# Threatened and Endangered Plant Surveys on Vandenberg Air Force Base, California

*2019 Final Report*

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**Prepared for**

30th Space Wing, Installation Management Flight, Environmental Conservation
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# Acronyms and Abbreviations

| | |
|---|---|
| 30 CES/CEIEA | 30th Space Wing Installation Management Flight, Natural Resources Management Environmental Conservation |
| ac | acre(s) |
| AGL | above ground level |
| Base | Vandenberg Air Force Base |
| CCH1 | Consortium of California Herbaria |
| cm | centimeter(s) |
| ESA | Endangered Species Act |
| FR | Federal Register |
| GPS | Global Positioning System |
| ha | hectare(s) |
| INRMP | Integrated Natural Resources Management Plan |
| mm | millimeter(s) |
| MCMP | Maritime Chaparral Management Plan |
| MMD | minimum mapping distance |
| MSRS | ManTech SRS Technologies, Inc. |
| RDM | residual dry matter |
| SAIC | Science Applications International Corporation |
| USFWS | United States Fish and Wildlife Service |
| VAFB | Vandenberg Air Force Base |

Cover photos, clockwise from top left:

Lompoc yerba santa (*Eriodictyon capitatum*) photographed at the airport stand discovered in 2019; beach layia plants growing with other native dune-loving species; Vandenberg monkeyflower (*Diplacus vandenbergensis*) habitat as viewed from the helicopter; tarplant (*Deinandra increscens*) flowers being inspected for characters that differentiate the subspecies.

# 1.0 Introduction

Vandenberg Air Force Base (VAFB or Base) is located on the south-central coast of California, approximately halfway between San Diego and San Francisco (Figure 1-1). Base covers approximately 99,000 acres (ac; 40,063 hectares [ha]) in western Santa Barbara County (VAFB 2007) and is headquarters to the 30th Space Wing. The primary mission of VAFB is to launch and track satellites, test and evaluate America's intercontinental ballistic missile systems, and support aircraft operations in the Western Range. Much of Base is managed as open space that acts as a natural security buffer to support this mission.

However, much of VAFB that is open space also provides native habitat for various sensitive resources, such as 15 terrestrial species listed under the Endangered Species Act (ESA) of 1973, five of which are plants: Vandenberg monkeyflower (*Diplacus vandenbergensis*; V. monkeyflower); Lompoc yerba santa (*Eriodictyon capitatum*; yerba santa); Gaviota tarplant (*Deinandra increscens villosa*); La Graciosa thistle (*Cirsium loncholepis*); and beach layia (*Layia carnosa*; layia) (USAF 2015).

In 2019, the 30th Space Wing Installation Management Flight, Environmental Conservation (30 CES/CEIEA) tasked Colorado State University to survey for new localities and track the population status of known stands of four of the five federally listed plant species occurring on VAFB through a cooperative agreement with the U.S. Army Corps of Engineers (W9126G-18-2-0040; XUMU034618). Colorado State University subcontracted ManTech SRS Technologies, Inc. (MSRS) to perform these activities which included surveying for V. monkeyflower, yerba santa, Gaviota tarplant , and La Graciosa thistle (Figure 1-2). Additionally, during the initial kickoff meeting for this contract, VAFB requested that layia be added to the list of target survey species. These additional surveys were offset by a commensurate reduction in effort to locate yerba santa in marginal habitats on Base (Figure 1-2).

This report provides survey methodologies, results, discussion, and recommendations for management of the five species listed above based on the 2019 field surveys and additional locality information provided by 30 CES/CEIEA.

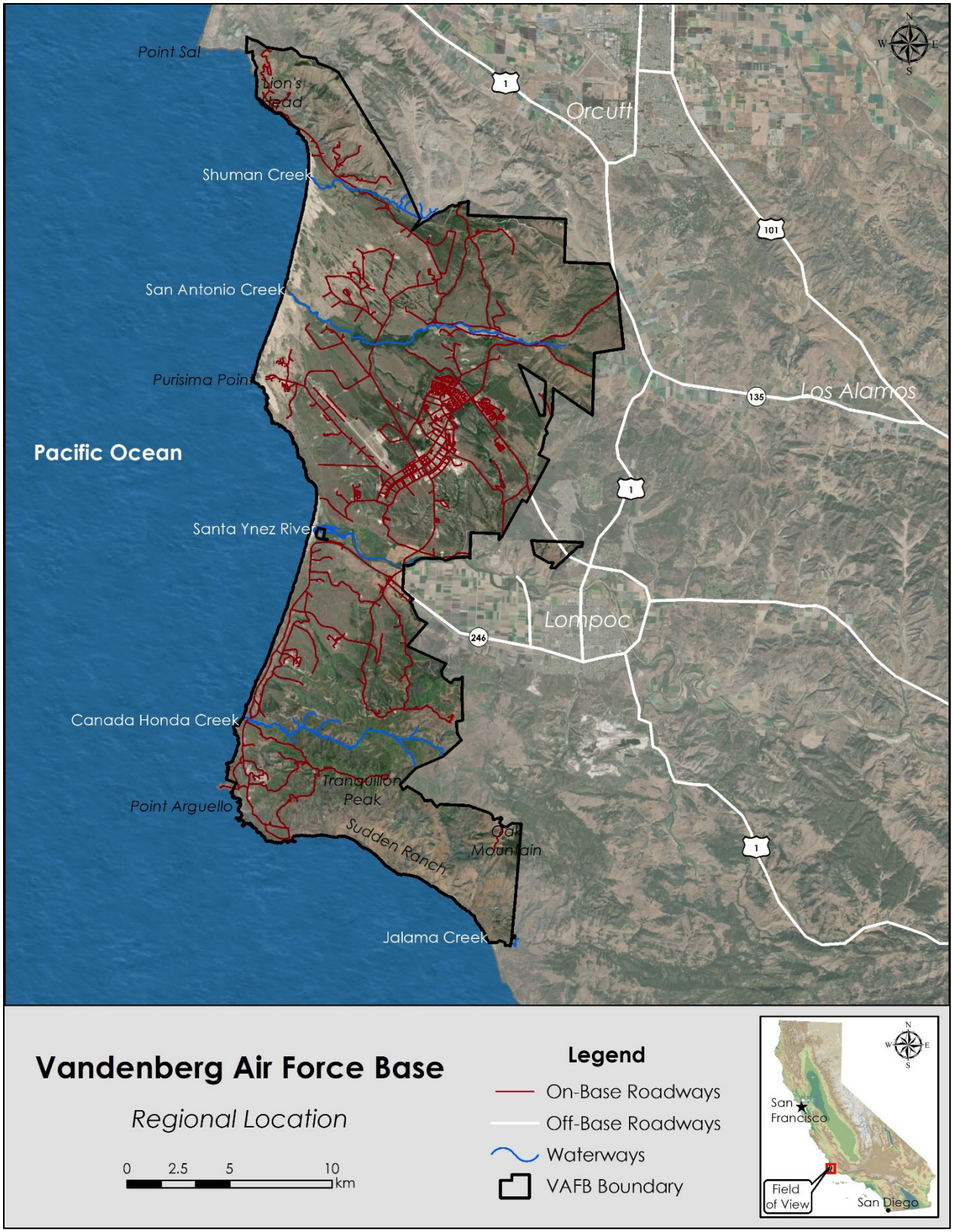


**Figure 1-1.** Vandenberg Air Force Base regional location.

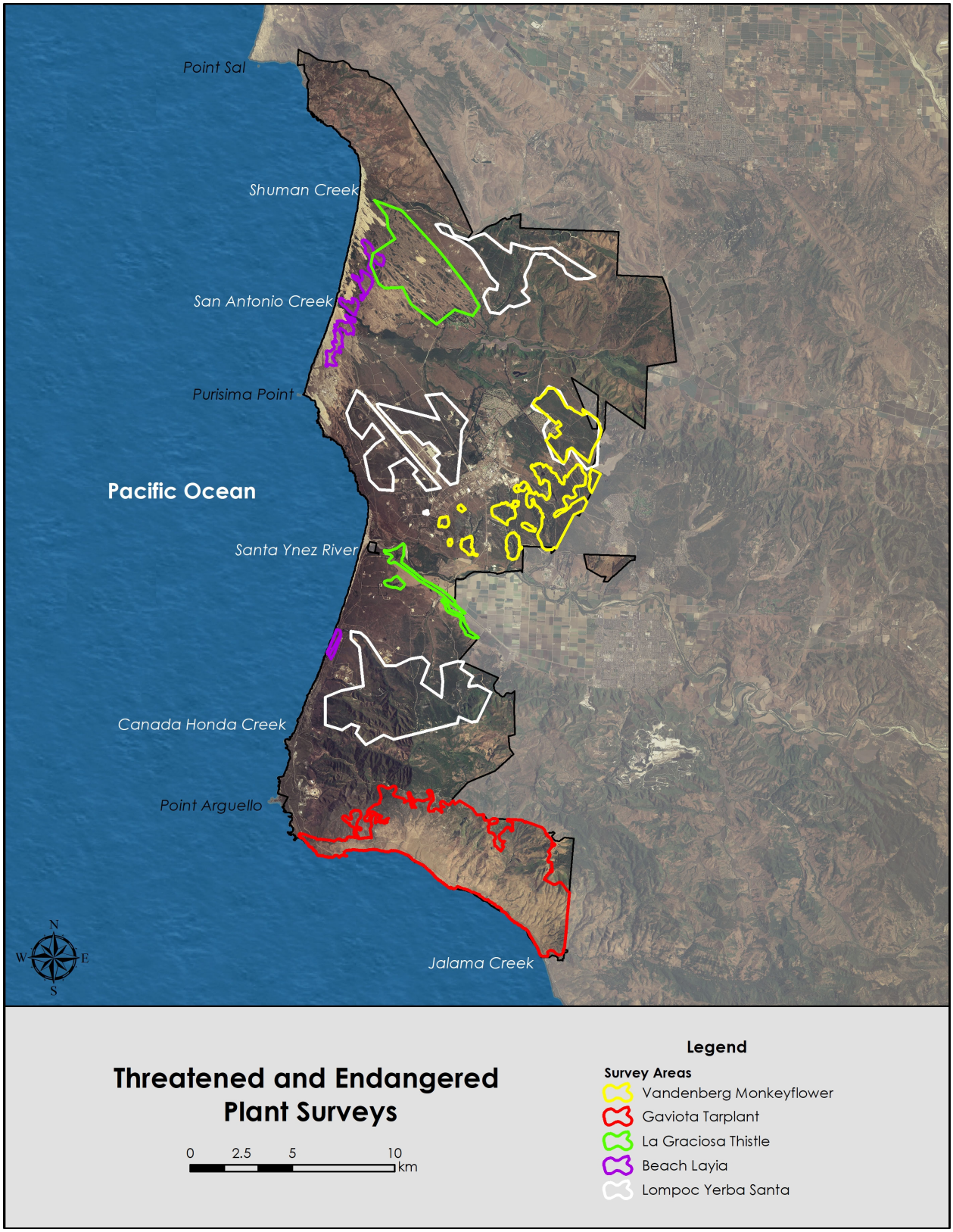


**Figure 1-2.** Threatened and endangered plant survey areas in 2019.

## 1.1 Species Accounts

### 1.1.1 Vandenberg Monkeyflower

**Life History and Status**

V. monkeyflower is a small, herbaceous, spring-blooming, annual plant in the lopseed family (Phrymaceae) with glandular stems that are usually green, sometimes aging to purple. Small plants may produce a single yellow flower while larger plants can support multiple branches and flowers. V. monkeyflower was listed as federally endangered under the ESA on 26 August 2014 after its split from the closely related Fremont's monkeyflower (*Diplacus fremontii*; 79 FR [Federal Register] 50844; Thompson 2005). The U.S. Fish and Wildlife Service (USFWS) designated critical habitat for this species on 11 August 2015 (80 FR 48142). VAFB was excluded from this designation under section 4(a)(3) of the ESA. No recovery plan has been drafted for this species.

V. monkeyflower is known only from the Burton Mesa, an ancient sand sheet located in Santa Barbara County and including a portion of Base, north of the Santa Ynez River. Burton Mesa supports several unique native vegetation communities, including the Burton Mesa chaparral vegetation alliance, which supports V. monkeyflower. This alliance is dominated by evergreen shrubs and scattered multi-trunked coast live oaks (*Quercus agrifolia*) that range from relatively open stands to almost impenetrable thickets (Odion *et al.* 1992). V. monkeyflower grows in gaps in the canopy in between shrubs where loose and relatively unconsolidated sand impedes shrub growth (Figure 1-3). These sandy openings are characterized by high abundance and diversity of annual and perennial herbaceous species relative to the understory of the adjacent shrubland (Hickson 1987; Davis *et al.* 1989; Keeley *et al.* 1981; Horton and Kraebel 1955).

**Figure 1-3.** Aerial view of Vandenberg monkeyflower growing in an open sand patch surrounded by Burton Mesa chaparral. Inset shows flower detail.

V. monkeyflower germination is dependent on annual rainfall amounts and may be low or nonexistent when rainfall levels are low. The sometimes dramatic annual fluctuations in the number and location of plants indicate the presence of a seed bank that allows the species to persist through dry years (Figure 1-4).

In addition to stands on VAFB, V. monkeyflower is known from two locations on the nearby Burton Mesa Ecological Reserve, and two locations at La Purisima Mission Historic Park. Additional historic locations on private lands in the Santa Rita Valley and within lower Santa Lucia Canyon on the Burton Mesa Ecological Reserve appear to have been extirpated (79 FR 50844).

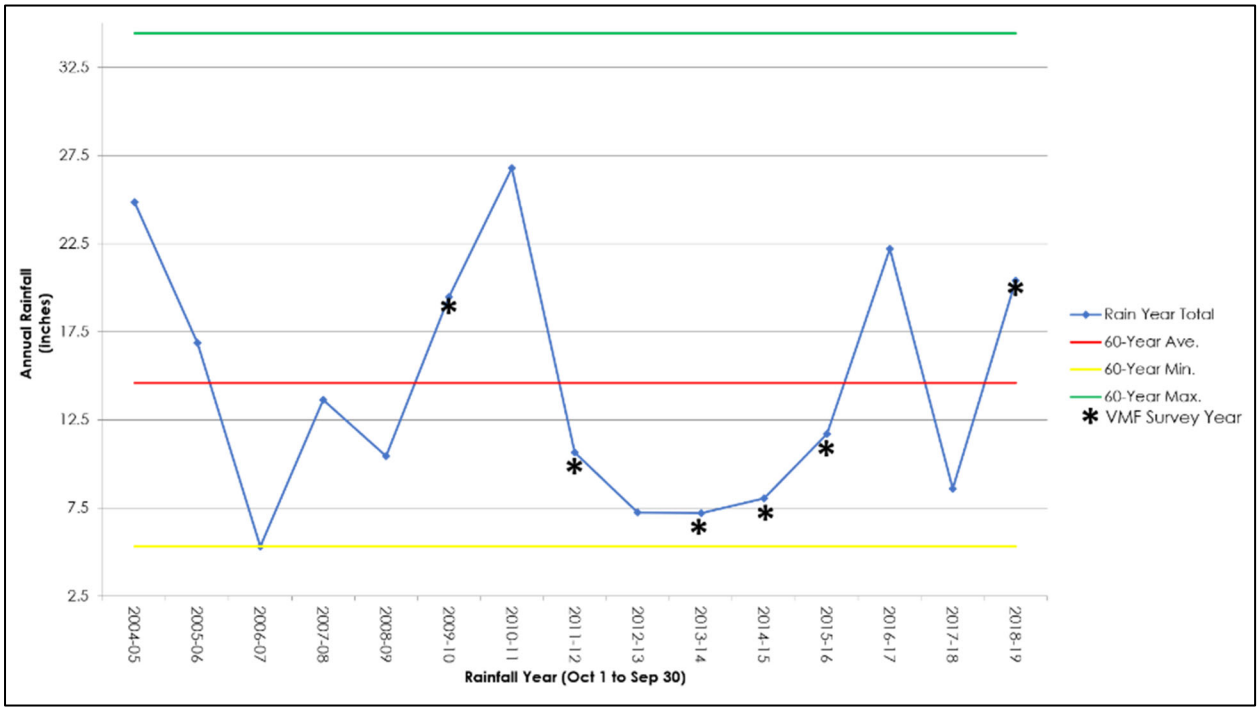


**Figure 1-4.** Rainfall by water year for the last 15 years at Lompoc City Hall (SBFCD 2019).

## History on Vandenberg AFB

On VAFB, V. monkeyflower occurs primarily in chaparral openings in three main watersheds: Oak Canyon, Pine Canyon, and Lake Canyon, with Lake Canyon supporting the largest stands. Surveys on Base have been conducted six times since 2010 (Table 1-1). MSRS conducted surveys in 2010, 2015, and 2016. In addition, Science Applications International Corporation (SAIC) surveyed in 2012, and VAFB GIS data indicates that Benjamin Wagner surveyed in 2014. Note that these surveys focused on different areas and used different methodologies including minimum mapping distances (MMD), so they are not comparable for trends of the total population across base.

Regular monitoring at a subset of stands in Lake and Pine canyons indicates that rainfall is important in determining the number of V. monkeyflower each year (see Section 2.2 for further discussion of these stands). Many of these stands had the largest numbers of plants recorded in 2010, the first year the stands were monitored and a very wet year with 133 percent of average rainfall (average rainfall was calculated over a 60-year moving average). However, rainfall does

not appear to be the only factor that determines counts at the monitoring stands, as some high counts were recorded in 2014 and 2016 with only 50-80 percent of normal rainfall. Timing of rainfall is likely also an important factor. Anecdotal observation of previously occupied habitat that no longer supports V. monkeyflower indicates that invasion by veldt grass (*Ehrharta calycina*) is also a factor in the decline of some stands.

**Table 1-1.** Results of past Vandenberg monkeyflower surveys. Note that some surveys focused on surveys for new occurrences, and not all known populations were censused each year.

| Survey Year | Number of Individuals* | Acres of Monkeyflower Polygons Mapped | Total Acres Surveyed | Percent of 2019 Survey Area |
|---|---|---|---|---|
| 2010 | 5,183 | 5.66 | 459 | 13% |
| 2012 | 213 | 0.18 | 376 | 10% |
| 2014 | 5,579 | 2.29 | Not Available | *n/a* |
| 2015 | 874 | 0.13 | 1,648 | 45% |
| 2016 | 8,359 | 2.02 | 6,590 | 180% |

*Survey effort not consistent across all survey years because all populations were not censused all years and some surveys focused on unsurveyed areas while others were resurvevs of known stands.

**Threats Facing the Species**

The key threats to V. monkeyflower and the habitat that supports it include:

- Present or threatened destruction, modification, or curtailment of habitat;
- Overutilization for commercial, recreational, scientific, or educational purposes;
- Disease or predation;
- Inadequacy of existing regulatory mechanisms; and
- Other natural or man-made factors affecting its continued existence such as invasive, non-native plant species (80 FR 48142).

### 1.1.2 Lompoc Yerba Santa

**Life History and Status**

Lompoc yerba santa is an evergreen shrub in the borage family (Boraginaceae), which may grow to five meters tall. It has smooth, sticky leaves, and branched inflorescences of tubular, lavender flowers (Figure 1-5). It is endemic to Santa Barbara County, where it occurs on VAFB, the Solomon Hills in Orcutt, and in the Santa Ynez Mountains (Rosatti 2007).

Yerba santa was listed as federally endangered under the ESA on 20 March 2000 (65 FR 14888) and as a state rare species by the California Fish and Game Commission in September of 1979 (California Code of Regulations, Title 14, Section 670.2). Critical habitat for this species was designated on 7 November 2002 but VAFB was excluded from this designation under section 4(b)(2) of the ESA (67 FR 67967). No recovery plan has been drafted for this species.

**Figure 1-5.** Left: yerba santa flower. Right: yerba santa growing in chaparral habitat.

Yerba santa occurs in chaparral, central coast scrub, and bishop pine forest habitats. Based on genetic analysis and reproductive biology, some stands are comprised of a single large clone with a self-incompatible genotype, decreasing the chances of fertilization and seed production even after successful pollination (Elam 1994; Jacks *et al.* 1984). For this reason, lost uniclonal populations are not likely to be re-established from seed, making yerba santa particularly vulnerable to events such as development.

Seed set does occur in multiclonal populations where outcrossing is possible. However, the number of clones in a stand is likely not the only driver of seed production, with other factors such as the spatial distribution of clones within a stand, fruit parasitism, and pollen quality also playing a role (Elam 1994).

Yerba santa primarily reproduces via rhizomes (Elam 1994). Rhizomal growth may be stimulated by fire (67 FR 67967); however, fire is not required for rhizomal growth, as evident from new growth in areas that have no records of burning within the past 60 years according to VAFB historical fire data (e.g. the Pine Canyon population on VAFB). In 1982, a controlled burn of part of the 35th Street stand on VAFB resulted in an increase in the number of yerba santa ramets. Unfortunately, the vegetative growth was accompanied by invasion of iceplant (*Carpobrotus* spp.; Jacks *et al.* 1984).

Factors that constitute suitable habitat for yerba santa include:

- Soils with a large component of sand that tend to be acidic.
- Maritime chaparral, particularly where associated with bush poppy (*Dendromecon rigida*), oak (*Quercus* spp.), and lilac (*Ceanothus cuneatus*) or southern bishop pine (*Pinus muricata*) forests that intergrade with manzanita (*Arctostaphylos* spp.), and black sage (*Salvia mellifera*).
- Suitable habitat directly adjacent upslope and downslope from known populations, as this species appears to spread primarily through vegetative reproduction (67 FR 67967).

When critical habitat for yerba santa was designated in 2002, the species was known from the Solomon Hills, three populations in the Santa Ynez Mountains, and three populations on VAFB (67 FR 67967).

## History on Vandenberg AFB

In 2006, surveys were conducted basewide to re-assess and map historic stands and look for new stands. During 2006 surveys, a fourth VAFB population was found in Lake Canyon (Table 1-2, "Lake Cyn"; SRS Technologies, Inc. 2006).

In 2015, all known VAFB yerba santa stands (35th Street, Santa Lucia Canyon, Lake Canyon, and Pine Canyon) were re-assessed and found to be extant. In addition, five new stands were discovered: two in the Pine Canyon area, and three in the Santa Lucia Canyon area (Table 1-2). The discovery of the additional stands increased the count of VAFB ramets from a high of 1,682 ramets on 4.59 ac (1.86 ha) in 2006, to 8,229 ramets on 7.19 ac (2.91 ha) in 2015 (MSRS 2015).

In 2019, an additional stand was discovered just off the south end of the VAFB runway during surveys for a proposed project, and a south Base occurrence was found in upper La Salle Canyon and censused by the Base Botanist, Luanne Lum (L. Lum, pers. comm.). The airfield occurrence was censused and mapped by MSRS under this contract, and results are presented in Section 3.2 below. The La Salle Canyon occurrence consisted of two stands for 0.20 ac (0.08 ha) and a total of 93 individuals (Table 1-2). This stand represents a significant range expansion of this species, which was formerly known only from North VAFB.

**Table 1-2.** Summary findings of Lompoc Yerba Santa surveys by population. Specific areas surveyed and known populations differed annually.

| Survey Year | Population | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 35th Street | Santa Lucia Cyn #1 | Lake Cyn | Pine Cyn | Pine Cyn Rim | Upper Pine Cyn | Santa Lucia Cyn #2 | Santa Lucia Cyn #3 | Santa Lucia Cyn #4 | Air Field | La Salle Canyon |
| 2006 | 1,017 | 11 | 20 | 634 | NA | NA | NA | NA | NA | NA | NA |
| 2010 | 807 | 5 | 48 | 660 | NA | NA | NA | NA | NA | NA | NA |
| 2015 | 733 | 3 | 28 | 580 | 691 | 4 | 56 | 134 | ~6000 | NA | NA |
| 2016 | 616 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2017 | 507 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2018 | 617 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2019 | 489 | NA | NA | NA | NA | NA | NA | NA | NA | 70 | 93 |
| **Estimated total ramets based on most recent available data for all populations:** | | | | | | | | | **8148** | | |

Local trends on VAFB are difficult to discern as all stands are not consistently monitored each year, but the 35th Street stand can be examined for trends as it has been censused yearly since 2015 (MSRS 2019a). This stand may not be representative of all other stands, but the number of ramets recorded each year has declined, with the exception of 2018, which saw a slight rise (Table 1-3). The increase in the number of stands found recently is encouraging and may indicate that additional stands will continue to be documented in future years.

**Table 1-3.** Census data from the 35th Street yerba santa stand.

| Year | Rainfall | Ramet Count | Stem Count | Ratio of Ramets: Stems |
|---|---|---|---|---|
| 2006 | 16.86 | 1017 | Not Counted | *NA* |
| 2010 | 19.44 | 807 | | |
| 2015 | 8.03 | 733 | 958 | 0.77 |
| 2016 | 11.69 | 616 | 651 | 0.95 |
| 2017 | 22.2 | 507 | 627 | 0.81 |
| 2018 | 8.59 | 617 | 804 | 0.77 |

**Threats Facing the Species**

Key threats to yerba santa include fire management practices not adapted to yerba santa needs, invasive non-native plant species, low rates of sexual reproduction, and naturally occurring catastrophic events, particularly in monoclonal stands. Activities that have potential to adversely affect yerba santa habitat include:

- Activities that affect the age structure and community composition of chaparral habitat. These activities include:
    a. Unnatural fire regime. Fire suppression or prescribed fires that are too frequent or poorly-time.
    b. Residential and commercial development including road building and golf course installations.
    c. Agricultural activities, including orchard development, viticulture, row crops, and livestock grazing.
    d. Vegetation manipulation such as brush clearing in the watershed upslope from yerba santa.
- Activities that degrade or destroy native maritime chaparral and oak woodland communities, including but not limited to livestock grazing, clearing, disking, introducing or encouraging the spread of nonnative species, and heavy recreational use (67 FR 67967).

### 1.1.3 Gaviota Tarplant

**Life History and Status**

A member of the Asteraceae family, Gaviota tarplant is a yellow-flowered, gray-green, soft hairy annual that is three to 35.0 inches (7.6 to 88.9 centimeters [cm]) tall with stems branching near the base (Figure 1-6). It was formerly known only from coastal terraces in the Gaviota area along the southern coast of Santa Barbara County, California but was subsequently also documented on VAFB (Baldwin 2009). Suitable habitat characteristics for Gaviota tarplant include sandy soils associated with coastal terraces or uplifted marine sediments at interior sites up to 3.5 miles (mi; 5.6 kilometers, [km]) inland from the coast. Gaviota tarplant is most often associated with annual grasses, and on occasion, with coastal shrubs such as coyote brush (*Baccharis pilularis*) and

coastal goldenbush (*Isocoma menziesii*). Gaviota tarplant is an early successional species and is adept at colonizing disturbed areas (67 FR 67967).

Gaviota tarplant was listed as federally endangered under the ESA on 20 March 2000 (65 FR 14888) and as state endangered by the California Fish and Game Commission in January 1990 (California Code of Regulations, Title 14, Section 670.2). The USFWS designated critical habitat for this species on 7 November 2002 (67 FR 67967). VAFB was excluded from this designation under section 4(b)(2) of the ESA. No recovery plan has been drafted for this species.

**Figure 1-6.** Gaviota tarplant growing in open, gravelly, grassland habitat.

Several species and subspecies of tarplant are found on VAFB, including two taxa under *D. increscens* as well as the closely related paniculate tarplant (*D. paniculata*) and more distant relative clustered tarweed (*D. fasciculata*). There is currently no formal consensus from the USFWS on what combination of morphological character states constitutes the identification of Gaviota tarplant. The taxonomy and firm identification of Gaviota tarplant and differentiation from the closely related grassland tarweed (*D. increscens* ssp. *increscens*) and paniculate tarplant is challenging (Baldwin 2009).

In 2002, when critical habitat was designated, Gaviota tarplant was known from seven locations ranging from the Gaviota marine terraces to Point Arguello with a disjunct location south of Point Sal in the vicinity of Lion's Head on VAFB (67 FR 67967). In 2006, a genetic study was conducted to clarify taxonomic status of Gaviota tarplant. Specimens collected on VAFB for this study were determined to fall outside of the definition of Gaviota tarplant, with the exception of the Lion's Head population which appeared morphologically consistent based on an herbarium specimen. Based on this study, Gaviota tarplant occurrences were limited to the Gaviota type locality, the Point Conception area, Sudden Peak (adjacent to the VAFB boundary), and Lion's Head on VAFB (Baldwin 2009). In 2011, specimens from VAFB collected during tarplant surveys were sent to Dr. Bruce Baldwin for confirmation of identification. Only the Lion's Head plants were found to

conform closely to the Gaviota phenotype; collections did not include plants from the Sudden Ranch area on VAFB.

### History on Vandenberg AFB

Surveys in 2006 focused on roadways, the cantonment, and other potential habitat throughout VAFB. The 2006 surveys recorded plants with characters that were either consistent with grassland tarweed, consistent with Gaviota tarplant, had overlapping characteristics, or were unidentifiable using the 1993 Jepson Manual treatment. There were 515 Gaviota tarplant stands for a total of 263.79 ac (106.75 ha). Following the development of a new key to *Deinandra increscens* by Baldwin late 2008, most Gaviota tarplant identified in 2006 would key to grassland tarweed. Therefore, 2006 data should not be used for historic Gaviota tarplant localities or numbers.

Surveys conducted in 2008 also focused on roadways, the cantonment, and other habitat throughout VAFB where *Deinandra increscens* was known to occur. The goal of the 2008 survey effort was to reclassify known *Deinandra increscens* populations using the new key supplied by Baldwin to VAFB in summer 2008. During this re-examination of *Deinandra increscens* stands, the majority of plants in 2008 were found to conform to the revised definition of Gaviota tarplant. Plants conforming to the revised definition of Gaviota tarplant were only recorded in five stands located on coastal terraces north of Shuman Creek, southeast of Arguello Road, and a single plant on Space Launch Complex 4 for a total of 31.87 ac (12.90 ha).

The revised key produced by Baldwin in 2008 was based on genetic and greenhouse studies. This revised key focused on growth habit and plant architecture rather than floral attributes to differentiate the subspecies of *D. increscens*. Using either genetic or morphological data, it is difficult to fully resolve firm field characters or geographic distributions of the three taxa, but Baldwin (2009) concludes that plants at Point Conception and Sudden Peak conform well to the Gaviota tarplant morphology, likely an adaptation to windswept habitats. He also notes that plants "…approaching (but not fully encompassing) the morphological condition of ssp. *villosa* were found at sites west and north of Pt. Conception and Sudden Peak, such as at Jalama Beach, Pt. Arguello and Surf" but does not designate these as hybrids, intergrades, or as belonging to ssp. *villosa* (Baldwin 2009).

In 2010, Gaviota tarplant surveys were conducted in ridgeline habitat on north VAFB, ridgeline habitat southeast of Arguello Road, ridgeline habitat between Tranquillon Peak and Oak Mountain, and areas accessible on foot or vehicle on Sudden Ranch on south VAFB (MSRS 2010). Gaviota tarplant was only found on ridgeline habitat on between Tranquillon Peak and Oak Mountain where 1,197 plants were found on 0.6 ac (0.2 ha; Table 1.4).

In 2011, SAIC mapped *Deinandra increscens* throughout VAFB and employed the key developed by Baldwin for identification. SAIC recognized "mixed populations with individuals that exhibited morphological characteristics" of both grassland tarweed and Gaviota tarplant as well as hybrid plants (stipulated as a cross between *D. increscens* and the closely related paniculate tarplant) (SAIC 2012). A total of 2,215 Gaviota tarplant occupying 0.76 ac (0.31 ha) in the vicinity of Lion's Head were documented in 2011 (Table 1.4).

In 2015, MSRS performed surveys on VAFB focusing on the north end (Lion's Head area) and along the southern coast (MSRS 2017). No pure Gaviota tarplant stands were detected during these surveys and all stands contained either plants consistent with both subspecies (denoted "mixed" stands) or were comprised entirely of plants exhibiting characteristics intermediate between the two subspecies (denoted "hybrid"). On north base, 4,980 plants were identified as Gaviota tarplant, and on south base 873 were identified as Gaviota tarplant (Table 1-4).

The terms intergrade and hybrid have been confusingly applied to *Deinandra* during past surveys. Intergrade refers to the process of intergradation. If the ranges of two taxa overlap and there is there is extensive geneflow between taxa, then the products of this genetic exchange are intergrades. Intergradation can occur between varieties or subspecies of a recognized species, or between two distinct species. In contrast, the term hybrid refers to the cross between two distinct species. As applied to *Deinandra* on VAFB: the products of crosses between the two species *Deinandra increscens* and paniculate tarplant would be both hybrids and intergrades but the products of crosses between grassland tarweed and Gaviota tarplant would be intergrades (these cannot properly be termed hybrids because the genetic effect is occurring at the subspecies level). To provide clarity, MSRS will refer to any putative crosses between *Deinandra increscens* and paniculate tarplant as hybrids and any putative crosses between grassland tarplant and Gaviota tarplant as intergrades.

Population trends are particularly challenging with the VAFB stands of Gaviota tarplant due to the high degree of variation year to year and the changes in survey methodology. A given stand may exhibit characters that classify it as Gaviota tarplant one year, but the next year the new plants may be a mix of intergrade plants and plants that conform to the morphologies of both parent subspecies. Rainfall appears to be an important factor in determining the overall numbers of tarplant of either morphology on any given year. Areas of occupied tarplant habitat on VAFB have not been subject to development or other changes in land use that would result in significant changes in habitat quality. Annual precipitation levels and timing of precipitation have likely been the most important drivers of population fluctuations observed since the inception of surveys.

**Table 1-4.** Summary findings of Gaviota tarplant surveys. Specific areas surveyed differed annually, therefore results are not comparable between years. 2006 data was excluded because identification parameters used do not match current standards.

| Year | Lowlands and Coastal Terraces North of Shuman Creek | | | Southeast of Arguello Road | | | Tranquillon - Oak Mountain Ridge | | | Sudden Ranch Area | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gaviota Tarplant[1] | All *D. increscens*[2] | Acres Occupied[3] | Gaviota Tarplant[1] | All *D. increscens*[2] | Acres Occupied[3] | Gaviota Tarplant[1] | All *D. increscens*[2] | Acres Occupied[3] | Gaviota Tarplant[1] | All *D. increscens*[2] | Acres Occupied[3] |
| 2008[4] | NA[5] | NA | 48.8 | NA[5] | NA | 0.39 | NA | NA | NA | NA | NA | NA |
| 2010 | NA | NA | NA | 0 | NA | NA | 1197 | NA | 0.6 | 0 | NA | NA |
| 2011 | 1691 | 3354 | 1.3 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 2015 | 4,980 | 8,338 | 511.1 | 838 | 1198 | 1.3 | NA | NA | NA | 35 | 1535 | 12.7 |
| 2019 | NA | NA | NA | NA | NA | NA | 0 | 0 | 0 | 49,648 | 146,749 | 84.0 |

1: excludes all putative hybrids, intergrades, and plants not completely conforming the the *D. i. villosa* phenotype

2: includes all *Deinandra increscens* (including *D. i. villosa*) documented in the area

3: total acres occupied by *Deinandra increscens* (including *D. i. villosa*) in the area

4: only area occupied was assessed; numbers of plants were not assessed in 2008

5: 20.4 ac in the Lion's Head area, and 0.39 ac in the Arguello area were occupied by *D. i. villosa* in 2008

**Threats Facing the Species**

Threats to Gaviota tarplant are primarily related to human activity. Specific anthropogenic threats that have potential to adversely affect Gaviota tarplant habitat include:

- Unnatural fire regime
- Habitat conversion
- Poor grazing practices
- Chemical herbicides and hydroseed mixes applied to occupied ruderal habitat that can degrade its suitability for Gaviota tarplant
- Invasive species
- Residential and commercial development
- Wind energy development on the Gaviota Coast
- Agricultural activities

Key threats to Gaviota tarplant on VAFB include destruction of individual plants during construction projects, habitat degradation as a result of development, and competition with non-native species.

### 1.1.4 Beach Layia

**Life History and Status**

Endemic to California, beach layia is a small, succulent annual herb in the sunflower family (Asteraceae). Layia has low spreading branches and heads of small white to pink ray flowers and yellow disk flowers (Figure 1-7). Individual plants can produce one to over 100 heads. Within each head, achenes are produced with a bristly pappus that facilitates wind dispersal (USFWS 1998). On VAFB layia germinates in mid to late December depending on rainfall. Peak blooming and seed set occurs from March through April. Plants are typically senescent by June.

Layia was listed as federally endangered under the ESA on 22 June 1992 (57 FR 27848) and as state endangered by the California Fish and Game Commission in January of 1971 (California Code of Regulations, Title 14, Section 670.2). Critical habitat for this species has not been designated, but a Recovery Plan for layia was published on 30 September 1998 (USFWS 1998). During the most recent 5-year review, USFWS recommended down-listing layia to federally threatened protection status (USFWS 2012). In 2018, the listing status was under review by USFWS again.

**Figure 1-7.** Beach layia plants growing on open sand habitat along with other native, dune species.

Layia occurs on semi-stabilized sand ridges and troughs in coastal dune scrub vegetation and is closely associated with open sparsely vegetated sandy areas. It is known from seven dune systems in northern Santa Barbara, Monterey, and Humboldt counties. Given that this is an annual species living in a dynamic habitat, numbers and distribution of this species fluctuate significantly year to year depending on environmental factors such as rainfall, dune movement, and the extent of open dune sand habitat available (USFWS 1998).

### History on Vandenberg AFB

Layia was assumed to be extirpated from Santa Barbara County until 1995 when 80 plants were found along the west side of Coast Road on VAFB. Surveys on VAFB in 2010 documented additional localities on south VAFB, totaling 2,996 plants (MSRS 2010). In 2011, this species was discovered growing on San Antonio Terrace on north VAFB. Subsequently, surveys conducted in 2012 documented 2,350 layia within 28 separate stands on north VAFB (SAIC 2012). Layia's known range on VAFB currently begins with the northernmost stands on San Antonio Terrace and extends southward in a narrow band along the dunes to just north of Honda Creek. Surveys of all or portions of the known range and nearby suitable habitat have been conducted in 2006, 2009, 2010, and yearly between 2012 and 2018 (Table 1-5). The Santa Barbara Botanic Garden surveyed in 2009 and surveyed in concert with MSRS in 2017, SAIC surveyed in 2012; all other surveys were performed by MSRS.

**Table 1-5.** Summary findings of beach layia surveys. Specific areas surveyed differed annually; results are not comparable between years.

| Survey Year | South VAFB Restoration Area | South VAFB Honda Creek | South VAFB Kelp Road | North VAFB Restoration Area 3 | North VAFB Restoration Area 2 | North VAFB Restoration Area 1 | North VAFB San Antonio Creek North | Total Plants Documented |
|---|---|---|---|---|---|---|---|---|
| 2006 | 46 | NA | NA | NA | NA | NA | NA | 46 |
| 2009 | 265 | 3 | NA | NA | NA | NA | NA | 268 |
| 2010 | 2,959 | 13 | 24 | NA | NA | NA | NA | 2,996 |
| 2012 | 27 | 0 | 20 | 623 | 155 | 1,324 | 248 | 2,397 |
| 2013 | 797 | 0 | relocated | NA | NA | NA | NA | 797 |
| 2014 | 53 | 0 | 0 | NA | NA | NA | NA | 53 |
| 2015 | 366 | 0 | 0 | NA | NA | NA | NA | 366 |
| 2016 | 542 | 0 | 5 | 452 | 245 | 554 | 57 | 1,855 |
| 2017 | 2,911 | 0 | 5 | 702 | NA | 492 | 144 | 4,254 |
| 2018 | 2,363 | NA | NA | NA | NA | NA | NA | 2,363 |
| 2019 | 3,145 | NA | NA | 2,454 | 542 | 5,682 | 79 | 11,902 |

The layia stands located in the South Beach Layia Restoration Site have been censused intermittently since 2006 and yearly since 2012, providing a dataset to indicate trends on VAFB (MSRS 2019b). This species appears to be highly dependent on timing and amount of rainfall, with high counts often corresponding to large rainfall years (Table 1-6). Prior year rainfall is also likely important, as a large contribution to the seed bank from a good year would prime the following year for high counts as long as environmental conditions are suitable. The 2017 and 2018 counts were both relatively high and were part of an increase in documented numbers since 2014.

**Table 1-6.** Number of beach layia recorded at the South Beach Layia site since 2006.

| Survey Year | Number of Layia Documented | % of Average Rainfall |
|---|---|---|
| 2006 | 46 | 116% |
| 2009 | 265 | 71% |
| 2010 | 2959 | 133% |
| 2012 | 27 | 73% |
| 2013 | 797 | 50% |
| 2014 | 53 | 49% |
| 2015 | 366 | 55% |
| 2016 | 542 | 80% |
| 2017 | 2911 | 152% |
| 2018 | 2363 | 59% |

## Threats Facing the Species

Threats facing layia and the habitat that supports the species include:

- Development,
- Excessive recreational use of habitat, and
- The introduction of invasive non-native plant species (Johns 2009).

On VAFB, layia habitat is protected from development and recreation. Invasive plants are the primary threat especially those that alter natural dune processes by stabilizing soil such as European beach grass (*Ammophila arenaria*), iceplant (*Carpobrotus* spp.), and veldt grass.

### 1.1.5 La Graciosa Thistle

**Life History and Status**

La Graciosa thistle is an herbaceous biennial or short-lived perennial in the sunflower family (Asteraceae) with sessile or short-peduncled heads of white to purple-tinged flowers generally borne closely subtended by a basal rosette (Keil 2012, Figure 1-8).

**Figure 1-8.** La Graciosa thistle from the Guadalupe-Nipomo Dunes National Wildlife Refuge.

La Graciosa thistle was listed as federally endangered under the ESA on 20 March 2000 (65 FR [Federal Register] 14888). USFWS designated critical habitat for this species on 17 March 2004 (69 FR 12553) which was revised on 3 November 2009 (74 FR 56978). VAFB was excluded from this designation under section 4(b)(2) of the ESA. No recovery plan has been drafted for this species.

Extant populations of La Graciosa thistle are localized in the lower valley of the Santa Maria River where it occurs on the fringes of coastal marshes and dune wetlands. La Graciosa thistle is often found in association with low growing herbaceous species such as rushes (*Juncus* spp.), sedges (*Carex* spp.), willow (*Salix* spp.), poison oak (*Toxicodendron diversilobum*), salt grass (*Distichlis spicata*), and coyote brush (*Baccharis pilularis*) (65 FR 14888; Figure 1-9). The last documentation of La Graciosa thistle on VAFB was in 1958, at which time it was reported to be growing along the edge of willows and pasturelands bordering Ocean Avenue approximately 3 mi (5 km) southeast

of Surf Beach. Historically reported occurrences of La Graciosa thistle in VAFB San Antonio Terrace wetlands were misidentified pre-flowering Indian thistle (*Cirsium brevistylum*; Wilken *et al.* 2009).

**Figure 1-9.** La Graciosa thistle habitat on Guadalupe-Nipomo Dunes National Wildlife Refuge.

### History on Vandenberg AFB

Targeted surveys for La Graciosa thistle were conducted on VAFB in 1993 (Keil and Holland 1998), 2009 (Wilken *et al.* 2009), and 2012 (SAIC 2012). The species was targeted in concert with surveys for beach layia, Gambel's watercress (*Nasturtium gambellii*), and marsh sandwort (*Arenaria paludicola*) when suitable habitat was encountered in 2008 (MSRS 2008) and 2016 (MSRS 2017), but the species has not been re-documented on VAFB.

### Threats Facing the Species

The key threats to La Graciosa thistle and the habitat that supports it include:

- Present or threatened destruction, modification, or curtailment of its habitat;
- Disease or predation;
- Inadequacy of existing regulatory mechanisms; and
- Other natural or man-made factors affecting its continued existence such as invasive, non-native plant species (USFWS 2011).

## 1.2 Mapping Background

Recent developments in mobile technology and spatial data management tools have allowed significant advances in plant mapping methods. Leveraging mobile technology and cloud-based data abilities, MSRS has developed a new method of mapping that addresses the difficulties of comparing and tracking plant polygons through time while visualizing background layers in the

field. This mapping and data management system incorporates a nested grid system that is scalable for the survey target(s) and achieves the goals of 1) collecting spatial data quickly and effectively (reducing data entry and improving data integrity); 2) allowing for a true comparison of the extent and cover of populations through time and space; 3) providing field technicians real-time historical context on past populations; and 4) allowing project managers and installation biologists (e.g. 30 CES/CEIEA) access to data in near real-time.

This methodology centers on the concept of collecting data that is attributed to a permanent nested grid that extends from 12.5-, 25-, 50-, 100-, 200-, 400-, to 800-meter cells with four nested cells in each subsequently larger cell. The fixed grid cells are permanent sampling or census units in which data on rare plant abundance, extent, density, etc. can be analyzed and evaluated against a static framework through time. The nested grid system does not discard polygons but incorporates the portion of data that overlaps with the grid cell to the grid cell (Figure 1-10). Applied for use in the field, a GPS-equipped mobile device running Esri's mobile data collection platform Collector for ArcGIS displays orthoimagery overlaid with the grid cells at the relevant scale, the user's real-time location, and any other background information required such as the project area and historic locality data.

MSRS currently utilizes the grid system for managing invasive plant treatment data on VAFB and in 2019, incorporated this trackable system for Threatened and Endangered Plant Surveys. For landscape level surveys, MSRS uses a hybrid and flexible approach to locating rarer plant species—first locating populations by aerial survey, then following up with more detailed and finer resolution ground data collection when appropriate. Determining the optimal mapping resolution—for the grid cell size and polygon mapping—is based on the unique microhabitat in which each survey target grows *and* the context of the surrounding habitat in which the microhabitat occurs. Utilizing both the grid and polygon together or independently of each other at an appropriate scale is important to determine because it defines the dataset resolution and establishes a repeatable standard for dataset comparison, thereby effectively evaluating each species' population trends through time. Typically, a 25-m grid cell coupled with mapping polygons defined by a 100-foot MMD (the distance at which two adjacent plants are merged into a single polygon) provides a sufficient resolution to track plant populations through time.

However, each of the 2019 survey targets occur in vastly different microhabitats and with different growth habits across the landscape precluding a 'one size fits all' mapping approach. Therefore, MSRS evaluated the microhabitat characteristics for each specific survey target and determined the appropriate grid cell resolution for grid mapped species and/or the effective MMD for polygon mapped species (Table 1-7):

**Vandenberg Monkeyflower**

Specifically, V. monkeyflower occurs in discrete sand patches with a dominant herbaceous cover surrounded by a broader vegetation community composed of hardy, maritime chaparral species. Because of its occurrence is such a distinct and small area, MSRS determined that grid mapping alone would capture too much of the surrounding chaparral. Therefore, we mapped V. monkeyflower by polygon only with a 10-ft MMD (Table 1-7).

**Lompoc Yerba Santa**

For 2019 Threatened and Endangered Plant Surveys, yerba santa offered the best example of using this hybrid mapping method for documenting population trends through time by mapping the species with a polygon defined by its standard 100-ft MMD *and* counts of the species coincident with 25-m grid cells (Table 1-7). Because it is not prolific in its seed production and mainly reproduces vegetatively, attributing ramet counts to a static and unchanging grid cell coupled with a polygon offers the best approach for elucidating population trends through time.

**Gaviota Tarplant**

Gaviota tarplant is a widely dispersed annual subspecies that occurs across vast grasslands. Because of these characteristics, polygon mapping alone is not sufficient to capture population trends because counts of the subspecies and its polygon boundaries would change from year to year rendering comparisons ineffective. Attributing the subspecies' cover class and demographic information to the grid system enables us to effectively analyze trends in its distribution and demography. Therefore, in 2019, we mapped Gaviota tarplant by 25-m grid cell only (Table 1-7). Additionally, due to the vast and dispersed distribution of the subspecies and the limited time frame to capture its complete range, we implemented a subsampling methodology within the 25-m grid system to document phenology, density, and demographic information detailed in Section 4.1.

However, if Gaviota tarplant were to occur near Base infrastructure, we would map Gaviota tarplant in a similar method to yerba santa with the hybrid polygon and grid approach to allow for discrete planning efforts.

**Beach Layia**

Layia is restricted to openings in coastal sand dunes, colonizing sparsely vegetated, semi-stabilized dunes and areas of recent wind erosion. Populations may change from year to year challenging traditional polygon comparisons. Layia was not initially scoped to be included in the 2019 effort; however, VAFB observed that 2019 was a productive year for layia emergence and redirected effort to include the species in the surveys. Though MSRS mapped layia according to previous methods—by polygon with a 100-ft MMD—based on its habitat, we recommend that future efforts use the hybrid approach of mapping by a 25-m grid cell and polygon with a 100-ft MMD (Table 1-7).

**La Graciosa Thistle**

La Graciosa thistle occurs in 'island niche' habitats, often in seeps or dune swales. Like V. monkeyflower, these microhabitats are extremely limited and small in nature, surrounded by drier, dune habitat. Therefore, a finer MMD of 10-ft is employed for this species if it were to occur on VAFB and would be attributed to a 25-m grid cell (Table 1-7).

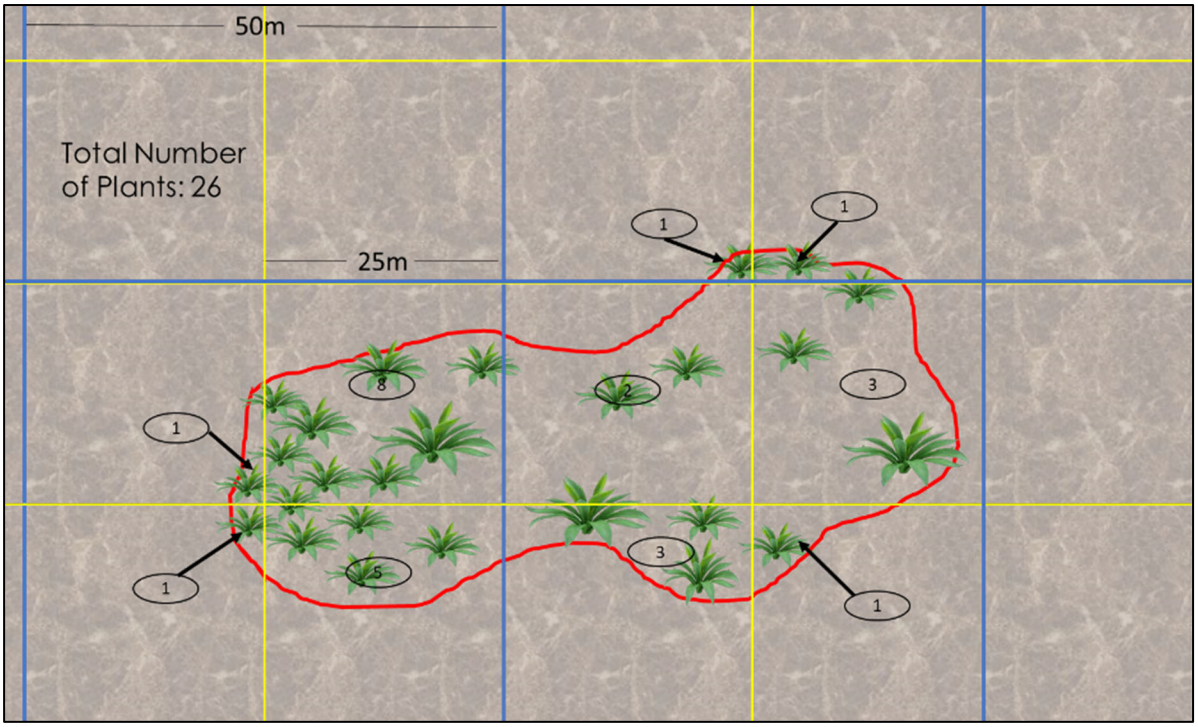


**Figure 1-10.** Schematic of a plant stand mapped using a hybrid approach to polygon and grid mapping.

**Table 1-7.** Grid cell resolution and minimum mapping distances by 2019 survey target.

| Survey Target | Grid Cell Resolution | Minimum Mapping Distance |
|---|---|---|
| Vandenberg monkeyflower | mapped by polygon only | 10 feet |
| Lompoc Yerba Santa | 25 meter | 100 feet |
| Gaviota Tarplant | 25 meter | mapped by grid cell only |
| Beach Layia | mapped by polygon only | 100 feet |
| La Graciosa Thistle | 25 meter | 10 feet |

# 2.0 Vandenberg Monkeyflower Surveys

## 2.1 Methods

V. monkeyflower occupies small sandy openings in dense chaparral that can be difficult to access by ground-based surveys or easily overlooked from the ground. Additionally, accessing V. monkeyflower by trail-blazing could potentially create a vector for the transport of invasive plant propagules such as veldt grass (*Ehrharta calycina*). Therefore, an aerial survey is critical to identifying potential suitable habitat, conducting a comprehensive count of all plants, maintaining biosecurity, and minimizing impacts on chaparral communities and V. monkeyflower itself.

All surveys were conducted in a McDonnell Douglas 500 helicopter in 2019 between 8-13 May, 5-9 June, on 11 June, and on 13 June for a total of 13 survey days. A team of two to three personnel participated in the surveys: a pilot, a lead surveyor and Geographic Information System (GIS) mapper (herein lead surveyor), and a botanist that functioned as a secondary surveyor while in the helicopter or, when needed, as ground mapping support. The MSRS survey team has

professional botanical training as well as extensive experience surveying for plants from helicopters.

Helicopter survey tracks were recorded using a Garmin aviation Global Positioning System (GPS) unit to minimize transect overlap. During these surveys, the helicopter was flown in a systematic, serpentine pattern over Burton Mesa chaparral at an above ground level (AGL) of approximately 150 ft (46 m) in order to locate open sand patches (Figure 1-3). Once identified, these sand patches were inspected at an AGL of approximately 20 to 50 ft (6 to 15 m) to determine if V. monkeyflower was present. Typically, the bright yellow V. monkeyflower flowers were visible from the helicopter with the naked eye; however, in situations where plants were extremely small, or where obstructions such as terrain, wind direction, or power poles constricted the flight path, the surveyor scanned the ground using 10 x 42 binoculars. .

The lead surveyor also took a series of photographs of suitable habitat and of plants. Photographs were taken using two gyro-stabilized, GPS-encoded Canon EOS 5D Mark III digital SLR cameras. One set of images was taken with a medium wide-angle lens (Canon EF 24-105 mm f/4L IS II USM) to establish a wide-angle index view of the habitat. The second round of images was taken with an ultra-telephoto lens (Canon EF 600 mm f/4L IS II USM) for a high-resolution image that could later be used for exact counts. A population count, identification of associated species, and an assessment of habitat quality were derived later from these photographs. As explained in Section 1.2, above, localities were mapped using polygons and a MMD of 10 ft (3 m). Mapping was performed using an Xplore XC6 Tablet computer equipped with GPS and Esri ArcPad software.

To allow for comparisons across years, polygons that were mapped in 2010 were used as the baseline and defined as “monitoring stands” and assigned a unique identifier, a code combining the overall occurrence area and a sequential number. Because the extent and location of polygons vary year to year, 2019 polygons were defined to be associated with the 2010 monitoring stands if they occurred within the 2010 polygon or a 66 ft (20 m) buffer of that polygon. This enabled comparisons of the status of V. monkeyflower at each monitoring stand to be made across years.

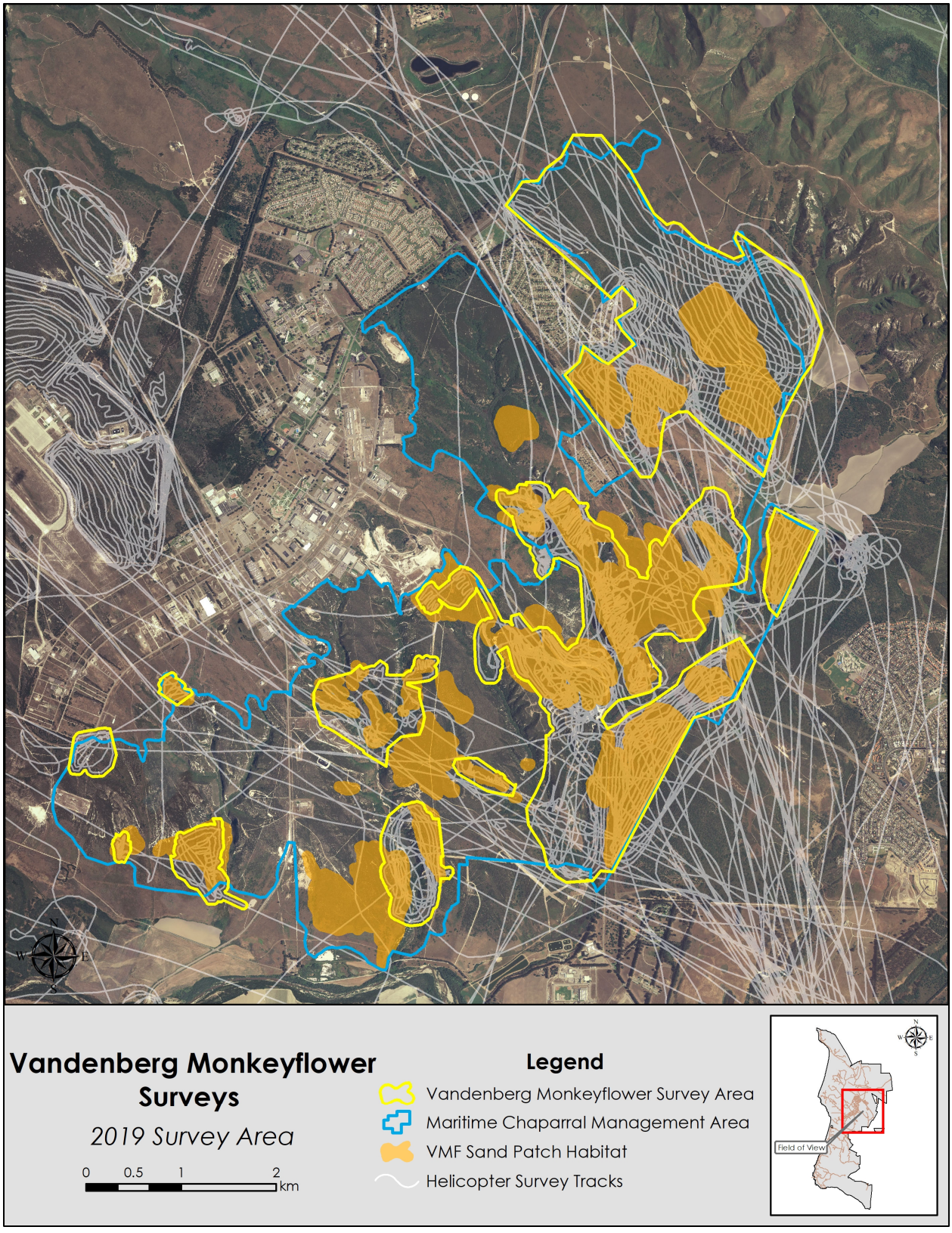


**Figure 2-1.** Survey area selected for targeted surveys of Vandenberg monkeyflower with helicopter survey tracks.

## 2.2 Results & Discussion

During the aerial survey for V. monkeyflower, a total of 55 polygons were mapped. Many of the separately mapped polygons were parts of the 2010 stands that have fractured over time (Figure 2-2). Of the stands mapped in 2019, 17 were greater than the 66 ft (20 m) buffer from previously mapped stands and were assigned a new stand number. Twenty of the stands consisted of fewer than 10 individuals, but one stand consisted of 1,105 plants. A total of 2,536 V. monkeyflower were documented in 0.64 ac (0.26 ha) of occupied habitat (Table 2-1). Stands were scattered throughout the survey area but were slightly more concentrated in Lake, Santa Lucia, Pine, and Oak Canyons.

V. Monkeyflower surveys have been performed in six of the past ten years (2010, 2012, 2014, 2015, 2016, and 2019). Only 2010 and 2019 have had rainfall totals above the 60-year average of 14.6 in (37.1 cm; Figure 1-4). 2017 was also an above-average year but was not a survey year. To facilitate tracking the V. monkeyflower population on VAFB, stands were grouped into seven watershed sites (Figure 2-2). Surveys within these sites have not been comprehensive each year (Table 2-1). To facilitate year-to-year comparisons, MSRS designated a subset of 11 V. monkeyflower stands as "monitoring stands". These stands have a consistent survey history and census of these stands was prioritized during survey years (Table 2-2; Figure 2-3).

The total number of V. monkeyflower in 2019 was low relative to some historic counts, especially the 2016 counts (Table 2-1). Only the Santa Lucia East and Upper Oak Canyon sites had more plants in 2019 than in 2016. Table 2-2, which presents the total count of plants at the monitoring stands, shows an overall decline in numbers as well. 2019 was the lowest count year for five monitoring stands, and no monitoring stand had its highest count in 2019. Additionally, of the 11 monitoring stands, four contained no V. monkeyflower in 2019. It is unclear how much of this decline was due to past drought conditions and how much was due to delayed germination in 2019.

Despite the above-average rainfall in 2016-2017 and 2018-2019, V. monkeyflower may still be suffering from the five years of consecutive drought earlier in the decade and the low rainfall in 2017-2018. The drop in numbers between 2016 and 2019 may also be due, in part, to differential flowering of plants in 2019. In order to maximize counts, in 2016, many stands were assessed twice approximately a month apart to capture them at peak phenology (MSRS 2017). In 2019, the primary focus was on documenting new stands and known populations were only overflown once. At the time of 2019 surveys, most plants observed were in early flower so it is likely that additional late-germinating V. monkeyflower were present and not detected during 2019 surveys.

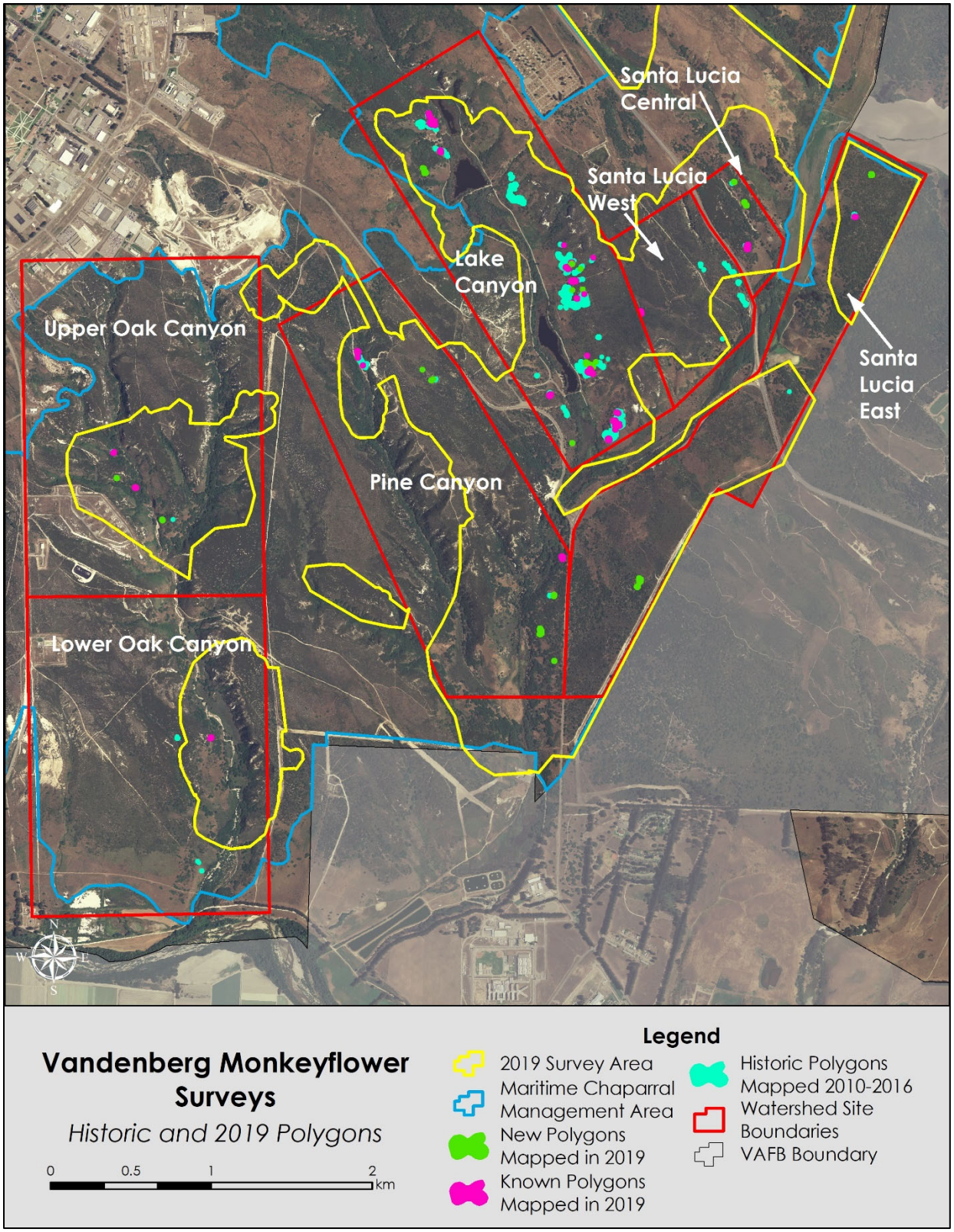


**Figure 2-2.** Vandenberg monkeyflower polygons mapped in 2019 and historic polygons mapped between 2010 and 2016. Green polygons marked as "new" may be part of a known stand number but did not spatially overlap with any previously mapped polygon.

**Table 2-1.** Total number of Vandenberg monkeyflower documented by site from 2010 to 2019. Annual data is not comparable between years due to differing survey areas and discoveries of new stands.

| Survey Year | Santa Lucia East | Lake Canyon | Pine Canyon | Santa Lucia West | Santa Lucia Central | Upper Oak Canyon | Lower Oak Canyon | *Total* |
|---|---|---|---|---|---|---|---|---|
| **2010** | 1 | 4,817 | 365 | Not Assessed | Not Assessed | Not Assessed | Not Assessed | *5,183* |
| **2012*** | 0 | 91 | 109 | | | | | *200** |
| **2014** | 0 | 4,257 | 1,006 | 308 | | 0 | 8 | *5,579* |
| **2015** | 0 | 838 | 27 | 0 | | 9 | 0 | *874* |
| **2016** | 7 | 7,184 | 484 | 484 | 65 | 31 | 104 | *8,359* |
| **2019** | 61 | 2,311 | 100 | 11 | 34 | 52 | 5 | *2,536* |

*Surveys in 2012 focused on previously unsurveyed habitat; most known stands were not assessed

**Table 2-2.** Number of Vandenberg monkeyflower at monitoring stands each survey year. Red numbers indicate maxima for the stand through all survey years; blue indicates minima. Percentages indicate the percent of that rain year relative to the 60-year average, with only 2010 and 2019 as above-average years.

| Year | 2009-10 | 2013-14 | 2014-15 | 2015-16 | 2018-19 | Average |
|---|---|---|---|---|---|---|
| *(% 60-yr Average Rainfall )* | 133% | 50% | 55% | 80% | 140% | |
| lake_0001 | *1356* | *150* | *156* | *729* | *1105* | *699.2* |
| lake_0002 | *124* | *17* | *1* | *11* | *0* | *30.6* |
| lake_0003 | *22* | *16* | *0* | *1* | *0* | *7.8* |
| lake_0004 | *683* | *182* | *0* | *163* | *0* | *205.6* |
| lake_0005 | *183* | *366* | *4* | *198* | *18* | *153.8* |
| lake_0006 | *465* | *2346* | *189* | *3522* | *4* | *1305.2* |
| lake_0007 | *678* | *488* | *267* | *586* | *191* | *442* |
| lake_0008 | *1298* | *453* | *161* | *767* | *786* | *693* |
| lake_0010 | *3* | *1* | *0* | *8* | *0* | *2.4* |
| lake_0011 | *4* | *44* | *0* | *69* | *1* | *23.6* |
| pine_0001 | *365* | *1006* | *27* | *405* | *45* | *369.6* |
| ***Total*** | ***5181*** | ***5069*** | ***805*** | ***6459*** | ***2150*** | ***3932.8*** |

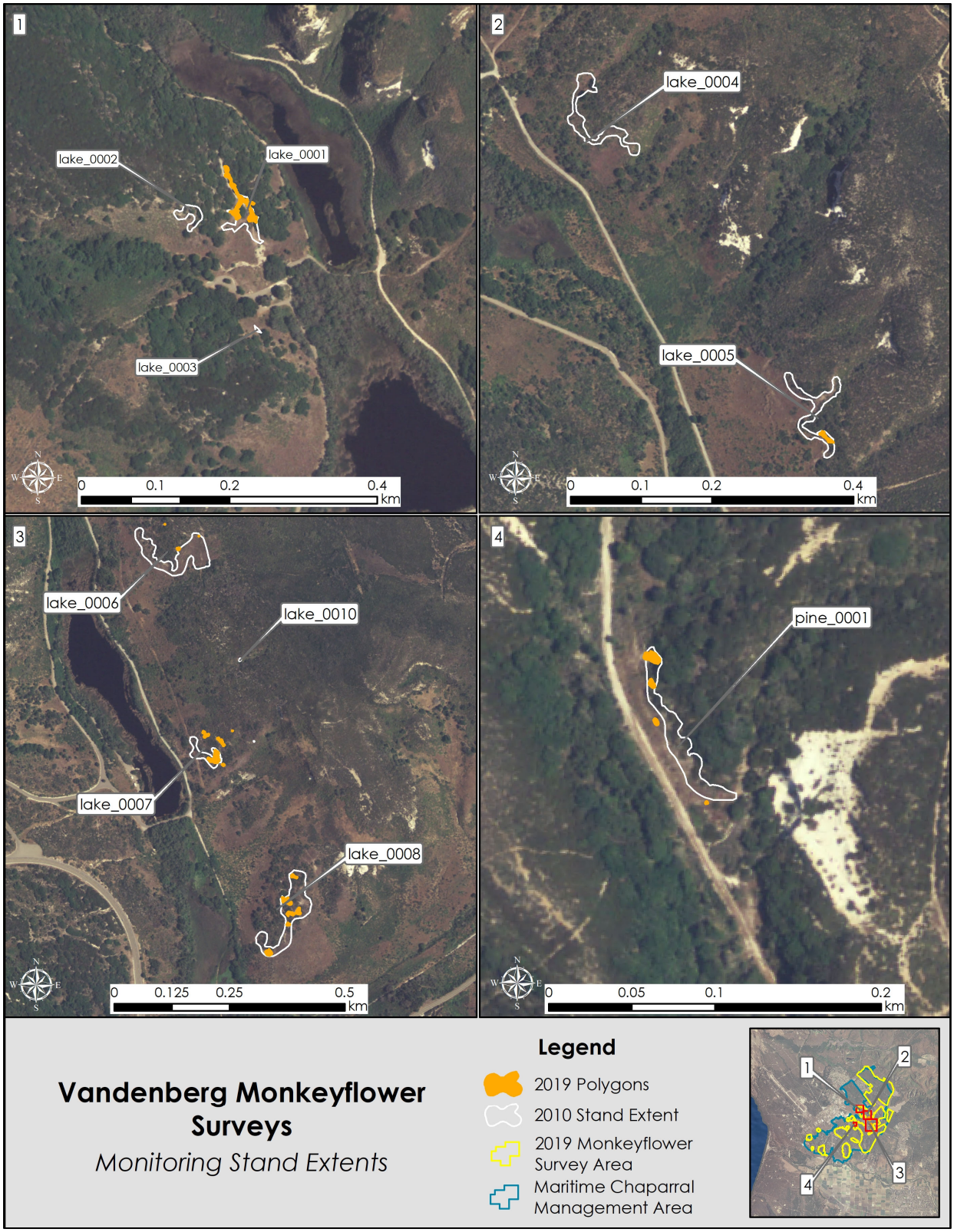


**Figure 2-3.** Vandenberg monkeyflower monitoring polygons and stands. Note that the 2019 polygons used to analyze lake_0007 consisted of three polygons outside the original 2010 extent, but within the buffer. This ensures that as the stand expands or contracts, monitoring remains consistent.

In addition to recent drought and late germination, non-native plant invasions are also likely a contributing factor to lower numbers of V. monkeyflower in 2019. As noted in past years, formerly open, native-dominated sand patches have been degraded by invasive plant species, primarily by veldt grass, and the overall habitat quality at almost all of the documented stands is in decline (MSRS 2017). MSRS biologists observed veldt grass colonizing areas in which it had previously been absent and becoming the dominant component of vegetation where infestations had historically been light (Figure 2-4).

In 2010, approximately 51% of plants at the Lake Canyon site had veldt grass encroachment. In 2016, surveyors noted that 98% of plants in Lake Canyon were in stands with veldt grass encroachment, and that pattern was still evident during the 2019 surveys. In 2019, veldt grass was one of the top five associated species in 20 polygons (53% of extant stands), and it was the *dominant* associated species in 16 polygons (42% of extant stands).

**Figure 2-4.** Vandenberg monkeyflower habitat in Lake Canyon heavily invaded by veldt grass in the interstitial spaces of Burton Mesa chaparral.

## 2.3 Recommendations for Vandenberg Monkeyflower

The greatest threat to the persistence of V. monkeyflower and its habitat is the proliferation of veldt grass. V. monkeyflower was once considered common lower in the Oak Canyon watershed near the confluence with the Santa Ynez River; however, this area is now heavily infested by veldt grass (MSRS 2012; 78 FR 64840). Although MSRS discovered new populations within Oak Canyon (including in 2019), no V. monkeyflower has been detected in the southern end of the canyon at

stands oak_0001 and oak_0002 since 2014. In 2014, these two stands together supported only eight individuals and were noted as being under heavy pressure from veldt grass (Wagner 2014).

To prevent continued degradation of habitat that supports this species, the restoration actions described in the Vandenberg Air Force Base Maritime Chaparral Management Plan (MCMP) should be implemented (MSRS 2018). Pending implementation of this Plan, early intervention should be undertaken to reduce pressure from veldt grass. Veldt grass treatment within and adjacent to V. monkeyflower stands should be conducted with appropriate herbicides. In particular, treatments should take place within the large accessible V. monkeyflower populations in Pine Canyon, Lake Canyon, and Highway 1 West. Treatments should also be conducted in the small stands in Upper and Lower Oak Canyon.

One option for treatment is to apply the grass specific herbicide clethodim. Aerial applications of clethodim have been used to good effect on infestations of veldt grass just north of VAFB on the Guadalupe-Nipomo Dunes National Wildlife Refuge (USFWS 2014). However, before broadscale application of clethodim should be implemented on VAFB, its effects on sensitive species should be determined. V. monkeyflower's close relative Fremont's monkeyflower can be used as a proxy for testing clethodim and if it does not show detrimental effects from application, testing could be expanded to applications of veldt grass in V. monkeyflower habitat (Figure 2-5).

**Figure 2-5.** Fremont's monkeyflower locality in Apache Canyon, Los Padres National Forest.

To further the goal of developing an effective control method for veldt grass, MSRS collected seed from the closely related Fremont's monkeyflower in 2019. Collections were made on the Los Padres National Forest after coordination with the Forest Botanist. Historical stand locations of Fremont's monkeyflower were accessed through the California Consortium of Herbaria, then

visited throughout the growing season to track phenology and collect seeds (Figure 2-6). One phenology-reconnaissance survey on 30 April 2019 was followed by two seed collection trips on 24 May 2019 and 7 June 2019. The bulk of the seeds were collected on the second trip, and approximately 1,500 seeds were collected. These seeds will be used to produce an experimental crop of plants on which to test clethodim.

Pending the results of clethodim testing on Fremont's monkeyflower, targeted applications of broad spectrum (glyphosate) and/or grass specific (clethodim) non-persistent herbicides should be conducted to control extant veldt grass infestations following recommended procedures in the MCMP (MSRS 2018b) briefly summarized below:

- *Veldt grass growing intermixed with native broadleaf species*: treat with clethodim twice from January through March when plants are actively growing. Broad-leaf plants with sensitive status should be avoided during clethodim applications
- *Veldt grass growing intermixed with iceplant or as a near monoculture*: treat with glyphosate once from January through March when veldt grass is actively growing. Any native species present should be avoided.

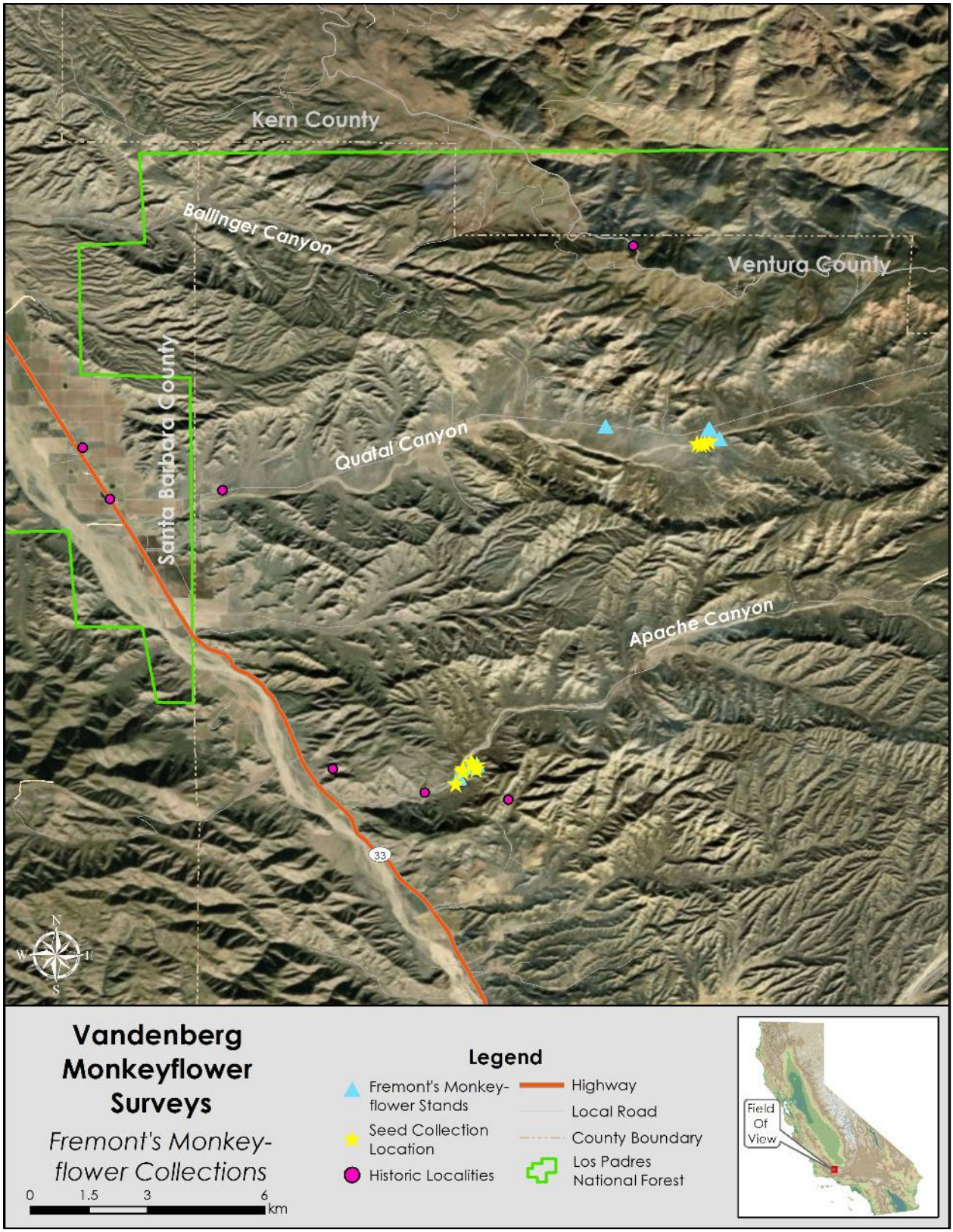


**Figure 2-6.** Fremont's monkeyflower seed collection locations in the Los Padres National Forest.

# 3.0 Lompoc Yerba Santa Surveys

## 3.1 Methods

Yerba santa's affinity for dense, tall chaparral makes it a challenging species to survey and detect consistently. Prior to using helicopters, MSRS utilized ladders erected in truck beds as mobile platforms to remotely search the upper chaparral canopy with binoculars and spotting scopes for yerba santa's distinctive lavender flowers (SRS Technologies, Inc. 2006). In 2015, the use of the helicopter vastly increased the area that could be surveyed and the ability of surveyors to detect stands of yerba santa, resulting in the detection of 8,237 individuals in 7.19 ac (2.91 ha) of occupied area. In 2019, MSRS again employed a helicopter for yerba santa surveys.

All surveys were conducted in a McDonnell Douglas 500 helicopter between 6-13 May, 6-7 June, and 5-11 August 2019 for a total of 17 survey days (Figure 3-1). A team of two personnel participated in the surveys: a pilot and a lead surveyor. Helicopter surveys for yerba santa were conducted 5-9 August 2019, and the 35$^{th}$ Street ground mapping was completed on 6 September 2019.

Yerba santa surveys were widespread across VAFB, with three target zones on north Base and a fourth on south Base (Figure 1-2). Survey areas were selected with similar habitat and vegetation communities to known stands; specifically, chaparral dominated by la Purisima manzanita (*Arctostaphylos purissima*), chamise (*Adenostoma fasciculatum*), and Bishop pine (*Pinus muricata*). On south VAFB, these same habitats were targeted within the 12,742-ac (5,156-ha) burn scar of the 2016 Canyon Fire. Survey areas that contained suitable habitat were systematically searched along parallel transects approximately 164 to 264 ft (50 to 75 m) wide with the helicopter at an AGL of 82 to 164 ft (25 to 50 m).

Survey effort was documented using a Garmin GPS unit that continually recorded the helicopter's tracks (Figure 3-1). When a stand of yerba santa was located, the plants were photographed following methods in Section 2.1, and the location was noted. A botanist later returned to the site via ground access to document ramet and stem counts, and associated species if the vegetation density and terrain permitted. Groups of ramets were mapped as polygons with an MMD of 100 ft (30.5 m).

In addition to surveys for new stands, MSRS revisited and remapped the yerba santa stand at 35$^{th}$ Street. This stand is monitored yearly to inform and support an associated restoration effort. To facilitate better tracking of the 35$^{th}$ Street stand, MSRS included the VAFB nested grid system this year. Over time, all yerba santa monitoring and survey efforts will incorporate grid mapping. For the 35$^{th}$ Street yerba santa survey, the botanist mapped the occupied cells at the 25-m resolution and tallied the number of live and dead ramets and stems within each cell. Associated species were noted for the whole stand.

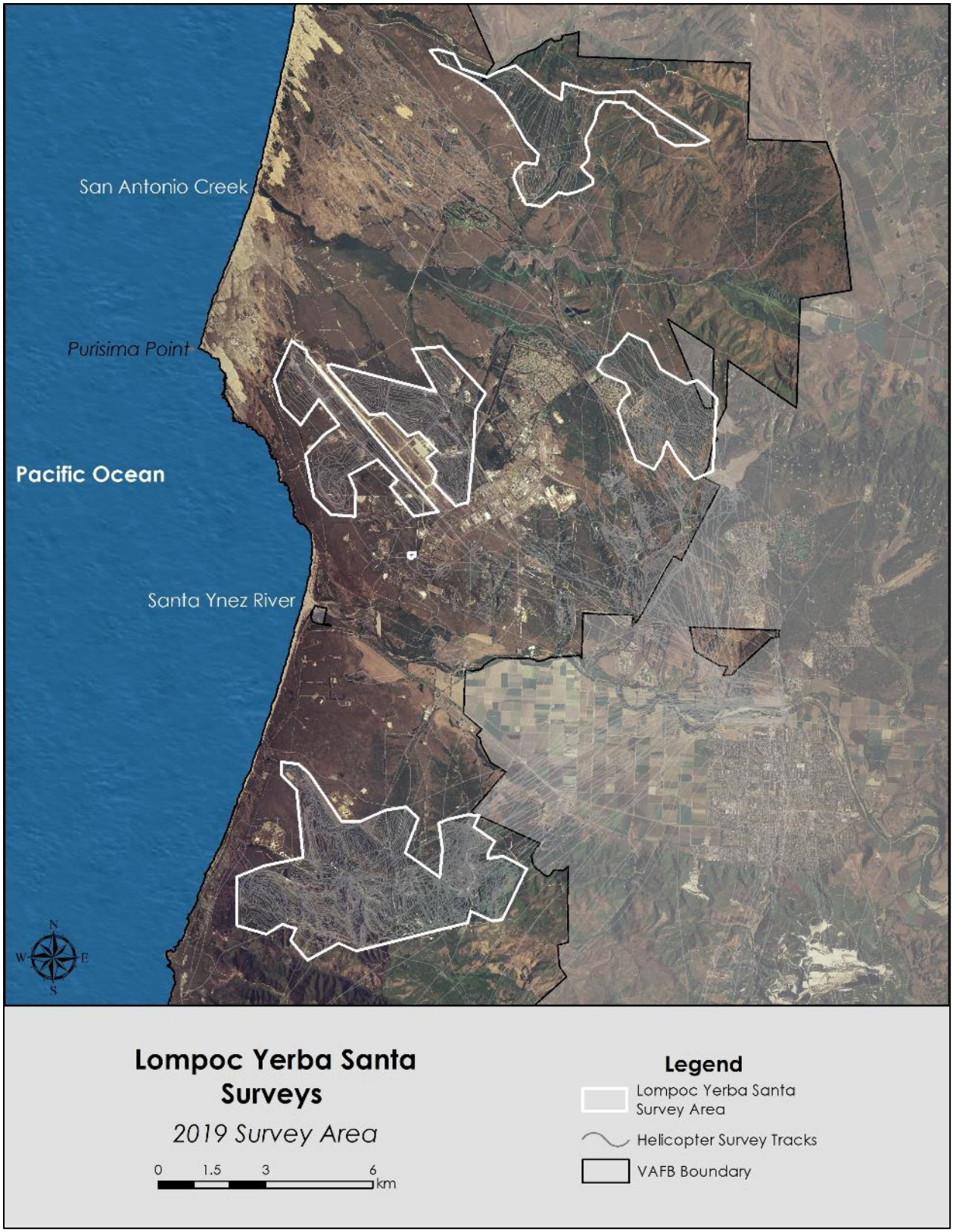


**Figure 3-1.** Yerba santa survey areas.

## 3.2 Results & Discussion

The yerba santa surveys conducted in 2019 searched extensive suitable habitat for new stands, verified the extent of a reported new stand, and were used to conduct the annual census of the 35th Street Restoration Site stand. A new stand at the VAFB airfield was reported to the VAFB Base botanist, Luanne Lum, who directed MSRS to perform a count and verify the extent. Additionally, in 2019, a Base contractor discovered a new yerba santa stand on south VAFB on the edge of the Canyon Fire burn scar that the Base botanist mapped. This new population did not require additional MSRS survey effort.

In 2019, the new stand at the VAFB airfield had a total of 77 ramets (Figure 3-2). These yerba santa were growing in high quality Burton Mesa chaparral habitat with dominant species including: La Purisima manzanita, coyote brush (*Baccharis pilularis*), chamise, and black sage (*Salvia mellifera*). Plants were large-statured, with some individuals over 4.9 ft (1.5 m) tall. Plants were mapped in a combined area of 0.08 ac (0.03 ha).

The 35th Street stand was counted following the annual census protocol but was mapped using grid cells for the first time using the nested grid system at the 25-m scale. A total of 316 ramets were mapped within 18 cells (Figure 3-3). Further details of restoration progress and discussion of this year's census results in the context of past years' counts can be found in the Lompoc Yerba Santa Habitat Restoration, 35th Street Stand Report (MSRS 2020a).

## 3.3 Recommendations for Lompoc Yerba Santa

Despite its large stature and distinctive flowers, yerba santa is a difficult-to-detect survey target. Utilization of the helicopter to aid in the survey effort greatly increases the ability to detect yerba santa plants, but several survey modifications may be useful in future years. Conducting surveys at different times of year may increase detection rates as shifts in the color and texture of vegetations changes throughout the season. In addition, future surveys on south Base in the Canyon Fire burn scar may be more productive as that area's vegetation recovers. In 2019, a vigorous, near-monoculture of deerweed (*Acmispon glaber*) completely covered the ground in some areas and hampered efforts to detect small yerba santa resprouts or seedlings. Deerweed is an early successional species which will likely decline over future years and as it dies off, repeat surveys for yerba santa should be conducted.

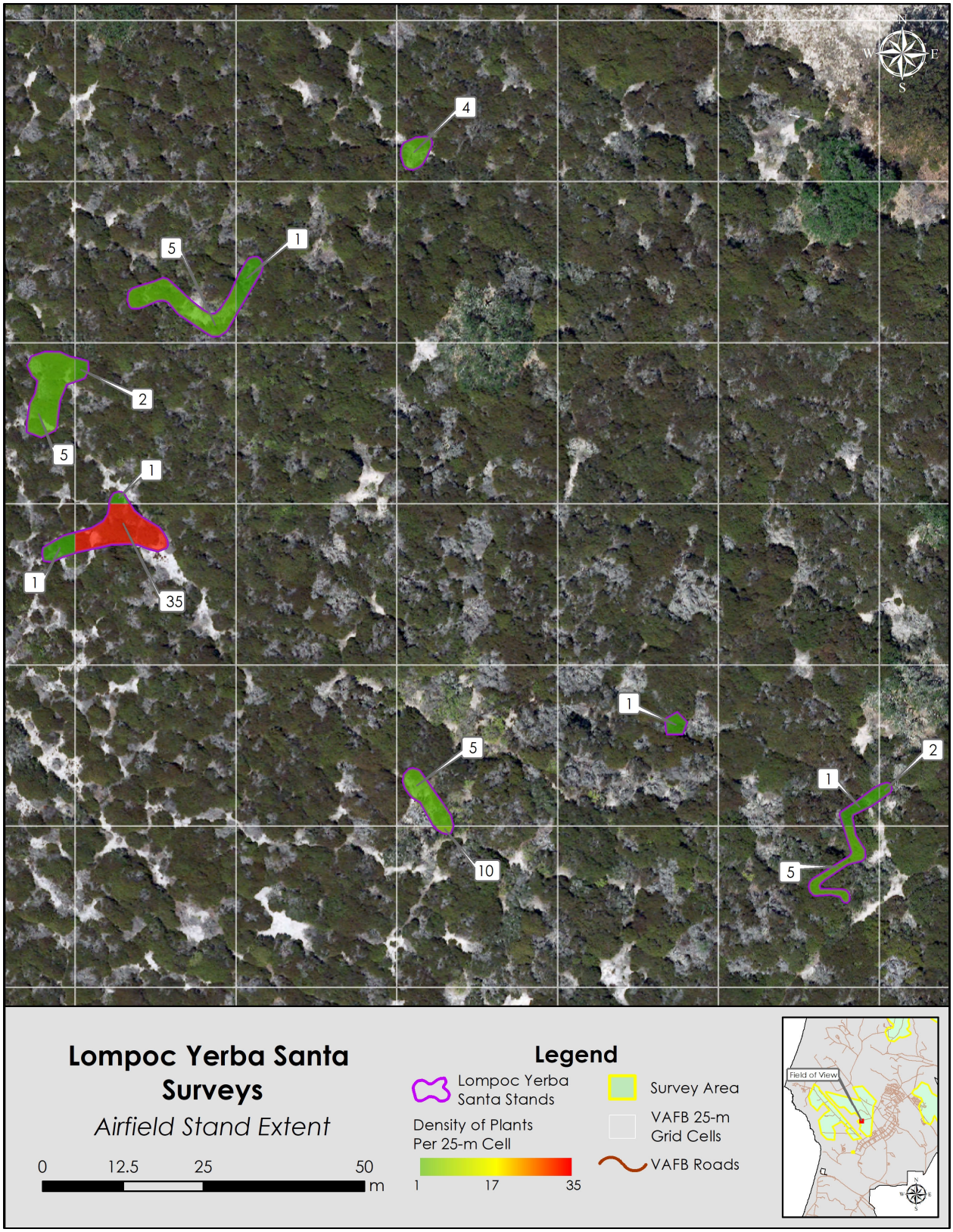


**Figure 3-2.** New yerba santa stand mapped in 2019 at the VAFB airfield.

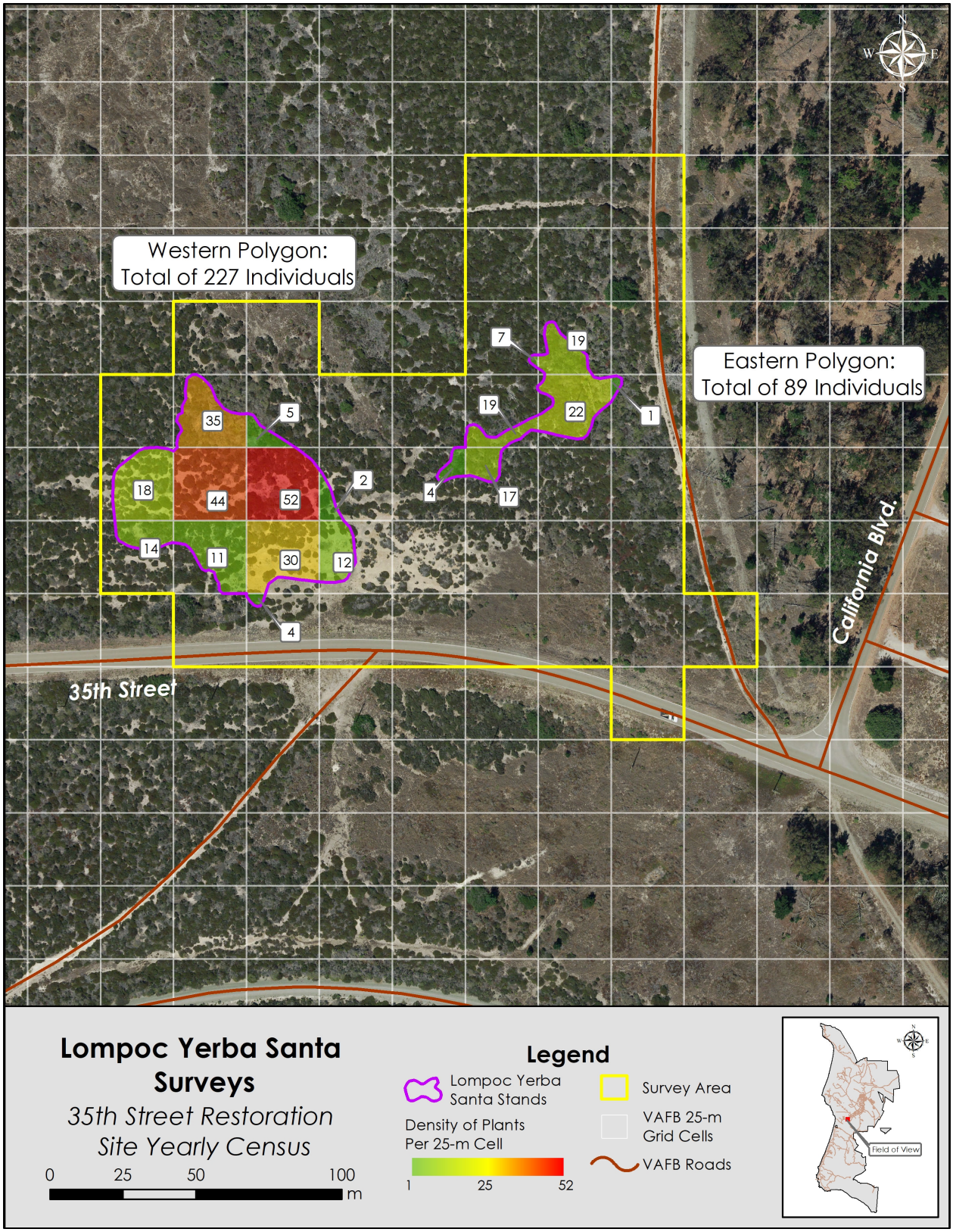


**Figure 3-3.** Results of the yearly census at the 35th Street Restoration Site. Numbers and heat map in each 25-m cell indicate the number of yerba santa ramets observed.

# 4.0 Gaviota Tarplant Surveys

## 4.1 Methods

Survey areas for Gaviota tarplant were selected in collaboration with VAFB Base botanist along the south coast of VAFB in order to determine the distribution and abundance of the subspecies (Figure 1-2). However, this subspecies is morphologically variable and determining key characters between various species and subspecies within *Deinandra* can be challenging.

Because of its phenotypic plasticity and dispersed occurrence across a vast landscape, MSRS combined aerial and ground-based methods to maximize efficiency and target areas of suitable versus non-suitable habitat with two survey teams: a visual search team in the helicopter to first locate tarplant species (*Deinandra* spp.) and a ground data collection team to confirm identification of the subspecies. Suitable habitat for Gaviota tarplant is composed of relatively low-growing grasslands whereas non-suitable habitat contains high cover of taller statured non-native grasses and forbs.

Prior to performing the aerial and ground-based surveys, ruggedized iPad tablets were loaded with a high resolution orthophotograph, historic localities of Gaviota tarplant, and data collection forms. Once on the ground, the team collected abundance and demographic information attributed to the 25-m grid system described in Section 1.2. Data collected during the survey effort are provided in a file geodatabase as a deliverable to VAFB.

Aerial surveys were conducted in a McDonnell Douglas 500 helicopter over the course of eight survey days from 20-27 August 2019. The helicopter maintained the aerial survey team composed of the pilot, the lead surveyor/mapper, and one botanist observer in order to identify new occurrences while a ground-team composed of a lead surveyor/mapper and one or two botanists collected finer resolution data from the ground. This strategy maximized the efficiency of the helicopter while allowing for simultaneous, detailed ground mapping.

In order to first locate tarplant occurrences, the pilot maintained an AGL of 33 to 492 ft (10 to 150 m) allowing the observers sitting on opposite sides of the helicopter to thoroughly inspect suitable habitat on either side of the transect. Transect widths varied based on the terrain but were generally 114 to 246 ft (35 to 75 m) wide. Upon locating tarplant, the aerial survey team mapped the full extent of the population by recording presence within each 25-m grid cell. In areas of non-suitable habitat, the helicopter conducted wider transects approximately 246 ft to 656 ft (75 m to 200 m) in order to quickly cover ground and confirm the absence of tarplant. Flight routes were digitally recorded to ensure total coverage and avoid recounting any tarplant occurrences (Figure 4-1).

After the aerial survey team mapped the full extent of each tarplant population, the ground team followed up by randomly selecting 25-m grid cells to subsample the population. MSRS determined and documented the subspecies of tarplant and collected abundance and phenology data in these randomized, subsampled grid cells to extrapolate characteristics to the larger tarplant population.

Data collected and attributed to each 25-m grid cell included:

- Key characteristics such as ray flower counts, tarplant height, panicle clustering, peduncular bract overlap, villousness, gland characteristics;
- Phenology and age class;
- Tarplant percent cover of the 25-m cell;
- Tarplant counts; and,
- Top five co-occurring species.

These data are provided in a file geodatabase as a deliverable.

### Identification of Subspecies, Intergrades, and Hybrids

MSRS used the updated key in the Jepson Manual to differentiate the federally endangered Gaviota tarplant from grassland tarweed (Baldwin *et al.* 2012). This key relies on plant size, head architecture, the length of the peduncle relative to the phyllaries, and the degree of overlap between the peduncular bracts and phyllaries. Ray flower count is also mentioned but the ranges cited overlap, so this character was collected but not given as much weight as the others (Table 4-3).

Intermediate characteristics or a combination of morphological key characteristics between the subspecies Gaviota tarplant and grassland tarweed were considered intergrades. Shared characteristics between *D. increscens* and paniculate tarplant were termed hybrids.

**Table 4-1.** Table of key characters used to differentiate subspecies of *D. increscens*.

| Subspecies | Key Characters | | | | |
|---|---|---|---|---|---|
| | **Plant Height** | **Head Stucture** | **Peduncle/Involucre Relationship** | **Peduncular Bracts** | **Number of Ray Flowers** |
| *D. increscens* ssp. *increscens* | ≤ 10 dm | Panicle-like clusters | Peduncle > Involucre | Overlapping < proximal 3/4 of phyllaries | 8 to 13 |
| *D. increscens* ssp. *villosa* | ≤ 5 dm | Pairs or tight groups | Peduncle < Involucre | Overlapping ≥ proximal 3/4 of phyllaries | (8)13(15) |

## 4.2 Results & Discussion

MSRS surveyed a total of 10,475.9 ac (4,239.4 ha) of the south coast of VAFB from south of Point Arguello to the base boundary near Jalama Creek. Stands of *D. increscens* were found throughout the eastern third of the survey area but were primarily concentrated along the southeastern tip of VAFB (Figure 4-1). In total, 84.01 habitat acres (34.00 ha) of tarplant were mapped, of which 0.66 ac (0.27 ha) were Gaviota tarplant, 0.0073 ac (0.003 ha) were grassland tarweed, and 1.43 ac (0.58 ha) were intergrades of the two subspecies (Table 4-2). These totals were extrapolated to the larger stand from the randomized, sub-sampled 25-m grid cells (Figure 4-2).

Of a total of 17 mapped tarplant stands, only two mapped stands of tarplant were determined to be pure Gaviota tarplant: Stands 1 and 8 (Table 4-2, Figure 4-3). Due to the annual nature and seasonal variability of Gaviota tarplant, some historic localities were not documented in 2019 (Figure 4-1). Likely the result of the absence of grazing, habitat on the upper slopes of Sudden

Ranch (on the boundary between VAFB and private property) is no longer suitable since it has been overrun with non-native annual species, such as thistles (Figure 4-6). However, just off Base where moderate grazing still occurs, habitat remains suitable and Gaviota tarplant was documented. Additionally, Gaviota tarplant was not documented in the heavily grazed lowlands of Sudden Ranch, as these areas were dominated by low growing and monotypic non-native annual grasses (Figure 4-4). Instead, Gaviota tarplant seemingly preferred moderately grazed grasslands with areas of bare ground and perennial and annual native broad leaf species, (such as doveweed (*Croton setigerus*) interspersed throughout (Figure 4-5). We recommend conducting residual dry matter (RDM) studies to determine optimal grazing conditions for the species (see Section 4.3).

The combination of aerially identifying tarplant stands followed by detailed ground-based mapping with two teams of surveyors allowed for efficiencies documenting the wide extent of tarplant on south VAFB. Additionally, this methodology coupled with attributing data to a 25-m grid system allowed for the collection of more fine-scale demography and species phenology data to offer a snapshot across a wide area (Figure 4-3**Error! Reference source not found.**).

**Table 4-2.** Summary of mapped tarplant results. These totals were extrapolated to the larger stand from randomized subsampling 25-m grids.

| Stand ID | Habitat Acres | Percent Cover of *D. increscens* ssp. *villosa* | Percent Cover of *D. increscens* ssp. *increscrens* x *increscens* ssp. *villosa* intergrade | Percent Cover of *D. increscens* ssp. *increscens* | Acres of *D. increscens* ssp. *villosa* | Acres of *D. increscens* ssp. *increscrens* x *increscens* ssp. *villosa* intergrade | Acres of *D. increscens* ssp. *increscens* | Total Count of *D. increscens* ssp. *villosa* | Total Count of *D. increscens* ssp. *increscrens* x *increscens* ssp. *villosa* intergrade | Total Count of *D. increscens* ssp. *increscens* |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 8.65 | 0.05 | 0.00 | 0.00 | 0.39 | 0.00 | 0 | 15,302 | - | 0 |
| 2 | 4.17 | 0.00 | 0.01 | 0.00 | 0.01 | 0.04 | 0 | 526 | 5,575 | 0 |
| 3 | 10.97 | 0.00 | 0.06 | 0.00 | 0.00 | 0.64 | 0 | 33 | 34,437 | 0 |
| 4 | 11.27 | 0.00 | 0.01 | 0.00 | 0.02 | 0.12 | 0 | 2,126 | 9,956 | 0 |
| 5 | 7.41 | 0.03 | 0.00 | 0.00 | 0.21 | 0.00 | 0 | 27,474 | 318 | 0 |
| 6 | 7.72 | 0.00 | 0.02 | 0.00 | 0.00 | 0.17 | 0 | - | 24,825 | 0 |
| 7 | 0.77 | 0.00 | 0.03 | 0.00 | 0.00 | 0.02 | 0 | 50 | 4,945 | 0 |
| 8 | 3.24 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0 | 2,163 | - | 0 |
| 9 | 1.85 | 0.00 | 0.01 | 0.00 | 0.00 | 0.01 | 0 | 458 | 1,834 | 0 |
| 10 | 0.93 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0 | - | 222 | 0 |
| 11 | 2.93 | 0.00 | 0.01 | 0.00 | 0.00 | 0.03 | 0.007 | - | 902 | 66 |
| 12 | 2.93 | 0.00 | 0.02 | 0.00 | 0.00 | 0.06 | 0 | - | 3,015 | 0 |
| 13 | 8.96 | 0.00 | 0.02 | 0.00 | 0.00 | 0.13 | 0 | - | 9,918 | 0 |
| 14 | 5.56 | 0.00 | 0.01 | 0.00 | 0.00 | 0.07 | 0 | 311 | 10,969 | 0 |
| 15 | 0.77 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 | 0 | - | 90 | 0 |
| 16 | 5.09 | 0.00 | 0.02 | 0.00 | 0.00 | 0.11 | 0 | - | 7,531 | 0 |
| 17 | 0.77 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0 | 50 | 450 | 0 |
| | | | | **Totals** | **0.66** | **1.43** | **0.0073** | **48,494** | **114,988** | **66** |

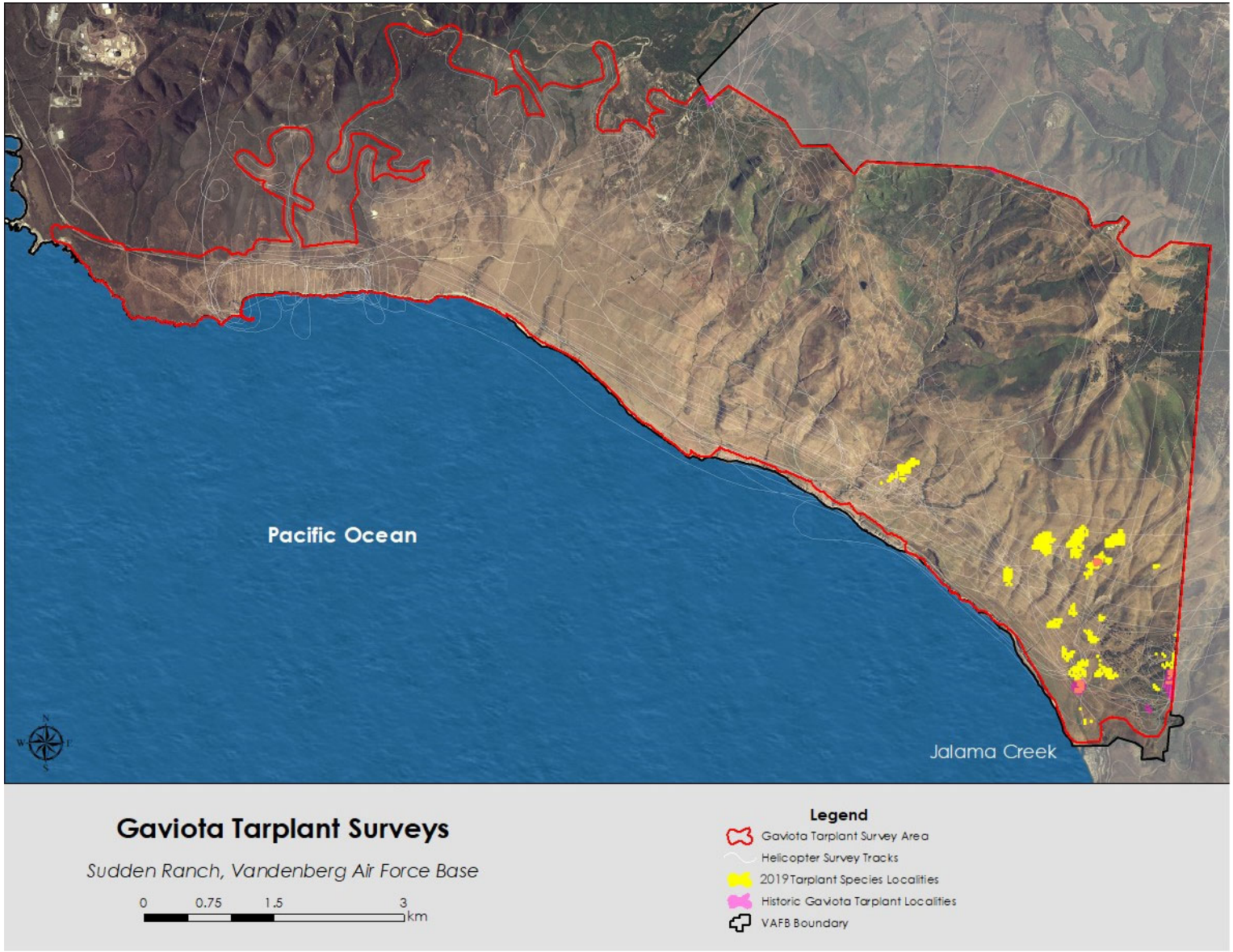


**Figure 4-1.** Survey tracks and stands of tarplant mapped throughout the entire survey area. Areas with no helicopter tracks were areas deemed non-suitable for tarplant.

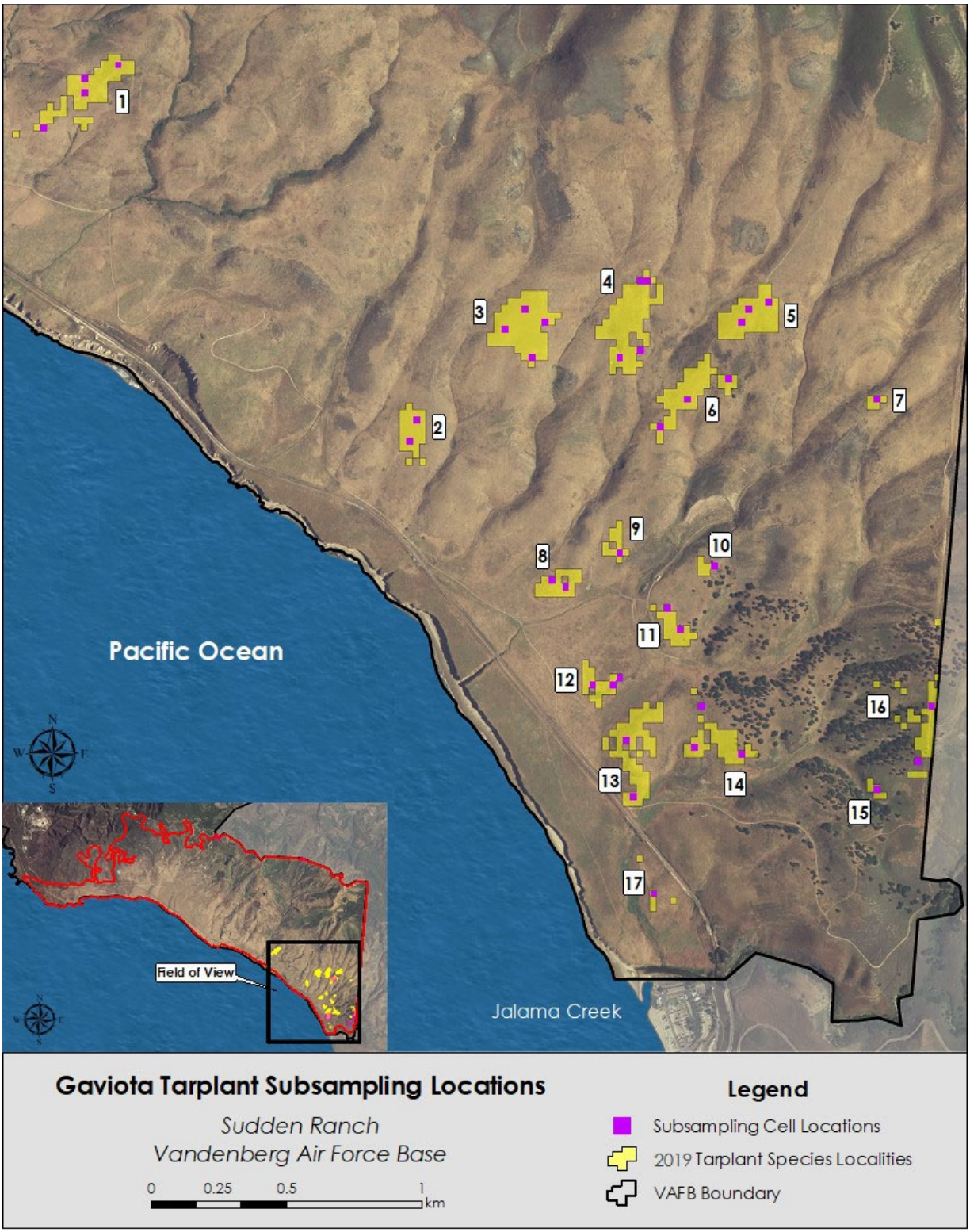


**Figure 4-2.** Locations of randomized subsampling units used to extrapolate population information to each stand.

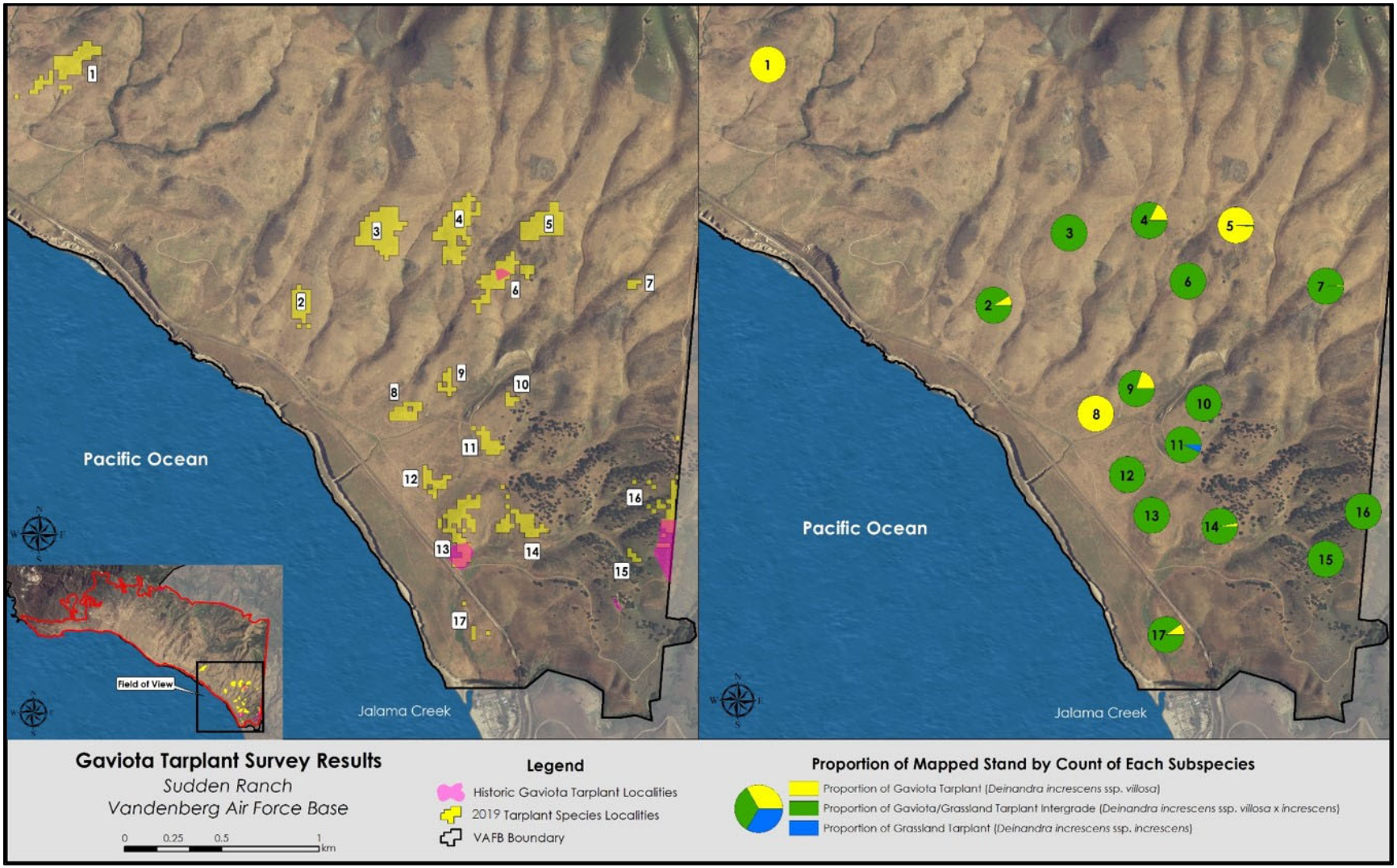


**Figure 4-3. Left:** Mapped stands of tarplant on Sudden Ranch and **right:** the proportional composition of tarplant by stand.

**Figure 4-4.** Overgrazed lowlands on Sudden Ranch dominated by monotypic, non-native annual grasses.

**Figure 4-5.** Moderately grazed grasslands interspersed with open areas and native annual and perennial species such as doveweed (*Croton setigerus*) appear to provide optimal habitat for Gaviota tarplant.

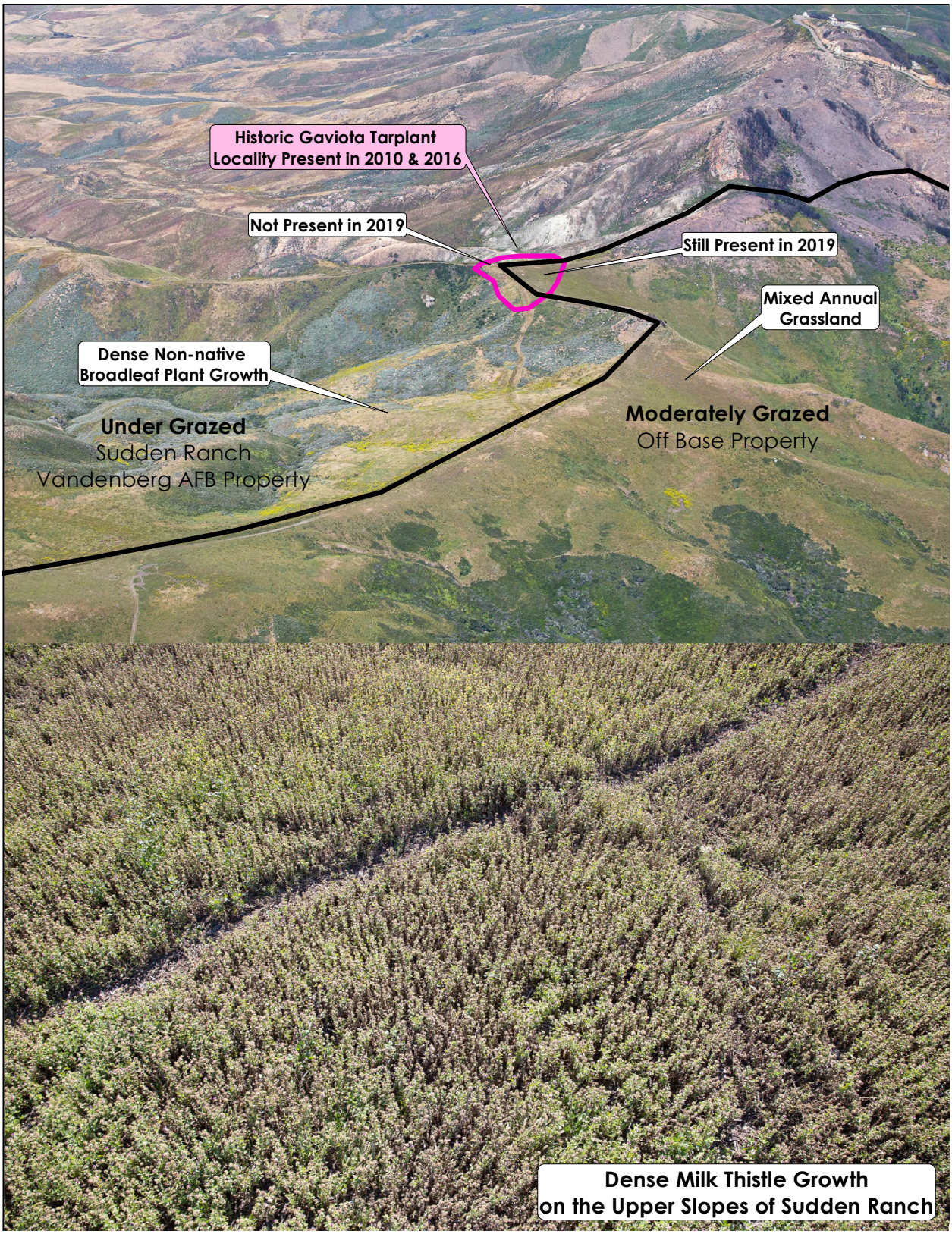


**Figure 4-6. Top**: Historic population of Gaviota tarplant visited in 2019 was not present on undergrazed Vandenberg property, but was present just off Base on moderately grazed property. **Bottom:** Dense, tall broadleaf growth in under grazed areas of the upper slopes of Sudden Ranch.

## 4.3 Recommendations for Gaviota Tarplant

Grassland habitat that supports Gaviota tarplant appears to be degrading on some of the ridgetops surveyed on south Base. Specifically, invasion by non-native broadleaf plants, such as mustards (Brassicaceae) and thistles, appear to be most problematic to habitat suitability. Gaviota tarplant appears to tolerate higher levels of RDM if the biomass is comprised primarily of grasses; however, exact RDM levels are not yet fully understood. Suitable habitat for Gaviota tarplant on south VAFB is managed as part of VAFB's rangeland program and the subspecies appears to prefer moderately grazed areas—absent from both under and overgrazed grasslands. Therefore, MSRS recommends identifying optimal RDM to use grazing as a restoration tool for Gaviota tarplant management.

A multi-objective and cross-disciplinary grazing plan should outline how to distribute grazing pressure more evenly across pastures (by herding or fencing) but should also emphasize more targeted grazing on ridge tops preferred by Gaviota tarplant. MSRS proposed fencing layouts and the production of functional water troughs to encourage cattle grazing in desired areas in the Honda Ridge Management Plan finalized in 2018 that can be referenced for a grazing-specific plan for Gaviota tarplant habitat enhancement. The goals of this should aim to lower the cover of non-native, broadleaf plants and select for grasses as the primary component of the vegetation community. However, this Plan should also analyze the timing and optimal RDM that best benefits Gaviota tarplant as detailed in the Honda Ridge Management Plan.

# 5.0 Beach Layia Surveys

## 5.1 Methods

MSRS selected survey areas for layia within all zones of existing restoration areas managed for layia, as well as in suitable habitat to the north of San Antonio Creek where MSRS and others had previously mapped stands in 2012, 2016, and 2017 (Figure 1-2; MSRS 2017).

Ground-based surveys were conducted from 11-22 March 2019 when plants were in a blooming to early senescence stage and most identifiable. A botanist walked narrowly spaced transects across all suitable habitat within the survey area while searching for plants along and between transects. Operating the mobile application Collector for ArcGIS with a sub-meter, Trimble R1 GPS, the botanist recorded total effort (area surveyed), number and location of plants found, and habitat characteristics such as associated species, soil type, and overall habitat quality. Habitat quality was determined by the presence of invasive species, with high-quality habitat relatively uninvaded and low-quality habitat still suitable but invaded. Polygons of layia were mapped using a MMD of 16 ft (5 m). When the distance between a mapped polygon and an additional plant exceeded the MMD, the outlying plant was mapped as part of a new polygon.

## 5.2 Results & Discussion

Including both north and south VAFB, MSRS detected a total of 11,902 layia individuals, the largest total number recorded than in any previous survey year (Table 5-1, Figure 5-1). On north VAFB, MSRS detected 8,757 plants and on south VAFB, surveyors detected 3,145 plants, both of

which were higher than any other historic count. A total of 46 stands of layia were mapped: 11 on south Base and 35 on north Base. Two stands consisting of 27 plants and a single plant respectively were found on south Base that did not coincide with any previously mapped stand. All other stands were within the MMD of a stand that was mapped in a prior year.

**Table 5-1.** Results of beach layia surveys conducted in 2019.

| Habitat Quality | Number of Stands | Acres of Occupied Habitat | Number of Individuals |
|---|---|---|---|
| Plants found on South VAFB | | | |
| High | 1 | 0.03 | 282 |
| Medium | 9 | 0.30 | 2,862 |
| Low | 1 | <0.01 | 1 |
| *South Total* | 11 | 0.33 | 3,145 |
| Plants found on North VAFB | | | |
| High | 21 | 1.62 | 7,249 |
| Medium | 13 | 0.81 | 1,416 |
| Low | 1 | <0.01 | 92 |
| *North Total* | 35 | 2.44 | 8,757 |
| ***Grand Total*** | 46 | 2.77 | 11,902 |

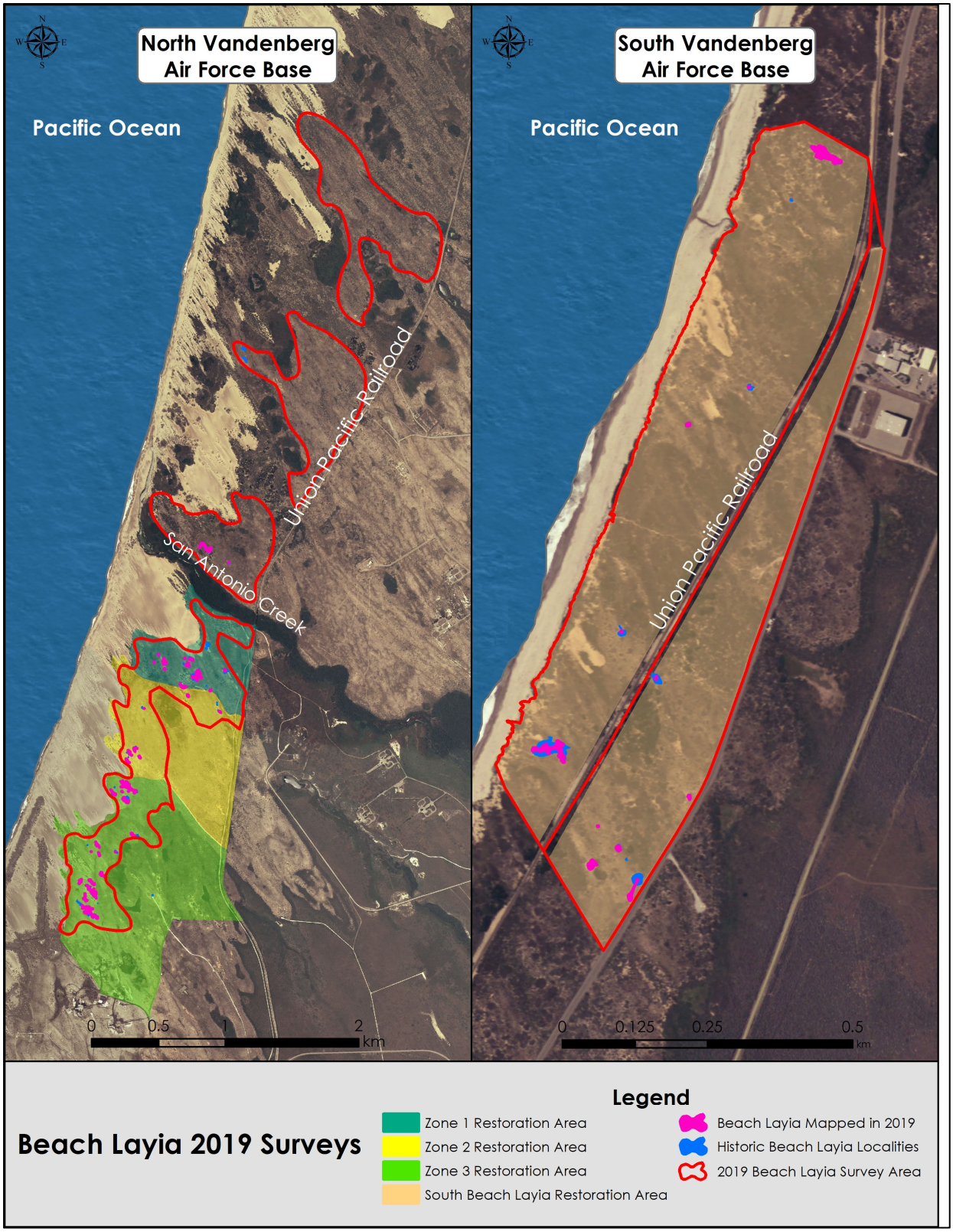


**Figure 5-1.** Beach layia 2019 census results.

## 5.3 Recommendations for Beach Layia

VAFB has conducted restoration of beach layia-occupied dune habitat since 2014 on south Base and since 2016 on north Base (MSRS 2020b). These treatments have resulted in declines of invasive species, particularly European beach grass (*Ammophila arenaria*), iceplant (*Carpobrotus* spp.), and Sydney golden wattle (*Acacia longifolia*). MSRS recommends that these efforts continue. The biomass that accumulates in dune systems after successful control of invasive species can in some situations act as a mulch and benefit recovery of native species, but in the case of layia sites it appears to be more problematic. Dead invasive cover has remained relatively high with little degradation and may impede layia growth. MSRS recommends monitoring the cover of dead invasive plants for another year to see if sufficient natural degradation occurs. If the dead cover remains overly high, biomass reduction measures such as hand-pulling and piling should be implemented.

As with other sand-dominated sites on VAFB, the layia dune habitat continues to be degraded by veldt grass and other non-native species such as iceplant. Like the threat posed to V. monkeyflower, non-native plants can outcompete native plants and interfere with proper function of the active sand dunes. To address these issues, MSRS finalized the Coastal Dune Management Plan in 2018 (MSRS 2018a) which contains detailed management strategies for conserving and restoring layia habitat. Similar to the recommendations for V. monkeyflower, aerial application of clethodim presents the best means to manage veldt grass infestations on the landscape scale, but aerial application is contingent on studies to ensure this would not adversely impact layia or co-occurring sensitive species.

Pending approval for broadscale clethodim application, the following measures from the CDMP can be employed to improve layia habitat:

- *Veldt grass growing intermixed with native broadleaf species*: treat with clethodim twice from January through March when plants are in active growth. Broad-leaf plants with sensitive status should be avoided during clethodim applications.
- *Veldt grass monocultures and veldt grass growing intermixed with iceplant*: treat with glyphosate once from January through March when veldt grass is in active growth. Desirable/sensitive natives should be avoided.
- *Iceplant:* treat with Glyphosate. Desirable/sensitive natives should be avoided.
- *Mature invasive trees:* Flush cut and consolidate cut material. Consolidation locations should be selected to facilitate biomass removal.
- For any other large infestations of invasive plants, see the CDMP for recommended herbicide formulations and removal methods.

# 6.0 La Graciosa Thistle Surveys

## 6.1 Methods

La Graciosa thistle surveys prioritized dune swale habitat on the San Antonio Terrace between Shuman Creek and San Antonio Creek as well as habitat in the vicinity of a historic locality along Ocean Avenue (Figure 1-2 and 6-1). The location of the historic locality was determined from searching the Consortia of California Herbaria (CCH1 2020). The area between Ocean Avenue and Clark Street contains suitable riparian habitat because of irrigation of agricultural fields and flow in Miguelito Creek.

Surveys were conducted in a McDonnell Douglas 500 helicopter in 2019 between 11-12 May and 6-9 June in the same manner described above with a two- to three-person survey team (see Section 3.1).

Helicopter survey tracks were recorded using a Garmin aviation GPS unit to minimize transect overlap. The helicopter was flown in a systematic, serpentine pattern at approximately 150 ft (45 m) AGL to locate potential thistle habitat. Once identified, these patches were inspected at approximately 20 to 50 ft (6 to 15 m) AGL to determine if La Graciosa thistle was present, using 10 x 42 binoculars when obstructions, wind direction, or power poles constricted the flight path. If any La Graciosa thistle localities had been found, they would have been aerially mapped and verified with on the ground assessments of plant characteristics, demography, phenology, and habitat quality.

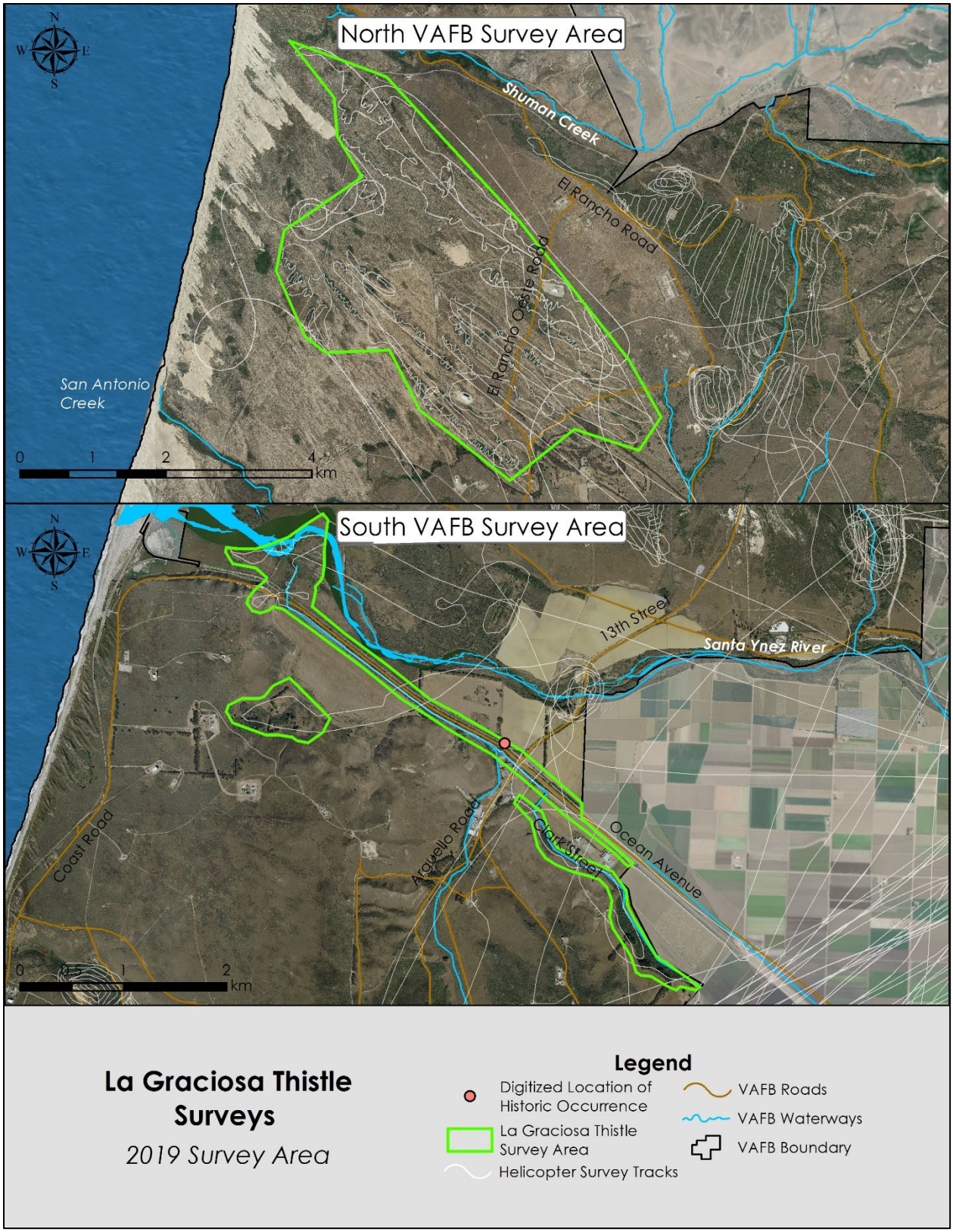


**Figure 6-1.** La Graciosa thistle survey areas and helicopter survey tracks. Areas with no tracks were deemed non-suitable habitat.

## 6.2 Results & Discussion

La Graciosa thistle plants were not found during the 2019 surveys. It is likely the historic occurrence on VAFB was confined to the Ocean Avenue location (Figure 6-1). Given extensive surveys that have been conducted for this species since that time and the change in habitat at the Ocean Avenue site, La Graciosa thistle does not appear to be present on VAFB.

## 6.3 Recommendations for La Graciosa Thistle

Potential suitable habitat for La Graciosa thistle does exist on VAFB on San Antonio Terrace. Surveys should be continued at five-year intervals to detect La Graciosa thistle should it appear. Additionally, to further species recovery, it may be worth investigating the feasibility of establishing experimental populations in VAFB dune wetlands on San Antonio Terrace. If this could be accomplished successfully without impeding VAFB mission, it would greatly improve the chances of long-term survival and recovery of the species.

# 7.0 Conclusion

The 2019 surveys for V. monkeyflower, yerba santa, Gaviota tarplant, layia, and La Graciosa thistle provided updated data on the status of these species on VAFB in terms of distribution, population health, and potential threats to long-term persistence. These surveys also support natural resource management goals for VAFB populations. To continue the recovery and persistence of these species on VAFB, MSRS has the following overall recommendations:

- Continue regular surveys of special status plants on VAFB. Future surveys for all species should include a grid-based data management system for precisely tracking populations' expansion/contraction and distribution. Where species ecology and past survey methods are conducive to it, a blended grid-and-polygon methodology should be used to gain the benefits of both systems together.
- Implement species-specific management recommendations as detailed herein and in various habitat management plans written for VAFB. In the event resources are limited, MSRS recommends that V. monkeyflower conservation be given the highest priority. Many V. monkeyflower stands are facing extirpation due to veldt grass invasion and will require timely intervention to ensure their persistence.

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