendron diversilobum				

Site	Date:	6/2/2004	
WSYC012004J	Surveyors:	Sandra Marquez, Carolyn Lieberman, John Martin, and Rod Dossey	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)			
Estimated N	73		
Adults	51		
Mature	15		
Juveniles	0		
Seedling	7		
Area in Hectares (area of Site)	0.074397		
Density (number/hectare)	981.226		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Baccharis sarothroides		Avena sp.	0.55
Calystegia macrostegia	0.1	Brachypodium distachyon	
Cercocarpus minutiflorus		Brassica sp.	
Daucus pusillus		Bromus diandrus	
Eriogonum fasciculatum		Bromus hordeaceus	
Eschscholzia californica		Bromus rubens	
Galium sp.		Centaurea melitensis	0.1
Hemizonia fasciculata		Erodium botrys	
Lathyrus sp.		Hedypnois cretica	
Lepidium sp.		Hypochaeris glabra	
Lessingia filaginifolia		Reseda luteola	
Linaria sp.		Silene gallica	0.35
Lonicera subspicata			
Mimulus sp.			
Monardella viminea			
Phacelia sp.			
Rhamnus crocea			
Salvia columbariae			
Silene laciniata			
Solanum parishii			
Stephanomeria virgata			
Toxicodendron diversilobum			

Site	Date:	5/28/2004	
WSYC012004K	Surveyors:	Dirk Netz, JoEllen Kassebaum	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	No		
Clumps (number of points taken)	0		
Estimated N	4		
Adults	1		
Mature	3		
Juveniles	0		
Seedling	0		
Area in Hectares (area of Site)	0.356414		
Density (number/hectare)	11.22292		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Adenostoma fasciculatum	0.2	Avena sp.	0.05
Artemisia californica	0.05	Brassica nigra	0.07
Baccharis salicifolia	0.07	Bromus madritensis	0.02
Baccharis sarothroides	0.02	Bromus diandrus	0.05
Calystegia macrostegia	0.05	Hordeum sp.	0.05
Carex sp.	0.05	Reseda luteola	0.05
Ceanothus tomentosus	0.05		
Chorizanthe fimbriata	0.05		
Cryptantha sp.	0.05		
Cuscuta sp.	0.05		
Deinandra fasciculata	0.05		
Dudleya pulverulenta	0.05		
Epilobium canum	0.05		
Eschscholzia californica	0.05		
Gnaphalium canescens	0.05		
Linaria sp.	0.05		
Malosma laurina	0.05		
Mimulus aurantiacus	0.05		
Opuntia littoralis	0.05		
Platanus racemosa	0.07		
Quercus agrifolia	0.1		
Salvia apiana	0.05		
Silene laciniata	0.05		

Site	Date:	5/25/2004	
WSYC012004L	Surveyors:	Sandy, Gary, JoEllen	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)	1		
Estimated N	7		
Adults	6		
Mature	1		
Juveniles	0		
Seedling	0		
Area in Hectares (area of Site)	0.137841		
Density (number/hectare)	50.78319		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Artemisia californica	0.05	Avena sp.	0.4
Calystegia macrostegia	0.05	Brassica nigra	0.05
Ceanothus tomentosus	0.2	Bromus diandrus	0.4
Cercocarpus minutiflorus		Erodium botrys	0.4
Cryptantha sp.	0.05	Hypochaeris glabra	0.05
Deinandra fasciculata	0.05	Lactuca sp.	0.05
Lupinus sp.	0.05	Reseda luteola	0.05
Malacothamnus fasciculatum	0.05	Rumex crispus	0.05
Malosma laurina	0.05		
Marah macrocarpus	0.05		
Phacelia sp.	0.05		
Prunus ilicifolia	0.1		
Quercus berberidifolia	0.2		
Silene laciniata	0.05		
Solanum parishii	0.05		
Toxicodendron diversilobum	0.05		

Site	Date:	5/25/2004	
WSYC012004M	Surveyors:	Julie, Derek, Bob, Diane, Chad, and	
Detail Site (type of Site)		Rod	
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)			
Estimated N	4		
Adults	3		
Mature	1		
Juveniles	0		
Seedling	0		
Area in Hectares (area of Site)	0.098817		
Density (number/hectare)	40.47869		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Artemisia californica		Avena sp.	0.3
Caulanthus heterophyllus		Brassica nigra	
Cercocarpus minutiflorus		Bromus diandrus	0.1
Clematis pauciflora		Bromus hordeaceus	
Eriodictyon crassifolium		Centaurea melitensis	0.1
Heteromeles arbutifolia		Erodium botrys	0.05
Lessingia filaginifolia		Filago gallica	
Malacothamnus fasciculatum		Hemizonia fasciculata	
Mimulus aurantiacus		Lolium multiflorum	
Phacelia sp.		Reseda luteola	
Quercus berberidifolia		Rumex crispus	
Rhamnus crocea		Silene gallica	
Stephanomeria virgata		Vulpia	
Toxicodendron diversilobum			

Site	Date:	??/??/????	
WSYC012004N	Surveyors:	?????	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)			
Estimated N	65		
Adults	16		
Mature	36		
Juveniles	12		
Seedling	1		
Area in Hectares (area of Site)	0.200868		
Density (number/hectare)	323.595		
Native Species (Species observed)	Percent Cover	otic Species (Exotic Species)	Percent Cover
Calystegia macrostegia	0.05	Bromus diandrus	0.07
Ceanothus tomentosus	0.25	Bromus madritensis	0.05
Cryptantha sp.	0.05	Bromus hordeaceus	0.05
Deinandra fasciculata	0.05	Centaurea melitensis	0.07
Epilobium canum	0.05	Erodium botrys	0.05
Eschscholzia californica	0.05	Lactuca sp.	0.05
Galium sp.	0.05	Silene gallica	0.05
Gnaphalium canescens	0.05	Vulpia sp.	0.05
Lepidium sp	0.05		
Linaria sp.	0.05		
Lonicera subspicata	0.05		
Lupinus sp.	0.05		
Malacothamnus fasciculatum	0.05		
Marah macrocarpus	0.05		
Monardella viminea	0.05		
Opuntia littorales	0.05		
Pellaea mucronata	0.05		
Phacelia sp.	0.05		
Platanus racemosa	0.05		
Prunus ilicifolia	0.07		
Quercus berberidifolia	0.08		
Rhus integrifolia	0.05		
Ribes speciosum	0.05		
Salvia apiana	0.05		
Stephanomeria virgata	0.05		
Toxicodendron diversilobum	0.05		
Hesperoyucca whipplei	0.05		

Site	Date:	5/26/2004	
WSYC0120040	Surveyors	Julie, Dirk, and JoEllen	
Detail Site (type of Site)			
Drainage Mapped (was drainage mapped or not)	Yes		
Clumps (number of points taken)	2		
Estimated N	9		
Adults	4		
Mature	5		
Juveniles	0		
Seedling	0		
Area in Hectares (area of Site)	0.18814		
Density (number/hectare)	47.837		
Native Species (Species observed)	Percent Cover	Exotic Species (Exotic Species)	Percent Cover
Baccharis sarothroides	0.05	Avena sp.	0.25
Calystegia macrostegia	0.05	Brassica nigra	0.1
Ceanothus tomentosus	0.05	Bromus diandrus	0.1
Cercocarpus minutiflorus	0.1	Bromus madritensis	0.05
Cryptantha sp.	0.05	Bromus hordeaceus (mollis)	0.05
Epilobium canum	0.05	Centaurea melitensis	0.07
Eschscholzia californica	0.05		
Lepidium sp.	0.05		
Lonicera subspicata	0.05		
Malacothamnus fasciculatum			
Marah macrocarpus			
Phacelia sp.	0.05		
Prunus ilicifolia	0.1		
Quercus berberidifolia	0.05		
Rhamnus crocea			
Salvia apiana	0.05		
Stephanomeria virgata	0.05		
Toxicodendron diversilobum	0.05		

Appendix 3

Precipitation Data

-----INTERNATIONAL STATION METEOROLOGICAL CLIMATE SUMMARY-----

:STA 722908 | KNKX | MIRAMAR NAS ,CA,US
 :LAT 32 52N :LONG 117 09W :ELEV 476(ft) 145(m) :TYPE NAVY SMOS V3 15101996
 35 - Year/Month TOTAL PRECIPITATION (INCHES) from Daily Obs.

POR: : 1947-1995

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1947	-	-	-	-	-	-	0	T	.63	.58	1.00	4.83	-
1948	T	1.46	.83	.08	T	.07	T	0	0	.87	.04	2.51	5.86
1949	2.59	1.37	.21	-	-	-	0*	T*	.06*	.25*	1.14	1.14	-
1950	3.00	1.08	1.64	.36	1.18	T	.02	T	T	T	1.31	.19	8.78
1951	1.87	1.09	.63	2.28	T	T	.15	.65	.20	1.58	1.16	4.95	14.56
1952	5.26	.30	5.03	1.65	T	.06	T	T	.05	T	1.72	2.30	16.37
1953	.56	.64	.95	.57	.14	.08	.02	T	T	.03	.59	.08	3.66
1954	3.62	.87	5.40	.11	.07	.01	.17	T	T	T	.96	.49	11.70
1955	3.39	1.00	.39	1.50	1.14	T	T	T	T	T	.80	.46	8.68
1956	2.17	.26	.02	1.54	.30	T	0	T	0	.01	0	.05*	4.35*
1957	6.48	.67	.81	1.16	1.55	.40	T	T	T	1.63	.63	.97	14.30
1958	.96	3.57	4.94	2.92	.27	T	T	T	.20	.07	.34	.09	13.36
1959	.66	3.69	T	.42	T	T	T	.04	T	.57	.19	1.83	7.40
1960	3.40	1.72	.92	.59	.32	.03	T	T	.38	.03	1.73	.11	9.23
1961	.85	.01*	1.45	.01	.05	.02	T	T	.01	.72	.95	1.22	5.29*
1962	2.88	3.48	1.48	T	.69	.09	T	0	T	.01	.01	.31	8.95
1963	.54	1.70	1.40	1.05	.08	.30	0	T	2.10	.12	1.67	.07	9.03
1964	1.25	.38	2.00	1.04	.36	.05	0	T	.36	.05	1.13	.71	7.33
1965	.31	.96	1.14	3.84	T	.01	.10	T	.20	.01	5.66	4.70	16.93
1966	1.02	1.19	.12	T	T	.24	.01	T	T	.97	1.26	4.23	9.04
1967	1.93	T	1.01	1.91	.04	.06	.08	T	T	0	1.93	1.23	8.19
1968	.41	.22	1.05	.56	.23	.01	.06	0	T	.03	.50	.73	3.80
1969	3.89	4.32	1.40	.24	.20	.24	.06	T	.01	T	.72	.47	11.55
1970	.64	2.06	.97	.29	.03	T	T	.03	0	.12	1.26	1.58	6.98
1971	.60	.47	.20	.88	.98	.01	T	.01	.02	.98	.17	2.88	7.20
1972	.07	.24	T	.02	.30	.76	0	T	.20	.81	3.71	1.31	7.42
1973	2.01	2.12	2.64	.05	.03	T	T	T	.02	.05	1.58	.19	8.69
1974	4.56	.06	1.93	.17	.18	.04	.07	0	T	2.11	.61	2.14	11.87
1975	.55	.77	3.09	3.52	T	.11	.12	0	.03	.13	.69*	.43	9.44*
1976	T	5.26	1.09	1.94	.34	.03	T	.11	1.98	.52	1.59	1.14	14.00
1977	2.27	.13	.94	.05	2.60	.03	T	1.42	T	.38	.01	2.40	10.23
1978	7.89	4.19	7.27	2.28	.24	0	0	0	.80	.03	2.22	3.18	28.10
1979	5.81	1.42	4.99	.05	.14	.03	.05	.03	.03	.93	.34	.04	13.86
1980	8.87	7.15	2.86	1.96	.18*	.01	T	T	.01	.03	0	.46	21.53*
1981	1.22	2.04	3.36	.30	.21	T	T	0	T	.22	.20	.68	8.23
1982	3.87	1.36	5.57	.36	.21	.09	T	.01	.68	.15	2.75*	1.25	16.30*
1983	1.70	3.82	7.70	1.96	T	T	T	.39	.28	.39	3.75	1.65	21.64
1984	.36	.05	.05	.69	0	.04	.03	.07	T	.24	1.43	3.42	6.38
1985	.65	.63	.43	.28	0	T	T	T	.25	.11	4.92	1.44	8.71
1986	.94	2.73	3.38	.62	T	0	.12	T	.78	.49	1.08	1.44	11.58
1987	2.02	.98	1.19	.30	.18	T	.10	.03	.40	2.63	1.27	3.10	12.20
1988	.76	1.24	.49	2.97	.05	0	0	T	.01	T	1.11	3.40	10.03
1989	.28	.66	.90	T	.09	.01	0	T	.21	.08	.17	.05	2.45
1990	2.02	.59	.76	.71	.47	.22	.01	.01	T	.06	.74	.72	6.31
1991	.89	1.78	4.96	.10	T	T	.47	T	.35	.23	.10	1.64	10.52
1992	1.87	4.67	2.19	.12	.12	T	.06	.04	0	.33	T	2.52	11.99
1993	6.45	3.27	1.25	T	.04	.67	.08	0	.02	.18	1.26	.55	13.77
1994	1.22	3.21	3.51	.73	.09	T	.17	.02	T	.06	.72	1.19	10.92
1995	7.14	1.03	5.48	1.55	.59	.31	.05	0	T	.05	.22	.76	17.18
1996	2.41	2.60	1.92	.74	.02	T*	.08	.04	.13	1.82	2.18	1.26	
1997	4.28	.45	.03	.12	.04	T	T	T	1.26	.01	1.03	1.61	
1998	2.58	11.81	3.54	1.72	1.25	-	T	T	.12	.06	1.16	.73	

* = INCOMPLETE

- = MISSING DATA

= EXCESSIVE MISSING DATA - VALUE NOT COMPUTED

-----FEDERAL CLIMATE COMPLEX ASHEVILLE-----

Appendix 4

Detailed Explanation of Life Stage Matrix

Life Stage Structure Analysis

Over time with monitoring demographic data will accumulate. There will be two types of data relevant to this part of the assessment. The first will be population sizes broken down by stage of the plants. The second will be the observed changes in stage from the detail plots. It is important to record the detailed plots for changes in stage. For example monitors will assess how many mature plants became adults, how many juveniles become mature, how many seedlings appear. It is also important to note any regression such as Adult plants that become mature, mature plants that become juvenile etc.... Finally it is important to note how many plants fail to change stage, for example adult plants that are still adults the following year.

Any shift in life stage is important since the proportion of adult plants that appear from mature plants is the value on which the matrix is built for predicting the stability of the population. Once enough data has accumulated to estimate these numbers a matrix can be constructed.

This matrix when combined with known number of individuals at each stage can provide a model for predicting population behavior. Here's how it works

A matrix is built using the probabilities of change, the probability of a seedling becoming an adult over the monitoring time interval would be put in position PA1. The probability of an adult becoming a juvenile (through for example fire or drought) would be put in position PJ4. The most difficult number to assess will be PS4 which is the probable number of new seedlings from a given adult within a given time interval. Given that the number of seedlings in willow monardella is low an estimate for this can be made by taking the number of new seedling in a plot(or all plots) and dividing by the number of adults in that plot (or all plots).

Next Year's Stage	This Year's Stage			
	Seedling	Juvenile	Mature	Adult
Seedling	PS1	PS2	PS3	PS4
Juvenile	PJ1	PJ2	PJ3	PJ4
Mature	PM1	PM2	PM3	PM4
Adult	PA1	PA2	PA3	PA4

These probabilities can then be considered a matrix and multiplied against the current stage structure to get a model of expected behavior of the population. The more accurate the probabilities, the more accurate the assessment will be. For example if the above table became the following matrix:

$$\begin{pmatrix} \text{PS1,} & \text{PS2,} & \text{PS3,} & \text{PS4,} \\ \text{PJ1,} & \text{PJ2,} & \text{PJ3,} & \text{PJ4,} \\ \text{PM1,} & \text{PM2,} & \text{PM3,} & \text{PM4,} \\ \text{PA1,} & \text{PA2,} & \text{PA3,} & \text{PA4,} \end{pmatrix}$$

These values can then be multiplied against a current stage structure.

For example NS_0 =the current number current of seedlings, NJ_0 = the number of current juveniles, NM_0 = the number of current mature, and NA_0 = the number of current adults.

The following values can be achieved.

$(NS_0 * PS_1) + (NS_0 * PJ_1) + (NS_0 * PM_1) + (NS_0 * PA_1) = NS_1$ or the expected number of seedling after the given time interval repeats.

This process can be repeated for each stage as appropriate. Resulting in the NS_1 , NJ_1 , NM_1 , NA_1 , which are the expected new values of the population stage structure after one iteration of the time interval.

Predictions can then be made and future monitoring can observe the accuracy of those assessments and modify the matrix values accordingly should that be necessary.

Once sufficient data for this type of analysis is available there are a few uses of the data. One is the stability of the population can be estimated by repeatedly multiplying the predicted populations by the original matrix and see if the species has potential to go to zero population and how many of the given time intervals is likely to occur before that happens. For example you would multiply the NS_1 , NJ_1 , NM_1 , NA_1 values against the matrix to get NS_2 , NJ_2 , NM_2 , NA_2 values. This can be repeated until the values equal zero (the population is unstable), or there is no apparent decline and the population either grows or remains roughly the same for a reasonable amount of time.

Additionally a sensitivity analysis can be made to determine how impacts to various stages have the greatest effect on the populations. This is a more complicated analysis which looks at each stage of the species and how it affects the overall population growth or decline.

Appendix 5

Field Data Forms

Checklist for Willowy Monardella Monitoring Project

Standard Plots:

1. Fill out survey site identification information, (e.g., date, name, site number, etc.).
2. Locate the four corners of the monitoring plot provided as Global Positioning System (GPS) points and delineated with square metal bars, currently painted light blue.
3. Survey the entire site, counting each willow monardella clump (see definitions listed at the end of the checklist). Any clump larger than one (1) meter across, measure in perpendicular directions the longest widths and record in meters. For separating small clustered clumps, use the 6" rule (see definitions listed below).
4. For each monardella clump, document its current life stage and phenology (see definitions). Record this information on the survey data sheets .
5. List all associated plant species found at the monitoring site. Record on the data sheets.
6. Estimate percent cover for each of the species that have at least 5% cover. Record on the data sheets.
7. Describe the stream channels (width, depth, relative location of monardella, rockiness etc.) on each site and record the information on the data sheets.
8. Describe any observations for the monitoring site or monardella plants, for example:
 - a. pollinators
 - b. hydrology
 - c. unusual observations
 - d. problems
 - e. positives
 - f. predators/herbivores, etc.

Detailed Plots (REQUIRES submeter GPS mapping)

9. Document all the data as listed above for each survey plot on the survey data sheets.
10. Map each willow monardella clump using a submeter GPS unit.
11. Map the channel edges for each monitoring site.

Definitions For Willow Monardella Monitoring Surveys

Seedling: A life stage assessment for any willow monardella clump observed lacking multiple stems and less than four inches tall.

Phenology: The annual life cycle stage of each plant at the time of survey, e.g., vegetative, flowering seeding etc.

Vegetative: A phenological assessment that the plant lacks any reproductive parts but isn't dried out/dormant.

Mature: A life stage assessment for any willow monardella clump observed more than four inches tall and having less than 20 stems.

Adult: A life stage assessment for any willow monardella clump having more than 20 stems and more than four inches tall.

Juvenile: Any monardella plant observed that is lacking multiple stems and more than four inches tall.

Flowering: A phenological assessment that the monardella has one or more flowers.

Dead/Dormant: A phenological and life stage assessment for individuals that are dried out and lack any obvious living tissue.

N: A scientific short hand for the number of individuals.

Seeding: A phenological assessment that a plant has finished flowering but still producing seeds.

Budding: A phenological assessment that plants have flower buds, but the flowers have not expanded to open yet.

Between Flowering and Seeding: A phenological assessment that there is no evidence of flowering or seeding, but all parts of the clump are clearly between those two stages.

Clump: A group of one or more willow monardella plants growing sufficiently intertwined that distinguishing individuals is difficult or impossible.

Channel: The low point in the flood plain where water obviously flows as indicated by scour marks in the vicinity.

*** 6" Rule:** For purposes of this survey any individuals that are separated by less than 6" are counted as the same individual clump.

Willowy Monardella Data Collection Sheet

Date _____ Start Time _____ End Time _____

Study Site Label _____ Detailed or Normal Survey Effort _____

Surveyors _____

Demographic Data (entire monitoring site, use tic marks):

Life Stage

Phenology

Number of Seedlings _____ Number Vegetative _____

Number of Juveniles _____ Number Budding _____

Number of Mature _____ Number Flowering _____

Number of Adults _____ Number between _____

Number of Dead/Dormant _____ Flower and Fruit _____

Number in Seed _____

Total Number of Individuals _____ Number Dormant/Dead _____

Habitat Data:

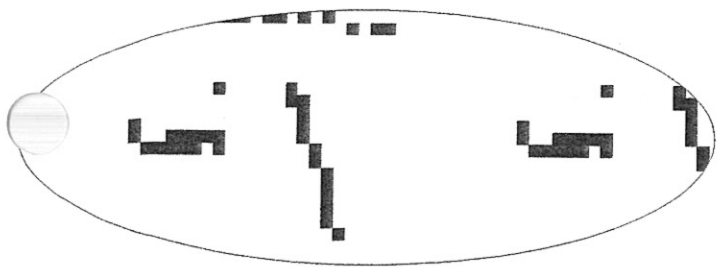
Surrounding Species Observed (Use the plant list sheet with codes. Add percent cover next to species names.)

List any new species below using the botanical name and the estimated percent cover next to the species name.

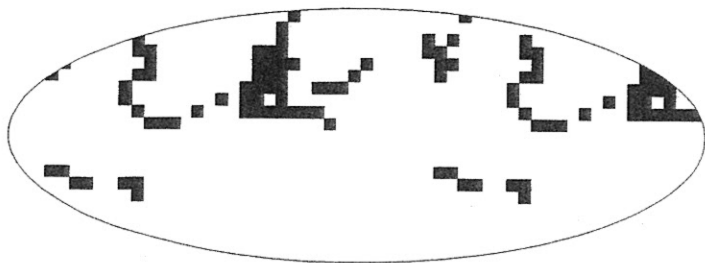
Describe the Channel (width, depth, rockiness etc.)

Natural History Observations (pollinators, herbivory, other noticeable features)

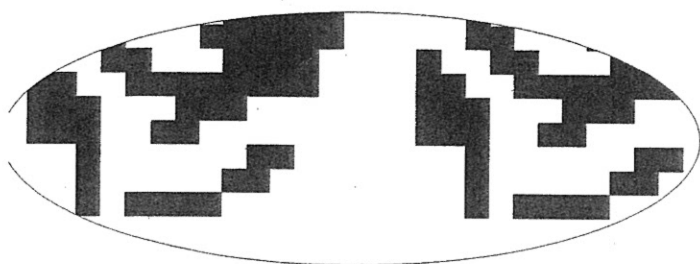
Add Clump size dimensions or other notes on back of this survey sheet.
Remember to use the 6" rule where applicable.



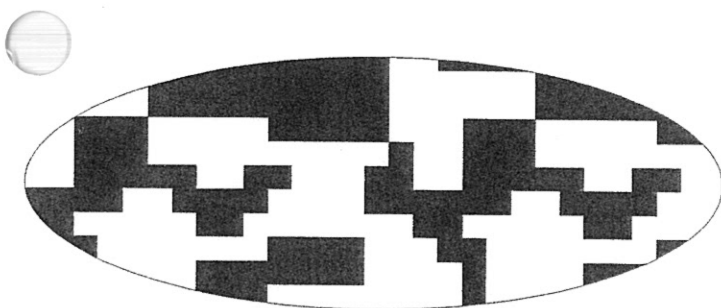
5 Percent Cover



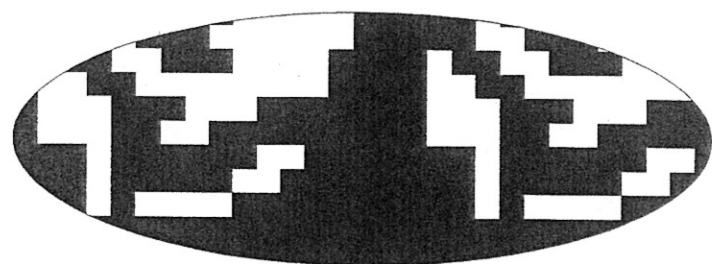
10 Percent Cover



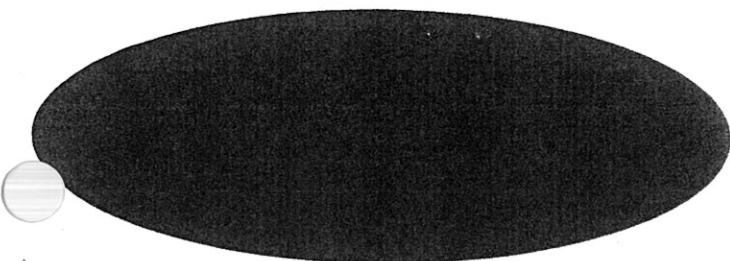
25 Percent Cover



50 Percent Cover



75 Percent Cover



100 Percent Cover

Appendix 6

Personnel

Personnel

Rod Dossey (Project Manager/Botanist)

Address: 404 Encinitas Blvd. #321
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Phone: (760) 436-0908
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Shannon Allen (Botanist)

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Jon Rebman (QA/QC/Botanist)

Address: P.O. Box 121390
San Diego, Ca. 92112-1390
Phone: (619) 255-0247
Employer: San Diego Natural History Museum

Jim Barry (GIS Specialist)

Address: 1725 Missouri St
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Phone: (858) 274-5757
Employer: Self Employed

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