MARIN MUNICIPAL WATER DISTRICT

Posting Date: June 17, 2019

220 Nellen Avenue Corte Madera CA 94925-1169
www.marinwater.org

NOTICE OF SPECIAL MEETING
BOARD OF DIRECTORS
(WATERSHED)

Notice is hereby given that a Special Meeting of the Marin Municipal Water District's Board of Directors will be held as follows:

MEETING DATE: Thursday, June 20, 2019
TIME: 1:30 p.m.
LOCATION: MMWD Board Room, 220 Nellen Ave., Corte Madera, CA 9492

AGENDA

ITEM		RECOMMENDATION	APPROX. START
☐	CALL TO ORDER		1:30 p.m.
☐	ADOPT AGENDA		1:31 p.m.
☐	PUBLIC EXPRESSION*		1:32 p.m.
☐	CALENDAR		
1.	Minutes of March 21, 2019 Meeting	*Approve*	1:45 p.m.
2.	Rare Plant Inventory Update Report	*Discussion*	1:50 p.m.
3.	Professional Services Agreement with ESA for On-Call Environmental Compliance Services	*Review & Refer to Regular Meeting of the Board for Approval*	2:00 p.m.
4.	Grazing Feasibility Study	*Discussion*	2:10 p.m.

Stephanie Eichner-Gross
Board Secretary

ADA NOTICE AND HEARING IMPAIRED PROVISIONS: The board room is equipped with sound amplifying units for use by the hearing impaired. The units operate in conjunction with the room's sound system. You may request the personal sound amplifier from the Board Secretary for use during meetings.

MMWD BOARD OF DIRECTORS: Larry Bragman, Jack Gibson, Cynthia Koehler, Armando Quintero, Larry Russell

** Anyone wishing to speak on an item other than those listed on this agenda will be recognized at this time. We ask any person wishing to be heard to come to the podium to address the board and state your name and address for the public record. A 3-minute limit is customary; however the Board chair may adjust the actual time allotted to accommodate the number of speakers.*

over -

In accordance with the Americans with Disabilities Act and California Law, it is the policy of the Marin Municipal Water District to offer its public programs, services, and meetings in a manner that is readily accessible to everyone, including those with disabilities. If you are disabled and require a copy of a public hearing notice, an agenda, and/or agenda packet in an appropriate alternative format, or if you require other accommodation, please contact Stephanie Eichner-Gross at (415) 945-1448, at least two days in advance of the meeting. Advance notification within this guideline will enable the district to make reasonable arrangements to ensure accessibility.

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FUTURE BOARD OF DIRECTORS MEETINGS:

Thursday, June 20, 2019 Special Meeting (Watershed), 1:30 p.m.	MMWD Board Room
Monday, June 24, 2019 Special Meeting (Retreat), 9:00 a.m.	Tiburon
Thursday, June 27, 2019 Special Meeting (Finance), 9:30 a.m.	MMWD Board Room
Tuesday, July 2, 2019 (Board), 7:30 p.m.	MMWD Board Room
Tuesday, July 16, 2019 (Board), 7:30 p.m.	MMWD Board Room
Friday, July 19, 2019 (Operations), 9:30 a.m.	MMWD Board Room
Thursday, July 25, 2019 Special Meeting (Finance), 9:30 a.m.	MMWD Board Room

MARIN MUNICIPAL WATER DISTRICT

ITEM NO. 1
MEETING DATE: June 20, 2019
MEETING: Board of Directors

STAFF REPORT

SUBJECT: Minutes of March 21, 2019 Special Meeting of the Board of Directors (Watershed)

SUBMITTED BY: Donna Lahey, Senior Administrative Assistant

RECOMMENDED ACTION: Approve

ATTACHMENT:

1. Minutes of March 21, 2019 Special Meeting of the Board of Directors (Watershed)

THE BOARD OF DIRECTORS
OF MARIN MUNICIPAL WATER DISTRICT

Minutes of the special meeting of the Board of Directors held on Thursday, March 21, 2019 at 220 Tamal Vista Blvd., Corte Madera, California. A quorum of the Board was convened to consider items scheduled on the agenda related to the Watershed.

Directors present: Directors Bragman, Gibson, Quintero and Russell
(Note: Director Russell arrived at 1:50 p.m.)

Directors absent: Director Koehler

CALL TO ORDER

Director Bragman called the meeting to order at 1:30 p.m.

AGENDA

On motion of Director Quintero, seconded by Director Gibson the Board adopted the agenda as presented by the following vote:

Ayes: Directors Bragman, Gibson and Quintero
Noes: None
Absent: Directors Koehler and Russell
Abstain: None

PUBLIC EXPRESSION

One person spoke during this time.

CALENDAR

ITEM 1 MINUTES OF DECEMBER 20, 2018 MEETING

On motion of Director Gibson, seconded by Director Quintero, the Board approved the minutes as presented by the following vote:

Ayes: Directors Bragman, Gibson and Quintero
Noes: None
Absent: Directors Koehler and Russell
Abstain: None

ITEM 2 RELEASE OF THE BIODIVERSITY, FIRE AND FUELS INTEGRATED PLAN (BFFIP) AND DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT REPORT FOR PUBLIC COMMENT

Crystal Yezman, Facilities and Watershed Division Manager, acknowledged staff for their efforts on preparing the plan.

Shaun Horne, Natural Resources Program Manager, presented the staff report. Mr. Horne said the BFFIP Programmatic EIR would be released for public review and comment from March 21, 2019, through May 7, 2019 which was developed to replace the 1995 Vegetation Management Plan. The BFFIP describes actions the District would take to minimize fire hazards and maximize ecological health on District lands. Mr. Horne gave a slide presentation outlining the BFFIP history, goals, plan organization, annual work plan, costs and draft EIR summary of scoping, structure, key impacts, mitigation and alternatives. A brief question and answer period followed.

Director Bragman opened the item for public comment.

Six people spoke during this time.

ITEM 3 UPDATE ON E-BIKES

Shaun Horne presented the staff report and slide presentation on the issue of increased e-bikes use throughout Marin County and recent public requests for and against the use of e-bikes on District lands. MMWD hosted a workshop in December 2018 to hear public comment on e-bikes. Mr. Horne requested direction from the Board of Directors on the possible formation of a Citizens Advisory Committee (CAC) to evaluate e-bike access and related issues and make recommendations to the Board of Directors.

Director Bragman supported the idea of the CAC and suggested that riders should be required to use bells on bikes as a mechanical warning to other trail users as a measure to mitigate trail conflicts.

Director Bragman opened the item for public comment.

Seventeen people spoke during this time.

Director Russell left the meeting at approximately 2:50pm.

Directors Bragman and Quintero agreed that more information was needed from the District's rangers regarding enforcement and other issues.

Ben Horenstein, General Manager, said staff would reach out to the public and solicit applications for the CAC to present to the Board.

There was discussion of the approach of each Board member recommending one committee member and the District work with local partner agencies and water municipalities to create a baseline study on trail users and public land impact.

Director Gibson advised staff to be specific with the committee in terms of its goals and what it hopes to achieve.

The Board directed staff to move forward with the formation a Citizens Advisory Committee on e-bikes to evaluate e-bike access and related issues.

ITEM 4 UPDATE ON GOAT GRAZING ACTIVITIES IN MARIN COUNTY

Shaun Horne presented the staff report and introduced local goat grazing project coordinator Rich Shortall.

Mr. Shortall gave a presentation of the Goat Grazing Project that included information on the management and performance of goat herds. A question and answer period followed

Director Gibson recalled a goat grazing initiative that was tested on District land that did not have favorable results because the herds tended to eat what they liked rather than what needed to be grazed.

Andrea Williams, Vegetation Ecologist, said past grazing feasibility studies and test projects have indicated it is less expensive and more effective to use humans rather than goats for vegetation management.

ADJOURNMENT

There being no further business, the meeting of March 21, 2018 was adjourned at 3:25 p.m.

_____
President, Board of Directors

ATTEST:

_____
Board Secretary

MARIN MUNICIPAL WATER DISTRICT

ITEM NO. 2
MEETING DATE: June 20, 2019
MEETING: Board of Directors

STAFF REPORT

SUBJECT: Rare Plant Inventory Update Report

SUBMITTED BY: Andrea Williams, Vegetation Ecologist
Crystal Yezman, Facilities and Watershed Division Manager

RECOMMENDED ACTION: Discussion

EXECUTIVE SUMMARY:

The last comprehensive review of the Marin Municipal Water District's rare plants occurred in 1990. From 2012-2018 District (MMWD) staff surveyed over 400 rare plant populations of 35 species covering nearly 5,000 acres of Mt. Tamalpais, Nicasio and Soulajule. Nearly 130 new populations and locally rare species were mapped and documented. While threats such as climate change; invasive species; road, trail and fuelbreak maintenance; lack of fire; and recreation impact many rare plants, only the fire-dependent Marin manzanita showed a significant loss of populations as compared to the 1990 report. All 24 listed species found in 1990 are still present, and an additional 15 species that have since been listed by the California Native Plant Society (CNPS) as rare are also present. The report contains species-by-species distribution, status, and recommended research and management practices. It also presents possibly present, presumed extirpated (locally extinct), and locally rare species.

FISCAL IMPACT: **YES** ____ **NO** X **FISCAL YEAR:** ____

FISCAL IMPACT NARRATIVE:

None.

BACKGROUND:

As part of its mission to sustainably manage its natural resources, and to comply with state, federal, and local regulations, the District needs an understanding of the distribution and health of its rare species populations. Watershed lands are recognized as botanically rich and are thought to support hundreds of rare plant populations, but the last comprehensive, field-based review of the district's rare plants occurred in 1990.

From 2012-2018 district staff led by Vegetation Ecologist Andrea Williams surveyed nearly 5,000 acres of watershed lands on Mt. Tamalpais, Nicasio and Soulajule, revisiting or mapping over 400 rare plant populations. In late 2017, the district hired Michelle O'Herron at a cost of $8,725 to assist with editing the compiled information into a streamlined, user-friendly report. The Rare Plant Inventory Update provides a brief overview of the District's resources, history and infrastructure in regards to rare plants; summarizes threats and stressors; and gives an

overview of rare and important plants and plant communities. After documenting methods and presenting lists of rare plants known to occur, potentially occurring, and presumed extirpated (no longer occurring), each of the 35 CNPS-listed species known to occur has a 2-page species account showing its biology, distribution, status (and trends if known), data gaps, and specific threats and management recommendations. Finally, the current list of 203 locally rare (three or fewer populations on District land) species is given.

Overall, rare plant populations are doing well on the district's Watershed lands. Only 20 of the 35 species have information in the 1990 report available for comparison, but of those only the fire-dependent Marin manzanita showed a significant loss of populations. While several populations of rare plants have disappeared, new populations have usually been found and species have not suffered a net loss. Status of the 35 species featured is as follows:

- **Secure**, populations numerous, well-dispersed, not threatened by management, **11 species**
- **Vulnerable**, populations are not well-dispersed, but not imminently threatened, **9 species**
- **Threatened**, populations are in decline and will disappear without intervention, **5 species**
- **Imperiled**, close to extirpation on watershed lands, **6 species**
- **Unknown**, not well-mapped; plants difficult to tell from closely related species, **4 species**

One of species considered imperiled, Baker's larkspur, is a reintroduction site and not a natural population. The above local status rankings mirror global criteria but only consider district populations in their assessment. Some of our species considered secure on the watershed may still be globally or state-ranked as imperiled.

Approximately 140 taxonomic groups were listed in the 1990 report as CNPS-listed rare species or of local concern. Of these, 36 of the 77 plants deemed "possible" have been found. Only two of the 44 plants found in 1990 are no longer present. All 24 of the listed plants present in 1990 are still present; 18 others of concern are not currently listed by CNPS or MMWD.

Species are maintaining current levels in part due to best management practices codified in the Draft Biodiversity, Fire, and Fuels Integrated Plan (BFFIP) Environmental Impact Report, including staff training, performing pre-project surveys, flagging populations for avoidance, and removing invasive plants. Further management recommendations in the Rare Plant Inventory Update are largely reflected in the draft BFFIP. Other species-specific information on research and data gaps may be used by staff in reaching out to partners and potential researchers, or addressing needs in-house.

An appendix with population-specific sensitive information such as maps and directions will be available to select audiences and included with spatial data submitted to the California Natural Diversity Database.

STRATEGIC PLAN ALIGNMENT:

This activity aligns with the District's Strategic Plan Goal 4 (Environmental Stewardship), Strategy 1 (Enhance ecosystem resiliency), Objective 4 (Monitor ecological vital signs).

REVIEWED BY:				
	A.S.D Manager/Treasurer		NA	X
	General Counsel	X	NA	
	General Manager	X	NA	

ATTACHMENTS:

1. Rare Plant Inventory Update Report
2. June 20, 2019 Special Board Meeting Item 2 Rare Plant Inventory Update Report Presentation

MARIN MUNICIPAL WATER DISTRICT
RARE PLANT INVENTORY UPDATE

MAY 1, 2019

ANDREA WILLIAMS, VEGETATION ECOLOGIST
MARIN MUNICIPAL WATER DISTRICT
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MICHELLE O'HERRON, COMMUNICATIONS CONSULTANT
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RECOMMENDED CITATION:

Williams, A., & O'Herron, M. (2019). *Marin Municipal Water District Rare Plant Inventory Update*. Corte Madera, CA: Marin Municipal Water District.

COVER PHOTO: The rare Sargent cypress-Mt. Tamalpais manzanita plant community, is also dominated by the rare endemic Mt. Tamalpais manzanita. Andrea Williams/MMWD

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Introduction

Marin Municipal Water District Resources Overview

First set aside in 1912 to provide clean, reliable, and affordable drinking water to local citizens, Marin Municipal Water District (MMWD) watershed lands have expanded over the last century to encompass the roughly 22,000 acres MMWD manages today. While the majority of these lands are around the summit of Mount Tamalpais, they are also a part of a 150,000-acre network of protected areas and open spaces managed by the National Park Service, California State Parks, Marin County, individual cities, homeowner groups, agricultural interests, and nonprofit entities.

Watershed lands are managed to provide clean, safe drinking water to nearly 200,000 nearby residents, as well as for passive recreational uses. The reservoirs on Mount Tamalpais, along with the Nicasio Reservoir to the north, provide about 75 percent of the water MMWD supplies to its customers. The balance is imported from the Russian River. Soulajule Reservoir, also to the north of Mount Tamalpais, is not regularly used for water supply but is available in the case of a severe drought. MMWD also conducts numerous environmental restoration, stewardship, science, educational, and volunteer programs to help meet their mission to manage their natural resources in a sustainable manner.

The following provides an overview of the built and natural environments as they relate to rare plant species on Mount Tamalpais. More information on each of these topics can be found in the sources listed in the references section.

Infrastructure and Land Use

Because watershed lands were protected relatively early in Marin County's history, they were never as fully developed as adjacent residential and commercial areas have been. However, some signs of past land uses are still evident on the landscape in the form of old logging skid roads and stumps, dilapidated barbed wire fence lines, and certain plant species introduced for grazing or gardening.

The numerous creeks on MMWD's land flow in all directions down from Mount Tamalpais into San Francisco Bay, Tomales Bay, or the Pacific Ocean. The Lagunitas Creek Watershed alone is home to four of the five reservoirs on the mountain: Lagunitas, Bon Tempe, Alpine, and Kent lakes. The fifth, Phoenix Lake, is on Ross Creek (a tributary of Corte Madera Creek) and is primarily used to supply water in the case of severe drought.

Water supply infrastructure includes the Bon Tempe treatment plant, dams, tanks and other facilities for potable water storage, water pumps, compressors, aerators, pipelines, tunnels, water intake and overflow structures, and the buildings associated with this infrastructure.

MMWD lands also encompass nearly 100 miles of service roads and over 60 miles of maintained trails. All trails are open to hikers, and a small number are also open to horses. Bikes are restricted to service roads. All reservoir shorelines are accessible for fishing, but swimming is not allowed.

Visitor, administrative, operational, and historic facilities include Sky Oaks Watershed Headquarters, five ranger residences, buildings for storage and communication, boat ramps, picnic and parking areas, convenience stations, the Porteous Ranch log cabin, West Point Inn, and Marin Stables. The Federal Aviation Administration also has telecommunication buildings and lines, and there are power lines owned by Pacific Gas and Electric.

Most of land surrounding the Nicasio and Soulajule reservoirs to the north is privately owned and includes farms, ranches, and scattered rural residential development. Water supply infrastructure includes dams, pump stations, compressors, service roads, electrical lines, and one parking area at Soulajule Reservoir.

Access to these sites includes a mix of roads and trails. Not all of the roads that serve these two reservoirs are owned or managed by MMWD. At Nicasio Reservoir, the service roads located on MMWD lands are not accessible for public use, except for Point Reyes Petaluma Road. Some hiking trails are located on MMWD-owned lands adjacent to Nicasio Reservoir. The service roads adjacent to Soulajule Reservoir are used as hiking trails; however, no other official hiking trails are located on MMWD-owned land adjacent to Soulajule Reservoir.

Biodiversity and Resource Values

The San Francisco Bay Area is part of both nationally and internationally recognized biodiversity hotspots thanks to the region's Mediterranean climate, topographic diversity, and coastal and bay influences on its climate. Likewise, Mount Tamalpais' varied topography, elevations, and location near the coast in an important marine upwelling and convergence zone create a huge array of microclimates in a relatively small area.

Remarkably high levels of biological diversity are found across MMWD's lands on the mountain, and in particular among its plant communities. A wide range of soils, including harshly metallic serpentine, create unique niches for different plant communities and the wildlife that depend upon them. These plant communities support the many endemic, rare, and/or special-status species that are the focus of this report.

The total number of species within MMWD lands is unknown, but it includes over 1,000 species of vascular plants, over 200 species of lichens, and at least 400 species of vertebrate animals. Many more species of fungi, non-vascular plants, and invertebrates such as insects and other arthropods also live here.

Habitats within the watershed include (acreages are approximate):

- Hardwood forests - 5,500 acres
- Conifer forests (non-redwood) - 4,500 acres
- Redwood forests - 3,500 acres
- Serpentine chaparral - 2,000 acres
- Grasslands - 2,000 acres
- Oak woodland - 1,200 acres
- Chaparral (non-serpentine) - 500 acres
- Riparian woodland - 500 acres
- Shrubland (non-chaparral) - 500 acres
- Wetland - 40 acres

MMWD's knowledge of its natural resources comes from a combination of historic records, museum specimens, and field data from their extensive inventory and monitoring programs, which are conducted by a mix of researchers, consultants, MMWD staff, and skilled volunteers. To date, MMWD has systematically inventoried and described its terrestrial vascular flora (both at species and community scales), aquatic vegetation, lichens, and weeds. Monitoring programs are in place to detect changing conditions for resources of particular interest, including vegetation community structure and forest health.

Ecological Threats and Stressors

Mount Tamalpais' plant and animal communities are threatened by global climate change, altered fire regimes, invasive, non-native plants and animals, habitat fragmentation, plant diseases, noise, light, and air pollution, and other human impacts. These ecological stressors can directly result in the loss and degradation of habitats and negatively affect the size, range, and reproductive capacity of plants and wildlife. Interactions among these stressors (e.g., between climate change and fire frequency, or between fire and plant diseases) further compound their effects and make managing them much more challenging.

In general, altered fire regimes, climate change, and invasive plants are the primary threats to rare plant populations on MMWD lands.

Fire

Some plant species prefer open areas and/or depend on fire to reproduce; however, fire is difficult to implement as a management tool on MMWD lands. For some species, mechanical clearing is sufficient to stimulate germination, but others need the "cues" from a burn such as smoke or heat to sprout. Mount Tamalpais has not seen a large, stand-replacing fire for over 70 years due to fire suppression policies and practices. This lack of fire is resulting, in part, in the succession of grasslands to shrublands and woodlands, and of shrublands and woodlands to Douglas-fir (*Pseudotsuga menziesii*) dominated stands. Fire suppression is also hindering the regeneration of fire-dependent species such as Sargent cypress (*Cupressus sargentii*) and the rare Marin manzanita (*Arctostaphylos virgata*) (Edson et al., 2016).

Climate Change

Changes in temperature, precipitation, fog, and soil moisture may make future conditions inhospitable for certain plant species or even entire plant communities. In the long term, climate change will alter the basic physical conditions under which native plant communities on Mount Tamalpais evolved, forcing a gradual shift in their composition and distribution. This shift will likely be accelerated by short-term (episodic) disturbances such as fires and floods, which will become more frequent in a changing climate. The sensitivity of vegetation to climate change is heterogeneous and somewhat difficult to predict, but models for Marin County suggest an expansion of climate conditions suitable for more drought-tolerant species and communities, such as coastal sage scrub and chamise chaparral, as climatic water deficit increases (Ackerly et al., 2012; Micheli et al., 2016). Although increasing drought stress will affect some species more than others, it is still likely to become a major driver of plant populations. In particular, locally rare and extirpated species tend to favor to wet habitats and may be more impacted by drought stress. Changes in (i.e., reduction of) fog may likewise be detrimental to maritime chaparral species.

Invasive Species

The major threats posed by invasive species include changes in fire frequency or intensity, groundwater depletion, changes to soil chemistry, competition with native species, and a loss of native species diversity. Currently, about 30% of the known plant species on Mount Tamalpais are non-native (Edson et al., 2016). While all watershed lands face some degree of threat from invasive plant species, some are more resistant to invasion than others due to varying soil types, moisture levels, and canopy density. The harshly metallic soils found in serpentine habitats are particularly unwelcoming to many other plant species; however, goatgrass (*Aegilops triuncialis*) and purple false brome (*Brachypodium distachyon*) have invaded some areas. Dense stands of chaparral are relatively weed free as well. Nevertheless, most other plant communities, including those that support rare plant species, have been highly impacted by invasive weeds.

Other Threats

Depending on their location, some rare plant populations may also be threatened by trampling and by fuel break or road and trail maintenance or construction. Best management practices can help prevent damage to plants and habitat from this kind of work, but additional management and enforcement efforts are required to prevent visitors from constructing illegal trails and hiking off-trail through rare plant habitats. Sudden Oak Death (SOD) is another localized threat. Rare plants in forest habitats can be crushed by fallen SOD-killed trees, and their response to microclimate shifts (e.g., shade, water availability) caused by the resulting changes in the forest structure is unknown.

Specific threats to each rare plant species are further described in the individual species accounts in this report.

Marin Municipal Water District Rare Plants

Mount Tamalpais and its surrounding lands have been long recognized for their botanical uniqueness and numerous rare plant species. A rare plant survey for MMWD published in 1990 (Patterson) provided a thorough inventory of the locations, vulnerabilities, and needs of the watershed's rare, endangered, or sensitive species. It included a compilation of historic records, coordinated with available data and field surveys, and also offered insights on ecological relationships and potential management concerns.

Almost 30 years on, much more has been learned about the watershed's rare plants. Additional taxa and populations have been found and listed by the California Native Plant Society (CNPS), while others have winked out. Better tools for searching, gathering, and displaying data have been developed, and emerging threats such as SOD and climate change add stress to habitats and species already burdened by fire exclusion and invasive species.

The years since the 1990 report have also seen many efforts to restore and protect these precious populations. MMWD has conducted regular vegetation mapping and plant surveys—including a series of botanical "bioblitzes" (Williams et al., 2017)—to document the mountain's flora. They also do regular invasive species survey and management activities and have undertaken numerous projects to help protect and restore all of their important plant communities—and their rare plants in particular. These have included weed removal in priority grasslands, planting rare species, social trail rehabilitation, and targeted Douglas-fir removal.

This document serves to update the 1990 Patterson report with what has been learned through all of this work, providing a summary of each rare plant species' status, biology, and locations, as well as specific threats, data gaps, and management considerations. This updated inventory, based on data mining and five-plus field seasons of searches, aims to provide more current information as well as a comprehensive look at rare plants and their habitats on all of the lands MMWD stewards—including Nicasio and Soulajule. While borrowing heavily from the 1990 Patterson report, this document represents a fresh jumping-off point to direct management, monitoring, and additional research.

Rare Plants on Watershed Lands Today

MMWD lands contain up to 50 special status plant species within approximately 88 distinct plant assemblages as defined by the National Vegetation Classification System (Evens & Kentner, 2006). These communities include endemic species found nowhere else in the world such as the Mt. Tamalpais thistle (*Cirsium hydrophilum* var. *vaseyi*), Mt. Tamalpais manzanita (*Arctostaphylos montana* ssp. *montana*), Tamalpais and Mt. Tamalpais bristly jewel flowers (*Streptanthus batrachopus* and *S. glandulosus* ssp. *pulchellus*), and Tamalpais lessingia (*Lessingia micradenia* var. *micradenia*). Upwards of 20 of these assemblages are considered sensitive natural communities by the state.

Approximately 140 taxa were listed in the 1990 report as CNPS-listed rare species or of local concern. Of these, 36 of the 77 plants deemed "possible" have been found: 18 are currently locally rare, and one is a CNPS List 4.2 species. Only two of the 44 plants found in 1990 are no longer present: snowbrush (*Ceanothus velutinus*) and showy milkweed (*Asclepias speciosa*). All 24 of the listed plants present in 1990 are still present; 18 others of concern are not currently listed by CNPS or MMWD.

Rare plants are not evenly distributed across MMWD lands. Rather, they tend to be clustered in certain locations or habitat types—particularly serpentine areas, which contain approximately half of the watershed's rare species and 80 percent of sensitive species occurrences. Other areas that provide sensitive plant habitat include forests [for Napa false indigo (*Amorpha californica* var. *napensis*), California bottlebrush grass (*Elymus californicus*), and several non-green plants], moist shaded rocks [for coast rockcress (*Arabis blepharophylla*) and western leatherwood (*Dirca occidentalis*)], and meadows and grasslands [for Gairdner's yampah (*Perideridia gairdneri* ssp. *gairdneri*), harlequin lotus (*Hosackia gracilis*), johnny-nip (*Castilleja ambigua* var. *ambigua*), and fritillaries].

Locally rare plants cluster as well, although water is more of a driver for where these species live than serpentine soil is. Wet meadows and vernally moist sites (including reservoir drawdown zones), redwood-riparian, and coastally or fog-influenced forests and grasslands support over 90% of MMWD's locally rare plant populations. Rock outcrops support most of the others. Some rare plant clustering may be due to the relatively small total area of these habitat types, which are further shrinking as a result of succession and climate change impacts.

Rare natural communities, or sensitive communities, are ranked globally by NatureServe (Master et al., 2012) and sub-nationally (for the United States, at the state level) following the same methodology used by each respective region's Natural Heritage Division. The California Department of Fish and Wildlife serves this function for California, and maintains lists of Sensitive Natural Communities (https://www.wildlife.ca.gov/Data/VegCAMP/Natural-Communities). This methodology has changed since MMWD's 2009 Biodiversity Report (LCA) was written, and so ranking categories differ between that report and this one.

The vegetation communities listed in Table 1 below are based on landscape-scale vegetation mapping from 2004–2014 (acreages have not changed since 2004). This type of vegetation mapping lacks the precision necessary to delineate or characterize different herbaceous communities such as specific types of wetlands and grasslands, so they are not included in the table. In addition to the vegetation communities listed below, native grasslands and sedge-dominated wetlands (as described in the CNPS Manual of California Vegetation Online, http://vegetation.cnps.org/keys/herbs) also qualify as rare, and are treated as such in project and restoration planning. In particular, wet meadows are being targeted for additional weed removal and larger-scale restoration efforts. Grassland, wetland, seep, and riparian habitat inventories and mapping, as well as identification of restoration projects, are slated for within two years of the adoption of the District Biodiversity, Fire, and Fuels Integrated Plan (Panorama Environmental, 2019).

Table 1. Non-Herbaceous Rare Vegetation Communities

Note: Acreages may include multiple types (e.g., redwood forest)

Community	Mount Tamalpais Watershed Acreage	Soulajule Watershed Acreage	Nicasio Watershed Acreage	State Rank
Bishop Pine Forest	30	0	0	Vulnerable
California Buckeye Groves	12	0	0	Vulnerable
Douglas-fir-Tanoak Forest	47	0	0	Vulnerable
Golden Chinquapin Thickets (shrub alliance)	49	0	0	Imperiled
Mount Tamalpais Manzanita Chaparral	682	0	0.3	Imperiled
Oregon White Oak Woodland	6	0	0	Vulnerable
Redwood Forest	3,839	0	0	Vulnerable
Sargent Cypress Woodlands and Forests	338	0	0	Vulnerable
Sensitive Manzanita Alliance	87	0	0	Imperiled-Vulnerable

Some of these vegetation types overlap with, are proxy for, or are dominated by rare species. Maritime chaparral grows within the climatic influence of the coast and is dominated by manzanitas and ceanothus. It contains several vegetation types in addition to the Sensitive Manzanita Alliance, and includes rare Marin manzanita, glory brush (*Ceanothus gloriosus* var. *exaltatus*), and Mason's ceanothus (*Ceanothus masonii*). The combination of rare species and rare alliance mapping should be sufficient to fully encompass and protect these more broadly described vegetation types such as maritime chaparral and wet meadow.

Methods

Making the List

Any rare plant survey must begin with a comprehensive review of known, expected, potential, reported, and unlikely but possible species for the survey area. Mount Tamalpais is an exceptionally well-botanized area, with a long history easily explored through voucher specimens and literature (particularly Howell's *Marin Flora* 1970 and subsequent updates).

The CNPS's Inventory of Rare and Endangered Plants of California (http://www.rareplants.cnps.org) is the current recognized authority on rare plants in the state, and MMWD's list is based on these, as well as other sources and individual expertise. Additional casual observations, area lists, and directed searches have also been compiled by Calflora (https://www.calflora.org/), where one may easily obtain a documented list of all rare species growing in a particular county, watershed, public land parcel, or named location. Over the past several years, visitors, volunteers and staff have also compiled additional photo-supported observations in iNaturalist (https://www.inaturalist.org/).

Records from these websites were compared and combined with prior lists from the Patterson 1990 report, the Biodiversity Management Plan (LCA, 2009), and the Biodiversity, Fire, and Fuels Integrated Plan (Panorama Environmental, 2019) to form a 78-species list. This list was divided into: known present; suspected but unconfirmed; formerly present but extirpated; recorded but unlikely; and nearby but possible. The first two categories were the target of directed searches in likely habitats, as well as some of the historic sites, based on age and quality of the sighting (see Field Surveys section below). Additional species were excluded based on taxonomic clarification. See Tables 2 and 3 for the final list of 35 known and 30 potential rare plants on MMWD lands. Each of the 35 known rare plant species is further described in the Species Accounts section of this report.

While not the focus of this report, a separate list of locally rare plants was compiled to help target management and conservation. Also using Calflora and its accessory functionality through the California Native Plant Exchange (http://www.cnplx.info/nplx/nplx?page=rangelimit&cc=MRN), native species growing in one or fewer adjacent counties were selected. After screening the 272 resulting taxa for rare species, synonyms and unrecognized varieties, statewide distribution, and species not known or thought to be present on watershed lands, 19 known and 21 probable species remained.

Additional species were added after further examination, the primary criterion being three or fewer known populations on watershed lands. Species will be removed from the list as additional populations are found; as of this report, 206 taxa (including 15 CNPS-listed species) are thought to be locally rare (see Table 4).

Field Surveys

A blooming calendar, known and historic locations, and habitat preferences from the CNPS online inventory for likely or suspected species guided the timing and location of field surveys between 2012 and 2018. Surveyors used identification materials, maps, reel measuring tapes, notetaking materials, a GPS-enabled camera or mapping device, and binoculars to aid in searching and recording.

Depending on the species and population size and accessibility, the number of individuals were either counted or estimated and patch size was measured or estimated. Associated species and exposure were also recorded. Noticeable threats and disturbances were noted, and search areas were noted on a map or by GPS. Later surveys (2016–present) used the Avenza Maps app on iPads to take georeferenced PDF maps into the field and log survey tracks, annotate existing polygons, and take geotagged photos of species and locations.

Population Delineation and Enumeration

Enumerating and mapping occurrences in the field and in the office can lead to very different population estimates, depending on how sites are defined and characterized. For weed mapping, a standard "interpatch distance" has been employed: if two patches of the same species are more than 20 meters apart, they are considered separate occurrences and mapped separately. The California Natural Diversity Database (CNDDB) uses a quarter-mile distance: if two populations are more than a quarter-mile from each other, they are distinct element occurrences and tracked separately. If the number of occurrences (an appropriate metric for annuals and clonal species) is being tracked, the use of one standard over another may over- or under-estimate the abundance of the species.

The CNDDB standard was used to count occurrences for these surveys, but the interpatch distance of 20 meters was generally used for mapping, so a single occurrence could encompass multiple patches. When remapping existing populations, preference was given to conserving existing polygons rather than shrinking them, but expansions were always incorporated.

Rare Plant Species and Ranges

The 1990 Patterson Report represented the state of the knowledge of rare plants at the time; however, understanding of species' ranges and taxonomy have changed. The publication of *The Jepson Manual: Higher Plants of California* (Hickman, 1993) provided comprehensive accounts of taxa, their ranges, and identifying characteristics. Changing understanding of relationships provided by genetic studies drove much of the renaming and reordering of genera and families in the Second Edition (Baldwin et al., 2012) and subsequent alterations to the Jepson eFlora (http://ucjeps.berkeley.edu/eflora).

The Sixth Edition of the *California Native Plant Society's Inventory of Rare and Endangered Plants of California* (Tibor, 2001) added over 300 taxa to the list of CNPS-ranked rare plants, expanding the number of known species considered rare from 19 to 35 (not counting possibly present species). CNPS has also moved their inventory online to respond to continual changes in available information. The habitat preferences in the table below are taken from CNPS Inventory information and edited down to region-specific types in some cases.

While this report represents the state of the knowledge of rare plants on MMWD watershed lands in 2018, and in particular summarizes field work from 2012–2018, MMWD is also moving toward keeping much of its rare plant data digitally. Lists in the below tables are maintained for public use in Calflora, and site-specific information is maintained in a shared internal server system for MMWD staff and cooperators. However, periodic summary reports have utility even in a digital world, as a time to review status, trends, and habitat quality for rare plants in the watershed.

Table 2. Rare Plants Known to Occur on MMWD Lands

Notes: Scientific names, common names, and habitat notes from CNPS (http://rareplants.cnps.org, 2019).

Common Name Scientific Name	Listing Status			Life Form	Habitat Preferences
	Federal	State	California Rare Plant Rank		
Napa false indigo *Amorpha californica* var. *napensis*	-	-	1B.2	Perennial deciduous shrub	Broadleaved upland forest, chaparral, cismontane woodland; moist sites
Coast rockcress *Arabis blepharophylla*	-	-	4.3	Perennial herb	Broadleaved upland forest, coastal bluff scrub, coastal prairie, coastal scrub, rocky outcrops, serpentine barrens

Common Name Scientific Name	Listing Status Federal	 State	 California Rare Plant Rank	Life Form	Habitat Preferences
Mt. Tamalpais manzanita *Arctostaphylos montana* ssp. *montana*	-	-	1B.3	Perennial evergreen shrub	Chaparral, valley and foothill grassland, rocky serpentine slopes
Marin manzanita *Arctostaphylos virgata*	-	-	1B.2	Perennial evergreen shrub	Broadleaved upland forest, closed-cone conifer forest, chaparral, North Coast conifer forest; on sandstone or granitic soils
Carlotta Hall's lace fern *Aspidotis carlotta-halliae*	-	-	4.2	Perennial herb	Chaparral, cismontane woodland; generally on serpentine outcrops
Brewer's milk-vetch *Astragalus breweri*	-	-	4.2	Annual herb	Cismontane woodland, chaparral, valley and foothill grassland; usually associated with serpentinite or volcanic substrate
Serpentine reed grass *Calamagrostis ophitidis*	-	-	4.3	Perennial herb	Chaparral, lower montane conifer forest, meadows and seeps, valley and foothill grassland; on serpentine balds and in serpentine grasslands
Brewer's calandrinia *Calandrinia breweri*	-	-	4.2	Annual herb	Chaparral, coastal scrub; sandy or loamy soils; seen on disturbed sites and after fire
Oakland star-tulip *Calochortus umbellatus*	-	-	4.2	Perennial bulbiferous herb	Broadleaved upland forest, chaparral, cismontane woodland, lower montane conifer forest, valley and foothill grassland; often on serpentine
Pink star-tulip *Calochortus uniflorus*	-	-	4.2	Perennial bulbiferous herb	Coastal prairie, coastal scrub, meadows and seeps, North Coast coniferous forest
Mt. Saint Helena morning glory *Calystegia collina* ssp. *oxyphylla*	-	-	4.2	Perennial rhizomatous herb	Chaparral, lower montane conifer forest, valley and foothill grassland; on open serpentine slopes

Common Name Scientific Name	Listing Status Federal	 State	 California Rare Plant Rank	Life Form	Habitat Preferences
Johnny-nip *Castilleja ambigua* var. *ambigua*	-	-	4.2	Annual herb (hemiparasitic)	Coastal bluff scrub, coastal prairie, coastal scrub, marshes and swamps, valley and foothill grassland, vernal pool margins
Glory brush *Ceanothus gloriosus* var. *exaltatus*	-	-	4.3	Perennial evergreen shrub	Chaparral; sandy or rocky substrates
Mason's ceanothus *Ceanothus masonii*	-	Rare	1B.2	Perennial evergreen shrub	Chaparral; on rocky serpentine ridges or slopes in chaparral or transition zone between chaparral and woodland
Mt. Tamalpais thistle *Cirsium hydrophilum* var. *vaseyi*	-	-	1B.2	Perennial herb	Broadleaved upland forest, chaparral, cismontane woodland, meadows and seeps; in serpentine seeps
Baker's larkspur *Delphinium bakeri*	Endangered	Endangered	1B.1	Perennial herb	Broadleaved upland forest, coastal scrub, valley and foothill grassland; on decomposed shale, often mesic sites
Western leatherwood *Dirca occidentalis*	-	-	1B.2	Perennial deciduous shrub	Broadleaved upland forest, closed-cone conifer forest, chaparral, cismontane woodland, North Coast conifer forest, riparian forest and woodland; brushy slopes in mesic sites
California bottle-brush grass *Elymus californicus*	-	-	4.3	Perennial herb	Broadleaved upland forest, cismontane woodland, North Coast coniferous forest, riparian woodland
Tiburon buckwheat *Eriogonum luteolum* var. *caninum*	-	-	1B.2	Annual herb	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland; sandy to gravelly serpentine slopes
Marin checker lily *Fritillaria lanceolata* var. *tristulis*	-	-	1B.1	Perennial bulbiferous herb	Coastal bluff scrub, coastal prairie, coastal scrub

Common Name Scientific Name	Listing Status Federal	 State	 California Rare Plant Rank	Life Form	Habitat Preferences
Fragrant fritillary *Fritillaria liliacea*	-	-	1B.2	Perennial bulbiferous herb	Cismontane woodland, coastal prairie, coastal scrub, valley and foothill grassland; often on serpentine
Marin western flax *Hesperolinon congestum*	Threatened	Threatened	1B.1	Annual herb	Chaparral, valley and valley and foothill grassland; serpentine
Thin-lobed horkelia *Horkelia tenuiloba*	-	-	1B.2	Perennial herb	Broadleaved upland forest, chaparral, valley and foothill grassland; in sandy soils, mesic openings
Harlequin lotus *Hosackia gracilis*	-	-	4.2	Perennial rhizomatous herb	Moist/wet soils within numerous vegetation types
Coast iris *Iris longipetala*	-	-	4.2	Perennial rhizomatous herb	Coastal prairie, lower montane conifer forest, meadows and seeps
Small groundcone *Kopsiopsis hookeri*	-	-	2B.3	Perennial rhizomatous herb	North Coast coniferous forest, open woodland
Bristly leptosiphon *Leptosiphon acicularis*	-	-	4.2	Annual herb	Chaparral, cismontane woodland, coastal prairie, valley and foothill grasslands
Tamalpais lessingia *Lessingia micradenia* var. *micradenia*	-	-	1B.2	Annual herb	Chaparral, valley and foothill grassland; usually on serpentine, often roadsides
Marin County navarettia *Navarretia rosulata*	-	-	1B.2	Annual herb	Closed-cone conifer forest, chaparral; open, dry rocky slopes and grassy areas; rocky or serpentine soils
Gairdner's yampah *Perideridia gairdneri* ssp. *gairdneri*	-	-	4.2	Perennial herb	Broadleaved upland forest, chaparral, grasslands, vernal pools; vernally mesic soils
Tamalpais oak *Quercus parvula* var. *tamalpaisensis*	-	-	1B.3	Perennial evergreen shrub	Lower montane conifer forest understory
Sanford's arrowhead *Sagittaria sanfordii*	-	-	1B.2	perennial rhizomatous herb (emergent)	Marshes and swamps (assorted shallow freshwater)

Common Name Scientific Name	Listing Status Federal	 State	 California Rare Plant Rank	Life Form	Habitat Preferences
Tamalpais jewel flower *Streptanthus batrachopus*	-	-	1B.3	Annual herb	Closed-cone conifer forest, chaparral; serpentinite barrens
Mt. Tamalpais bristly jewel flower *Streptanthus glandulosus* var. *pulchellus*	-	-	1B.2	Annual herb	Chaparral, valley and foothill grassland; serpentinite
Marsh zigadenus *Toxicoscordion fontanum*	-	-	4.2	Perennial bulbiferous herb	Chaparral, cismontane woodland, lower montane conifer forest, meadows and seeps, marshes and swamps; in wet meadows and along streams, often on serpentinite

Rare plants with "potential to occur" on MMWD lands are a mix of historically present and regionally possible taxa. Some of these species are also on the "likely extirpated" list and may still be present in the soil seedbank but barring a wildfire or other major disturbance need not be on active search lists; others may simply be in difficult-to-search (deep forest) areas or ephemerally present in rarely searched spots. The current list of MMWD's extirpated species can be found at http://www.calflora.org/entry/plantlist.html#vrid=px557.

Table 3. Rare Plants with Potential to Occur on MMWD Lands

Common Name Scientific Name	Listing Status			Life Form	Habitat Preferences
	Federal	State	California Rare Plant Rank		
Bent-flowered fiddleneck *Amsinckia lunaris*	-	-	1B.2	Annual herb	Grasslands and woodlands
Thurber's reed grass *Calamagrostis crassiglumis*	-	-	2B.1	Perennial rhizomatous herb	Chaparral, lower montane conifer forest, meadows and seeps, valley and foothill grassland; on serpentine balds and in serpentine grasslands
Nicasio ceanothus *Ceanothus decornutus*	-	-	1B.2	Perennial evergreen shrub	Chaparral; on rocky serpentine ridges or slopes in chaparral or transition zone between chaparral and woodland
Glory brush *Ceanothus gloriosus* var. *gloriosus*	-	-	4.3	Perennial evergreen shrub	Chaparral; sandy or rocky substrates
California lady's-slipper *Cypripedium californicum*	-	-	4.2	Perennial rhizomatous herb	Broadleaved upland forest, chaparral, cismontane woodland, meadows and seeps; in serpentine seeps
Bluff wallflower *Erysimum concinnum*	-	-	1B.2	Annual or perennial herb	Coastal bluff scrub, coastal dunes, coastal prairie
San Francisco wallflower *Erysimum franciscanum*	-	-	4B.2	Perennial herb	Chaparral, coastal scrub, coastal dunes, valley and foothill grassland; on serpentinite or granitic soils
Large-flowered leptosiphon *Leptosiphon grandiflorus*	-	-	4.2	Annual herb	Cismontane woodland, coastal dunes and prairie, coastal scrub, valley and foothill grassland; often sandy areas

Common Name Scientific Name	Listing Status			Life Form	Habitat Preferences
	Federal	State	California Rare Plant Rank		
Blue coast gilia *Gilia capitata* ssp. *chamissonis*	-	-	1B.1	annual herb	Coastal dunes, coastal scrub
Woolly-headed gilia *Gilia capitata* ssp. *tomentosa*	-	-	1B.1	annual herb	Coastal bluff scrub, valley and foothill grassland
San Francisco gumplant *Grindelia hirsutula* var. *maritima*	-	-	3.2	perennial herb	Coastal bluff scrub, coastal scrub, valley and foothill grassland
Diablo helianthella *Helianthella castanea*	-	-	1B.2	perennial herb	Broadleafed upland forest, chaparral, cismontane woodland, coastal scrub, riparian woodland, valley and foothill grassland
Congested-headed hayfield tarplant *Hemizonia congesta* ssp. *congesta*	-	-	1B.2	annual herb	Valley and foothill grassland
Santa Cruz tarplant *Holocarpha macradenia*	Threatened	Endangered	1B.1	annual herb	Coastal prairie, coastal scrub, valley and foothill grassland
Large-flowered leptosiphon *Leptosiphon grandiflorus*	-	-	4.2	annual herb	Coastal bluff scrub, closed-cone coniferous forest, cismontane woodland, coastal dunes, coastal prairie, coastal scrub, valley and foothill grassland
Woolly-headed lessingia *Lessingia hololeuca*	-	-	3	annual herb	Broadleafed upland forest, coastal scrub, lower montane coniferous forest, valley and foothill grassland
Point Reyes meadowfoam *Limnanthes douglasii* ssp. *sulphurea*	-	Endangered	1B.2	annual herb	Coastal prairie, meadows and seeps (mesic), marshes and swamps (freshwater), vernal pools

Common Name Scientific Name	Listing Status			Life Form	Habitat Preferences
	Federal	State	California Rare Plant Rank		
Mt. Diablo cottonweed *Micropus amphibolus*	-	-	3.2	annual herb	Broadleafed upland forest, chaparral, cismontane woodland, valley and foothill grassland
Marsh microseris *Microseris paludosa*	-	-	1B.2	perennial herb	Closed-cone coniferous forest, cismontane woodland, coastal scrub, valley and foothill grassland
Baker's navarretia *Navarretia leucocephala* ssp. *bakeri*	-	-	1B.1	annual herb	Cismontane woodland, lower montane coniferous forest, meadows and seeps, valley and foothill grassland, vernal pools
White-rayed pentachaeta *Pentachaeta bellidiflora*	Endangered	Endangered	1B.1	annual herb	Cismontane woodland, valley and foothill grassland (often serpentinite)
California pinefoot *Pityopus californicus*	-	-	4.2	perennial herb (achlorophyllous)	Broadleafed upland forest, lower montane coniferous forest, North Coast coniferous forest, upper montane coniferous forest
North Coast semaphore grass *Pleuropogon hooverianus*	-	Threatened	1B.1	perennial rhizomatous herb	Broadleafed upland forest, meadows and seeps, North Coast coniferous forest
Nodding semaphore grass *Pleuropogon refractus*	-	-	4.2	perennial rhizomatous herb	Lower montane coniferous forest, meadows and seeps, North Coast coniferous forest, riparian forest
Lobb's aquatic buttercup *Ranunculus lobbii*	-	-	4.2	annual herb (aquatic)	Cismontane woodland, North Coast coniferous forest, valley and foothill grassland, vernal pools
Victor's gooseberry *Ribes victoris*	-	-	4.3	perennial deciduous shrub	Broadleafed upland forest, chaparral
Point Reyes checkerbloom *Sidalcea calycosa* ssp. *rhizomata*	-	-	1B.2	perennial rhizomatous herb	Marshes and swamps (freshwater, near coast)

Common Name Scientific Name	Listing Status			Life Form	Habitat Preferences
	Federal	State	California Rare Plant Rank		
Marin checkerbloom *Sidalcea hickmanii* ssp. *viridis*	-	-	1B.1	perennial herb	Chaparral (serpentinite)
Santa Cruz microseris *Stebbinsoseris decipiens*	-	-	1B.2	annual herb	Broadleafed upland forest, closed-cone coniferous forest, chaparral, coastal prairie, coastal scrub, valley and foothill grassland
Two-fork clover *Trifolium amoenum*	Endangered	-	1B.1	annual herb	coastal bluff scrub, valley and foothill grassland (sometimes serpentinite)

Species Accounts

The following species accounts detail the life history, status, trends, distribution, threats, and management concerns for each of the rare species listed in Table 2. They may be used as a quick reference for managers, pulled out as fact sheets or training aids in the field, or utilized to guide research needs.

General References for the Following Species Accounts

Calflora: Information on California plants for education, research and conservation. [web application]. Berkeley, California. The Calflora Database [a nonprofit organization]. Retrieved June 20–July 17, 2018, from https://www.calflora.org

California Native Plant Society (CNPS) online inventory. Retrieved March 2019 from https://www.cnps.org/

Jepson Flora Project (Eds.) *Jepson eFlora.* Retrieved June 20–July 17, 2018, from http://ucjeps.berkeley.edu/eflora/

iNaturalist. Retrieved June–July 17, 2018, from https://www.inaturalist.org/

Note: There are additional specific references listed within some of the following species accounts. A comprehensive list of all references used in this document is available at the end of this report.

FABACEAE

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NAME

Scientific Name	*Amorpha californica* Nutt. var. *napensis* Jeps.
Common Name	Napa false indigo
Synonyms	*Amorpha californica* var. *hispidula*
CNDDB Element Code	PDFAB08012
USDA PLANTS Symbol	AMCAN

http://www.rareplants.cnps.org/detail/1812.html

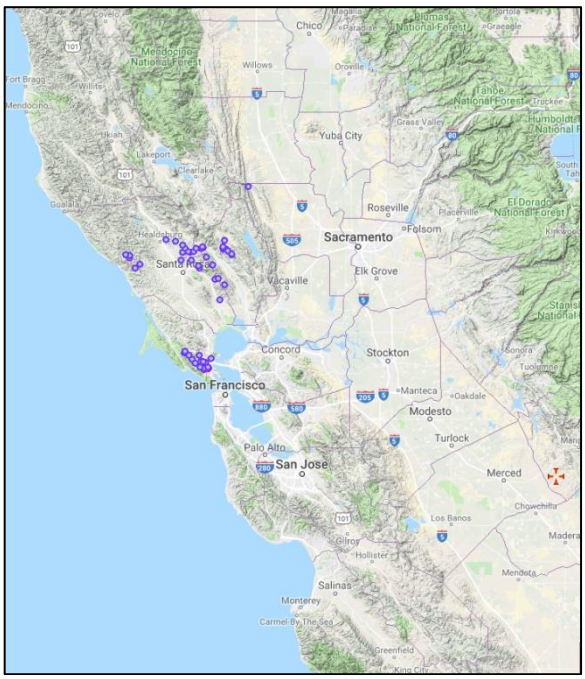
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2.** S2: Imperiled
Global Rank	**G4T2** T2: Imperiled. G4: (species) Apparently secure, considering populations outside California
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Perennial deciduous shrub, 1–3 m tall
Blooming Period	April–July
Habitat	Broadleafed upland forest (openings), chaparral, cismontane woodland

California distribution of Napa false indigo

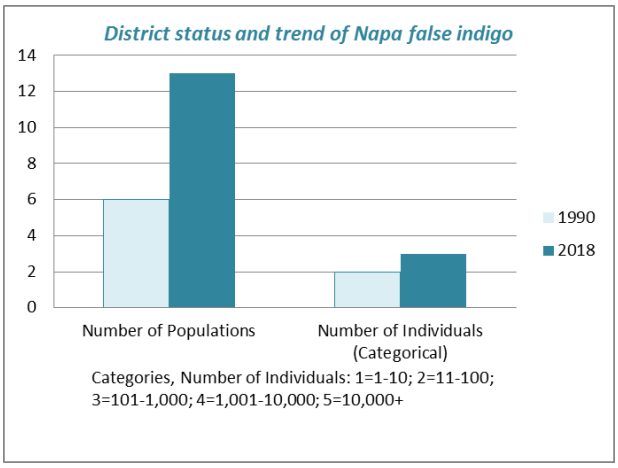


Global Distribution: This subspecies, while not as widely distributed as ssp. *californica*, can be found from Marin, Sonoma, and Napa to Santa Cruz counties.

Global Status: **Secure**. In 1990, Napa false indigo was not yet listed as a species of concern; it was placed on List 1B.2 in 2001. Its listing spurred additional mapping and nearly 70 populations are known, although some are threatened by the conversion of land to vineyards or other human use.

Local Distribution: The bulk of the populations occur around Kent Lake, but the plant may be found sporadically throughout watershed lands.

Local Status: **Secure.** This species appears to be relatively widespread, with patch sizes ranging from one to several dozen plants of various ages. It tolerates shade and sun, as well as some disturbance, and appears to do well in locations as disparate as the redwoods of Bolinas-Fairfax Road to the sunny hardwood forests of Eldridge Grade and Kent Lake's shore.



Data Gaps: Their tolerance to mowing at certain times of year is unknown. This should be explored as the abundance of roadside plants may create access issues.

Specific Threats and Management Recommendations: Roadside populations may be threatened by mowing. No management recommendations.

NAME

BRASSICACEAE

Scientific Name	*Arabis blepharophylla* H. & A.
Common Name	Coast rockcress
Synonyms	*Erysimum blepharophylla* Kuntze
CNDDB Element Code	PDBRA06040
USDA PLANTS Symbol	ARBL

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/182.html

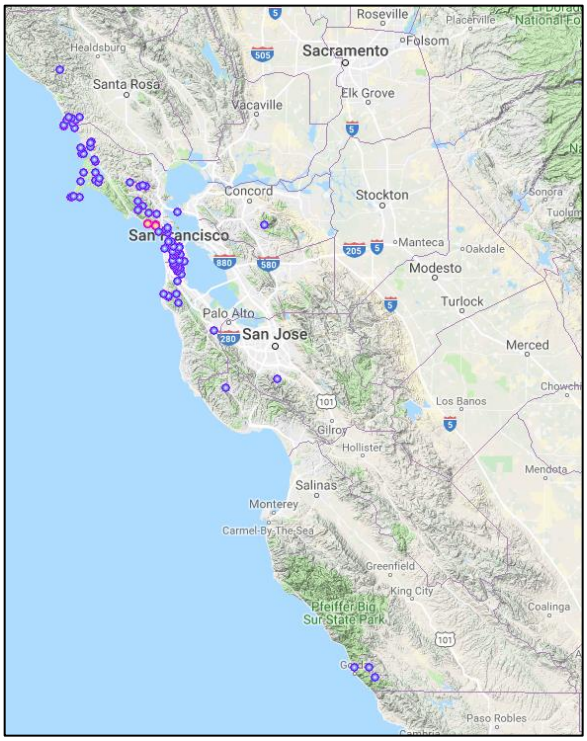
STATUS

Rare Plant Rank	**4.3**	**4:** Limited distribution in California **.3:** Not very endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S4**	S4: Apparently secure within California
Global Rank	**G4**	G4: Apparently secure, considering populations outside California
Watershed	**Vulnerable:** Populations are few but well-dispersed, not imminently threatened	

BIOLOGY

Lifeform	Perennial herb, 0.1–0.3 m tall
Blooming Period	February–May
Habitat	Rocky areas in broadleafed upland forest; coastal bluff, prairie, or scrub

California distribution of coast rock cress

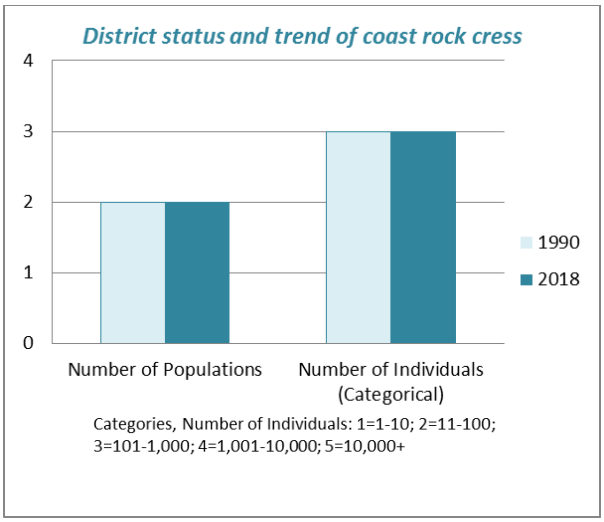


Global Distribution: This species is limited to the San Francisco Bay Area, except where it has been planted (cultivars are available from specialty growers).

Global Status: **Secure?** Because its ranking is at the lowest level of concern, populations are not tracked in a shared database such as the CNDDB. An estimated 50 populations have been found since 2000, and a dozen have been surveyed in Marin County, ranging in size from fewer than 10 to nearly 100 (Calflora, 2018).

Local Distribution: Only one historic population is extant on the watershed, downstream from Alpine Dam. Two others are extirpated, but an additional population was recently found.

Local Status: **Vulnerable.** Only two known populations exist, although they are not threatened by management. Additional searches of historic locations found no plants.



Data Gaps: Additional searches should be made in likely areas, and research should be done into propagation methods to establish new populations.

Specific Threats and Management Recommendations: Trampling and weed invasion may threaten the western population, and trail maintenance is a threat in the east. Climate change and Sudden Oak Death may also alter their habitat. MMWD should consider establishing additional populations at historic sites, as well as potentially on the slope north of Bullfrog Quarry or near the end of Alpine-Bon Tempe Pump Road.

NAME

ERICACEAE

Photo by MMWD, CC BY-NC 3.0

Scientific Name	*Arctostaphylos montana* Eastw. ssp. *montana*
Common Name	Mt. Tamalpais manzanita
Synonyms	*Arctostaphylos hookeri* ssp. *montana*, *Arctostaphylos montana*
CNDDB Element Code	PDERI040J5
USDA PLANTS Symbol	ARHOM

http://www.rareplants.cnps.org/detail/102.html

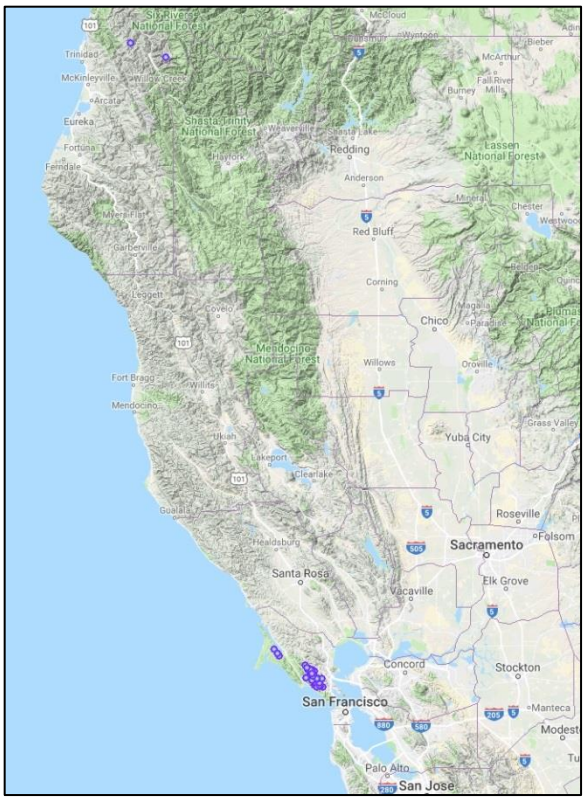
STATUS

Rare Plant Rank	**1B.3**	**1B:** Rare, threatened, or endangered in California and elsewhere **.3:** Not very endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S3**	S3: Vulnerable
Global Rank	**G3T3**	G3 (species): Vulnerable. T3: Vulnerable
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management	

BIOLOGY

Lifeform	Perennial evergreen shrub, 1–2 m tall
Blooming Period	February–April
Habitat	Chaparral, valley and foothill grassland; usually on serpentine

California distribution of Mt. Tamalpais manzanita

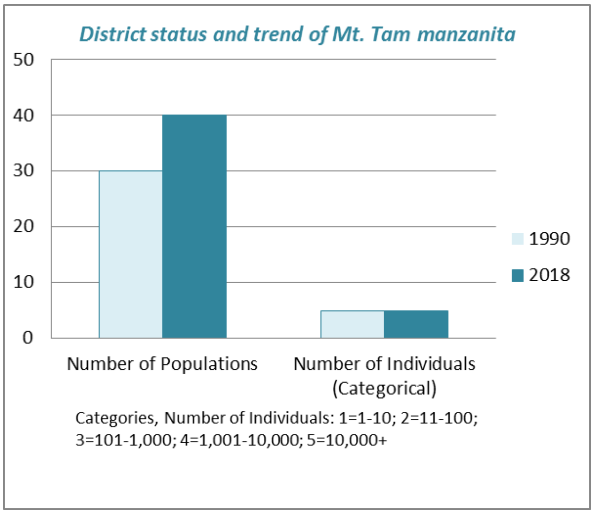


Global Distribution: This species is primarily found on watershed lands, although isolated patches are purported to grow along Inverness Ridge, in Lake County, and near French Camp Ridge and Trinity Summit in Humboldt County. While unlikely, the out-of-range populations are supported by herbarium specimens with recent determinations.

Global Status: **Vulnerable.** While often the dominant shrub where found, nearly the entire global population grows within a few thousand acres in Marin County.

Local Distribution: Common wherever serpentine is found on Mount Tamalpais watershed lands.

Local Status: **Secure.** This species is often the dominant shrub on serpentine. Its clonal, mounding nature makes counting individuals difficult, but populations are estimated at over 10,000 plants total on 2,400 acres.



Data Gaps: It is not known whether this species' physiological tolerances will be exceeded in a hotter and/or drier climate. DNA analysis of out-of-range plants would also help determine their relationship to "true" plants.

Specific Threats and Management Recommendations: Avoid mowing and road/trail grading through existing populations. Shrubs are low and can be passed over by regular fuel reduction work.

ERICACEAE

NAME

Scientific Name	*Arctostaphylos virgata* Eastw.
Common Name	Marin manzanita
Synonyms	*Arctostaphylos glandulosa* var. *virgata*, *Arctostaphylos columbiana* var. *virgata*
CNDDB Element Code	PDERI041K0
USDA PLANTS Symbol	ARVI3

Photo by David Greenberger, CC BY-NC-ND 4.0, via iNaturalist

http://www.rareplants.cnps.org/detail/110.html

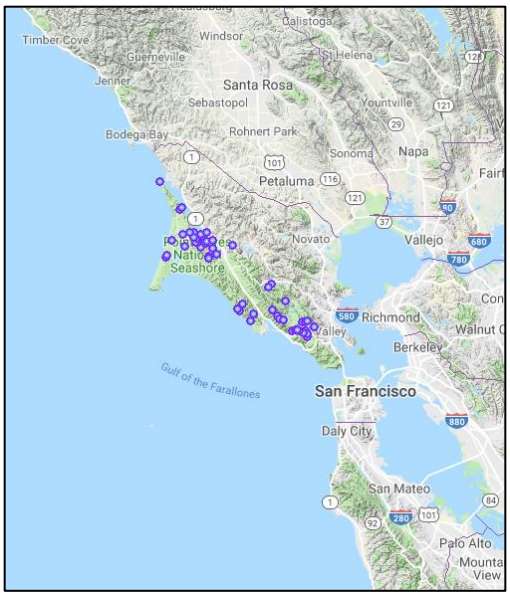
STATUS

Rare Plant Rank	**1B.2**	**1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S2**	S2: Imperiled
Global Rank	**G2**	G2: Imperiled
Watershed	**Imperiled:** This plant is close to extirpation on watershed lands	

BIOLOGY

Lifeform	Perennial evergreen shrub, 2–3 (5) m tall
Blooming Period	January–March
Habitat	Broadleafed upland forest, closed-cone coniferous forest, chaparral, North Coast coniferous forest

California distribution of Marin manzanita

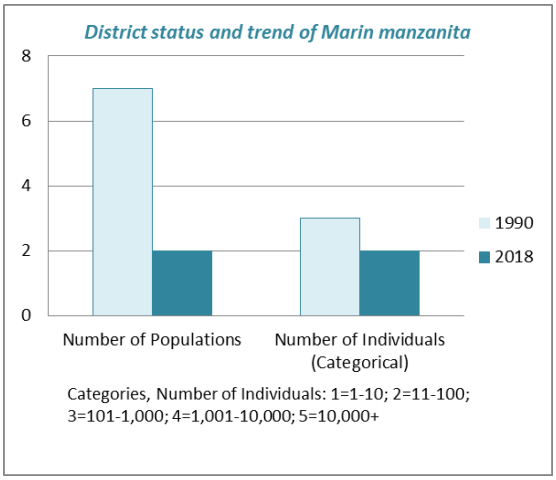


Global Distribution: This species is only found in Marin County, generally in forest gaps and chaparral within areas receiving four or more hours of fog on a regular basis (M. Vasey, personal communication, October 29 2016).

Global Status: **Declining.** Marin manzanita needs fire to reproduce and to keep Douglas-fir from shading out populations. Most of Marin has not burned in over 70 years, and many patches have disappeared. Populations that have burned, such as within the Vision Fire footprint, support many thousands of plants.

Local Distribution: Only two populations remain, both along a roadside where shading from Douglas-fir is not complete.

Local Status: **Imperiled.** Only two known population exist, and both are declining. Seeds from the Bolinas Ridge population were collected and banked with the Rancho Santa Ana Botanical Garden in 2015 as part of CNPS' Rare Plant Rescue Program for *ex situ* conservation of rare plants with few populations/restricted ranges.



Data Gaps: Research into propagation methods and techniques other than prescribed fire is needed.

Specific Threats and Management Recommendations: Shading and SOD are major concerns (Rooney-Latham et al. 2016). MMWD should consider applying prescribed fire to current or historic locations, reducing SOD spore load, removing competing Douglas-fir, and protecting plants from mowing.

Additional References:

Rooney-Latham, S., Blomquist, C. L., Williams, A., Gunnison, E., & Pastalka, T. (2016, June). *Identification of Five New Hosts of* Phytophthora ramorum *in an Infested Forest in California.* Proceedings of the Sixth Sudden Oak Death Science Symposium, San Francisco, California. Retrieved from https://www.fs.fed.us/psw/publications/documents/psw_gtr255/psw_gtr255_083.pdf

NAME

PTERIDACEAE

Scientific Name	*Aspidotis carlotta-halliae* (Wagn. & Gilb.) Lellinger
Common Name	Carlotta Hall's lace fern
Synonyms	*Cheilanthes carlotta-halliae*
CNDDB Element Code	PPADI07020
USDA PLANTS Symbol	ASCA17

Photo by John Game, CC BY-NC 3.0, via CalPhotos

http://www.rareplants.cnps.org/detail/1576.html

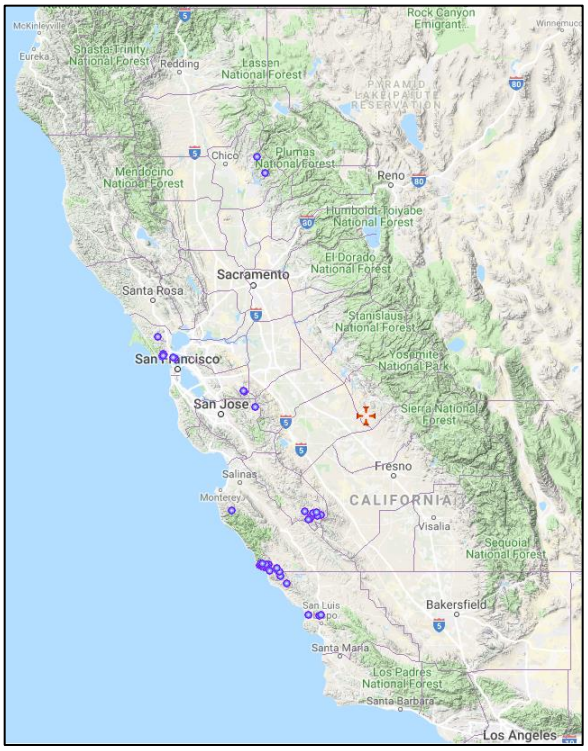
STATUS

Rare Plant Rank	**4.2**	**4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S3**	S3: Vulnerable
Global Rank	**G3**	G3: Vulnerable
Watershed	**Unknown:** Populations are not well-mapped; plants difficult to tell from closely related species	

BIOLOGY

Lifeform	Perennial rhizomatous herb, 0.04–0.1 m tall
Blooming Period	January–December
Habitat	Chaparral, cismontane woodland

California distribution of Carlotta Hall's lace fern



Global Distribution: This species has a fairly broad but sparse distribution and can be presumed to occur where the parent species (*Aspidotis densa, A. californica*) overlap.

Global Status: **Secure?** Carlotta Hall's lace fern is not tracked in CNDDB, but records from Calflora show nearly 100 populations, 27 of which are from within the last 20 years.

Local Distribution: As with the Global Distribution, this taxon can be presumed to occur where the parent species overlap. However, *A. californica* has only been found in three locations on watershed lands.

Local Status: **Unknown.** Plants are difficult to tell from closely related species, and exhaustive searches have not been made.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Additional populations, if any, should be located and mapped. Likely spore travel distance in this or related ferns should be further researched.

Specific Threats and Management Recommendations: Protect known sites from damage by mowers or climbers.

NAME

FABACEAE

Scientific Name	*Astragalus breweri* Gray
Common Name	Brewer's milk-vetch
Synonyms	*Tragacantha breweri* Kuntze
CNDDB Element Code	PDFAB0F1J0
USDA PLANTS Symbol	ASBR8

Photo by David Greenberger, CC BY-NC-ND 4.0, via iNaturalist

http://www.rareplants.cnps.org/detail/297.html

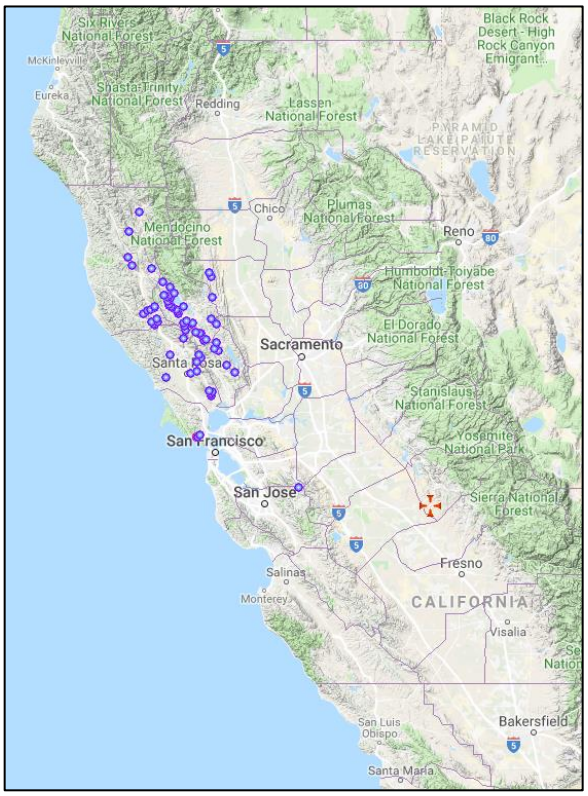
STATUS

Rare Plant Rank	**4.2**	**4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S3**	S3: Vulnerable
Global Rank	**G3**	G3: Vulnerable
Watershed	**Vulnerable:** Populations are not well-dispersed, not imminently threatened	

BIOLOGY

Lifeform	Annual herb, 0.1–0.3 m tall
Blooming Period	April–June
Habitat	Chaparral, cismontane woodland, meadows and seeps, valley and foothill grassland (open, often gravelly)

California distribution of Brewer's milk-vetch

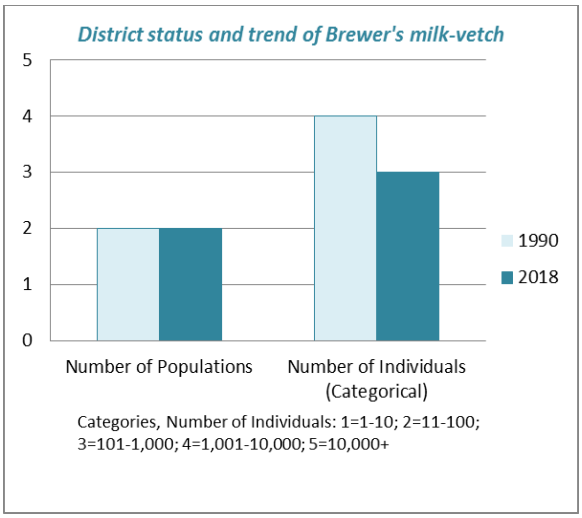


Global Distribution: This species can be found in the North Coast Ranges from Mendocino County south to the San Francisco Bay Area.

Global Status: **Vulnerable?** Brewer's milk-vetch is not tracked in CNDDB, but records from Calflora show well over 100 populations. Only 14 of these are from within the last 20 years, and many on private property are vulnerable to development and other land use changes.

Local Distribution: Known populations are limited to the Rock Spring area; a population from Pine Mountain found in the 1990 Patterson report was not rediscovered, but an additional site was found between Rock Spring and Laurel Dell.

Local Status: **Vulnerable.** Populations are not well-dispersed, but they are not imminently threatened; their serpentine habitat keeps them buffered from most non-native species invasions.



Data Gaps: Plants in Marin County are more purple-flowered than the cream-colored varieties found elsewhere; genetic testing would help determine the relationship between disjunct Marin populations and those up north as well as closely related *A. gambelianus'* purported variety "var. *elmeri*." Pine Mountain and other populations should be searched for again.

Specific Threats and Management Recommendations: Remove any encroaching Douglas-fir and any invading plant species. Also avoid constructing firelines through populations.

POACEAE

NAME

Scientific Name	*Calamagrostis ophitidis* (J.T. Howell) Nygren
Common Name	Serpentine reed grass
Synonyms	*Calamagrostis purpurascens* R. Br. var. *ophitidis* J.T. Howell *Calamagrostis foliosa* var. *ophitidis* J.T. Howell
CNDDB Element Code	PMPOA170V0
USDA PLANTS Symbol	CAOP2

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/372.html

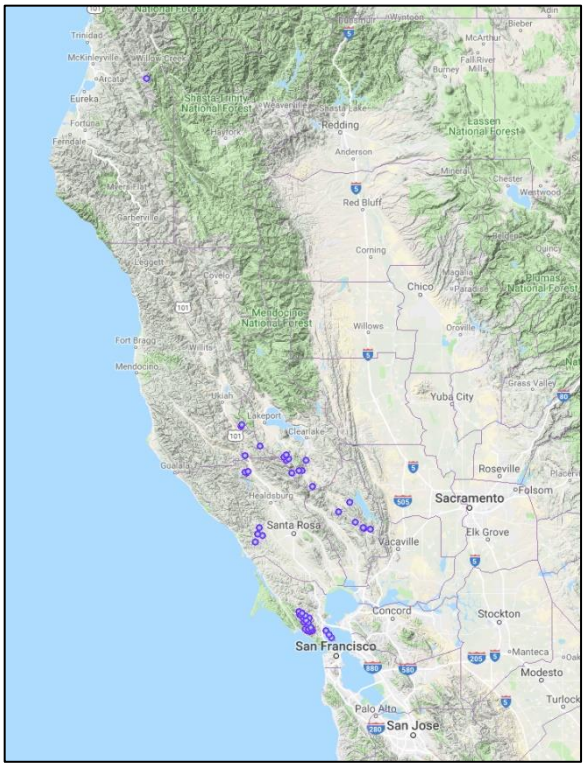
STATUS

Rare Plant Rank	**4.3**	**4:** Limited distribution in California **.3:** Not very endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S3**	S3: Vulnerable
Global Rank	**G3**	G3: Vulnerable
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management	

BIOLOGY

Lifeform	Perennial herb, 1–2 m tall
Blooming Period	April–July
Habitat	Chaparral (open, often north-facing slopes), lower montane coniferous forest, meadows and seeps, valley and foothill grassland

California distribution of serpentine reed grass

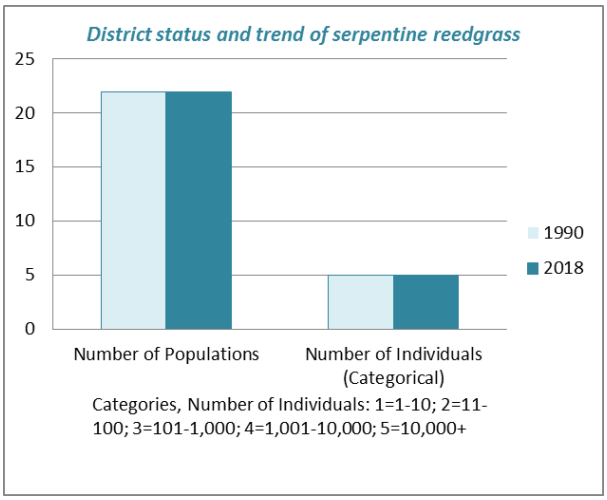


Global Distribution: Serpentine reedgrass can be found outside Marin County in Sonoma, Mendocino, Napa and Lake counties, although the most concentrated numbers can be found on watershed lands.

Global Status: **Vulnerable?** Serpentine reedgrass is not tracked in CNDDB, but records from Calflora show around 80 populations. Only eight of the populations outside of Marin are from within the last 20 years, and many on private property are vulnerable to development and other land use changes.

Local Distribution: Common along the ecotone between serpentine grassland and chaparral on watershed lands, occasionally in interstices of shrubs.

Local Status: **Secure.** This species is common on serpentine. Its clumping nature makes counting individuals difficult, and its abundance makes it unnecessary, but the total population is estimated at over 10,000 plants.



Data Gaps: Populations are not well-mapped due to its lower rarity ranking and local abundance. Areas of serpentine reedgrass grassland—the rare plant community, not just the species—should be mapped and submitted to CNDDB. MMWD should monitor long-term successional changes to assess impact on populations.

Specific Threats and Management Recommendations: Avoid constructing trails, roads, or firelines through populations.

NAME

MONTIACEAE

Scientific Name	*Calandrinia breweri* Wats.
Common Name	Brewer's calandrinia
Synonyms	None
CNDDB Element Code	PDPOR01020
USDA PLANTS Symbol	CABR3

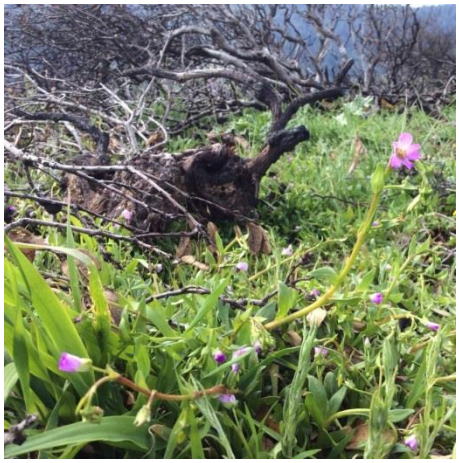


Photo by 2018 Hunter Breck, used by permission, via Calflora

http://www.rareplants.cnps.org/detail/1800.html

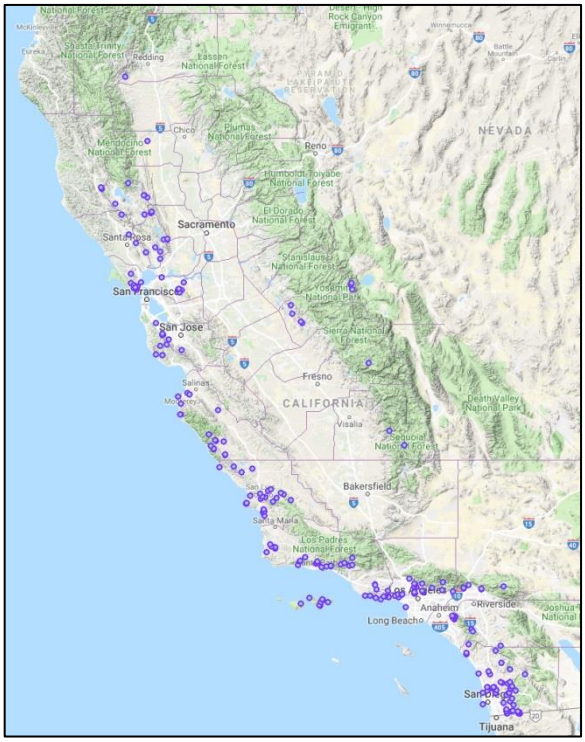
STATUS

Rare Plant Rank	**4.2**	**4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S4**	S4: Apparently secure in California
Global Rank	**G4**	G4: Apparently secure, considering populations outside California
Watershed	**Vulnerable:** Populations are few in number, but not imminently threatened	

BIOLOGY

Lifeform	Annual herb, 0.03–0.3 m tall
Blooming Period	(January) March–June
Habitat	Chaparral, coastal scrub

California distribution of Brewer's calandrinia



Global Distribution: Brewer's calandrinia can be found throughout California and into Mexico, generally on sandstone chaparral and in areas that have been recently burned.

Global Status: **Secure.** This species is common in burned areas, and burns are becoming more frequent. Of the hundreds of observations, about half are from within the past 20 years.

Local Distribution: This species was documented from herbarium specimens until the late 1940s, but other than one sighting near or on Blithedale Open Space Preserve, it was not found until 2013. In the last five years it has been seen around the peaks, on Rocky Ridge, and within the 2017 Pine Fire burn on Pine Mountain.

Local Status: **Vulnerable.** Populations are few in number, but not imminently threatened. If fire activity increases, more plants will likely emerge from the seed bank.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Population locations are not well known and are not likely to be seen unless fire or major disturbance occurs.

Specific Threats and Management Recommendations: If populations do emerge, they should be allowed to set seed. Postfire recovery should avoid mulching unless there is strong erosion potential from high fire severity and steep slopes.

NAME

LILIACEAE

Scientific Name	*Calochortus umbellatus* A.W. Wood
Common Name	Oakland star-tulip
Synonyms	*Calochortus collinus* Lemmon
CNDDB Element Code	PMLIL0D1E0
USDA PLANTS Symbol	CAUM

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/55.html

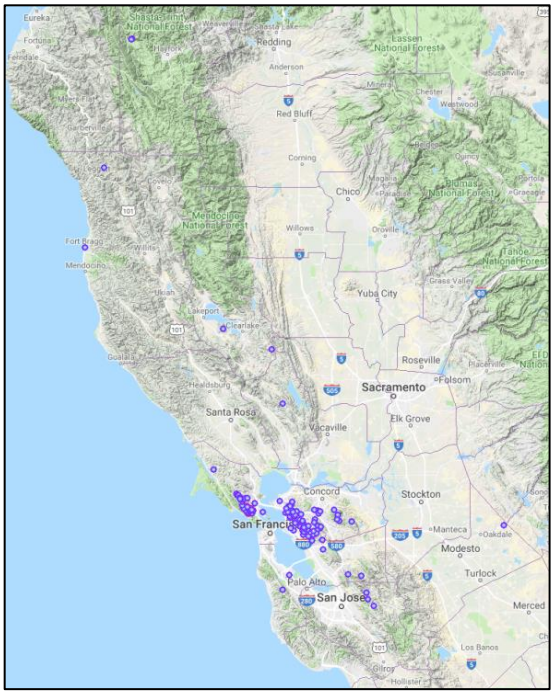
STATUS

Rare Plant Rank	**4.2**	**4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S3?**	S3: Vulnerable
Global Rank	**G3?**	G3: Vulnerable
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management	

BIOLOGY

Lifeform	Perennial bulbiferous herb, 0.06–0.3 m tall
Blooming Period	March–May
Habitat	Broadleafed upland forest, chaparral, cismontane woodland, lower montane coniferous forest, valley and foothill grassland

California distribution of Oakland star-tulip

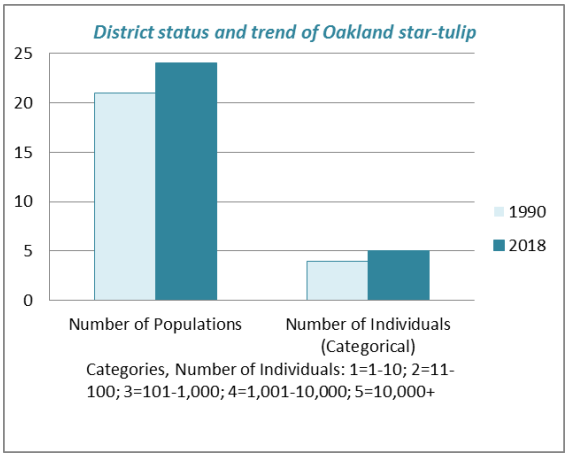


Global Distribution: Oakland star-tulip is generally found in Marin County and the East Bay Area, but also south to Santa Clara and San Mateo counties. Scattered plants have been reported from Lake and Mendocino counties as well. This bulbiferous herb grows mainly on serpentine, from barrens and grasslands to chaparral edges and interstices.

Global Status: **Vulnerable.** The core of this species' population is on MMWD and East Bay Regional Park protected lands, where it is common, but outside these areas populations are isolated and could be extirpated. Of the hundreds of observations, about 50 are from within the past 20 years.

Local Distribution: Common in serpentine grassland, barrens, and chaparral, often at chaparral ecotone or in interstices of shrubs, on watershed lands.

Local Status: **Secure.** This species is common on serpentine. Its variability in emergence—whole populations failed to emerge in 2014–2015 but were in the hundreds to thousands in 2017–2018—can make tracking numbers difficult. However, the total population is estimated at over 10,000 plants in a couple dozen locations.



Data Gaps: Varying emergence would be interesting to study, but not essential.

Specific Threats and Management Recommendations: Trails should not be routed through populations.

NAME

LILIACEAE

Scientific Name	*Calochortus uniflorus* Hook & Arn.
Common Name	Pink star-tulip
Synonyms	None
CNDDB Element Code	PMLIL0D1F0
USDA PLANTS Symbol	CAUN

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/3394.html

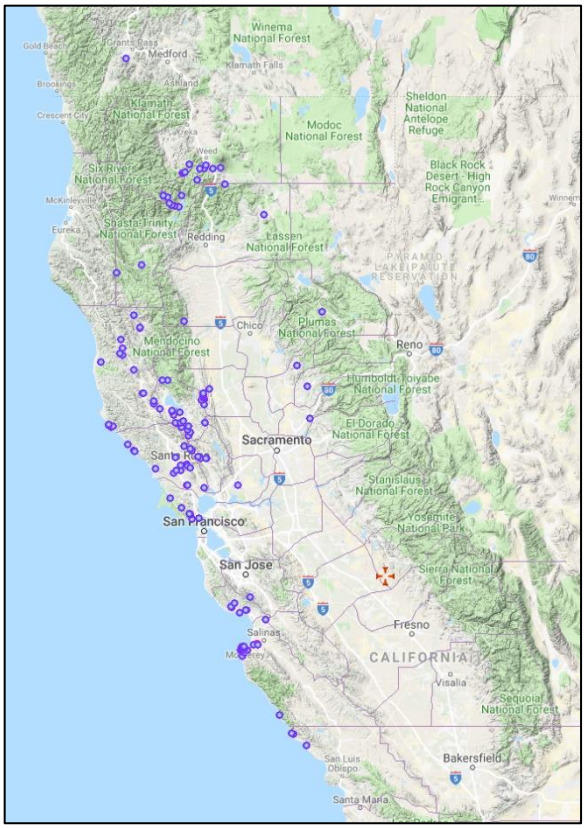
STATUS

Rare Plant Rank	**4.2**	**4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S4**	S4: Apparently secure within California
Global Rank	**G4**	G4: Apparently secure, considering populations outside California
Watershed	**Vulnerable:** Populations are not well-dispersed, not imminently threatened	

BIOLOGY

Lifeform	Perennial bulbiferous herb, 0.05–0.1 m tall
Blooming Period	April–June
Habitat	Coastal prairie, coastal scrub, meadows and seeps, North Coast coniferous forest

California and Oregon distribution of pink star-tulip

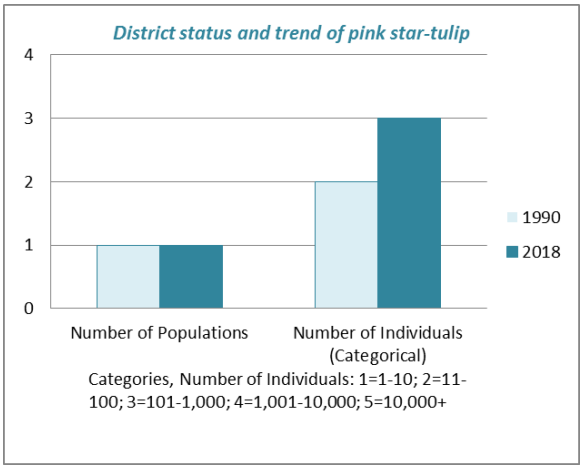


Global Distribution: Pink star-tulip can be found throughout California and into Oregon, generally in wet grasslands and meadows.

Global Status: **Secure?** This species is broadly distributed, and its bulbiferous nature allows it to wait out bad years underground, but overall water availability and grassland habitat are declining. Of the hundreds of observations, about 30 are from within the past 20 years.

Local Distribution: This species only grows at one location; a purported second population has not been found.

Local Status: **Vulnerable.** Only one population is known to occur in the watershed, but it is not imminently threatened.



Data Gaps: Propagation or transplant methods would be useful to know for establishing additional populations.

Specific Threats and Management Recommendations: Protect the existing site and establish additional populations at the two other major wet meadows.

NAME

CONVOLVULACEAE

Scientific Name	*Calystegia collina* (Greene) *Brummitt* ssp. *oxyphylla* Brummitt
Common Name	Mt. Saint Helena morning glory
Synonyms	None
CNDDB Element Code	PDCON04032
USDA PLANTS Symbol	CACOO

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/63.html

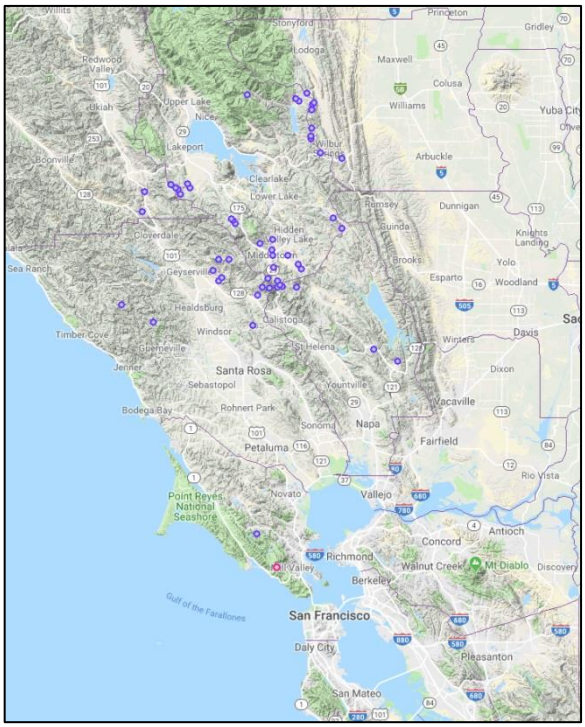
STATUS

Rare Plant Rank	**4.2** **4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S3** S3: Vulnerable
Global Rank	**G4T3** T3: Vulnerable G4: (species) Apparently secure, considering populations outside California
Watershed	**Unknown:** Populations are not well-mapped; plants are difficult to tell from closely related species

BIOLOGY

Lifeform	Perennial rhizomatous herb, 0.05–0.1 m tall
Blooming Period	April–June
Habitat	Chaparral, lower montane coniferous forest, valley and foothill grassland

California distribution of Mt. Saint Helena morning glory



Global Distribution: Mt. Saint Helena morning glory can be found outside Marin County in Sonoma, Mendocino, Napa and Lake counties, with the main population in Lake County.

Global Status: **Vulnerable.** While many populations exist, most have been found roadside and on unprotected lands, where they are susceptible to damage. Of the dozens of observations, about 20 are from within the past 20 years.

Local Distribution: This species may grow on several areas of serpentine, and purported populations have been mapped across watershed lands.

Local Status: **Unknown.** A few populations have been noted from watershed lands, but it is difficult to separate this subspecies from the more common subspecies.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Genetic studies along with morphological data are needed to determine the taxonomy of the *Calystegia collina* complex (Namoff, 2018). The current key separates these by leaf morphology, which varies in the field depending on site conditions.

Specific Threats and Management Recommendations: Genetic study to understand the subspecies and potential hybrid relationships will help guide management. Current populations will be protected by existing mechanisms along with the suite of serpentine endemics.

Additional References:

Namoff, S. (2018, February). *Taxonomic realignment of* Calystegia *(Convolvulaceae) in California.* Presented at the CNPS Conservation Conference, Los Angeles, CA.

OROBANCHACEAE

NAME

Scientific Name	*Castilleja ambigua* Hook. & Arn. var. *ambigua*
Common Name	Johnny-nip
Synonyms	*Castilleja ambigua* ssp. *ambigua*
CNDDB Element Code	PDSCR0D401
USDA PLANTS Symbol	CAAMA3

Photo by Vernon Smith, CC BY-NC 3.0, via CalPhotos

http://www.rareplants.cnps.org/detail/3361.html

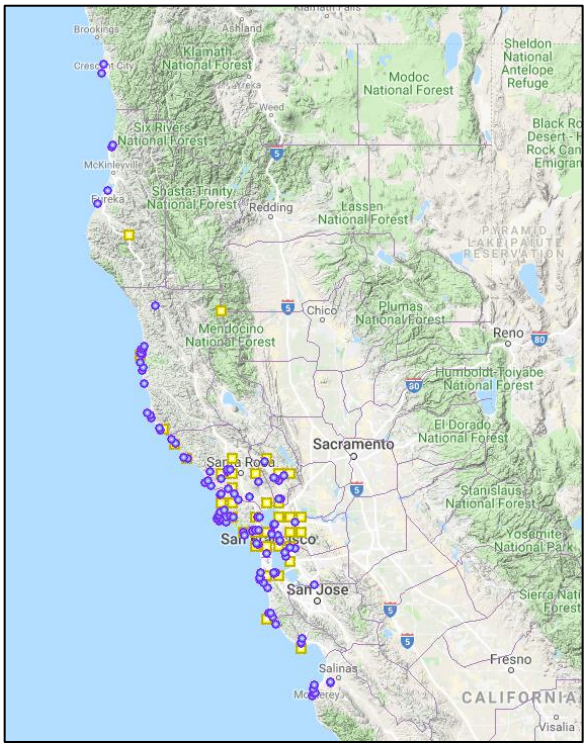
STATUS

Rare Plant Rank	**4.2** **4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S3S4** S4: Apparently secure in California S3: Vulnerable
Global Rank	**G4T5** T5: Secure, considering populations outside California G4: (species) Apparently secure, considering populations outside California
Watershed	**Vulnerable:** Populations are not well-dispersed, not imminently threatened

BIOLOGY

Lifeform	Annual herb (hemiparasitic), 0.05–0.2 m tall
Blooming Period	March–August
Habitat	Coastal bluff scrub, coastal prairie, coastal scrub, marshes and swamps, valley and foothill grassland, vernal pools margins

California distribution of johnny-nip



Global Distribution: Johnny-nip can be found throughout coastal California, and into the Sacramento Delta, generally in wet grasslands and marshes.

Global Status: **Secure?** This species is broadly distributed, but its wet-area habitats are declining and vulnerable to climate change. Of the hundred-plus observations, about 30 are from within the past 20 years.

Local Distribution: This species only grows at one location in the watershed.

Local Status: **Vulnerable.** Only one population is known from watershed lands. While individuals in this population number in the hundreds, there is annual variation. Nevertheless, it is not imminently threatened.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Johnny-nip is hemiparasitic; more knowledge about its host may help guide management and potential introductions at other wet meadow areas.

Specific Threats and Management Recommendations: Protect existing population site and consider introductions at other wet meadow areas.

NAME

RHAMNACEAE

Scientific Name	*Ceanothus gloriosus* J. Howell var. *exaltatus* J. Howell
Common Name	Glory brush
Synonyms	None
CNDDB Element Code	PDRHA040F4
USDA PLANTS Symbol	CEGLE

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/1867.html

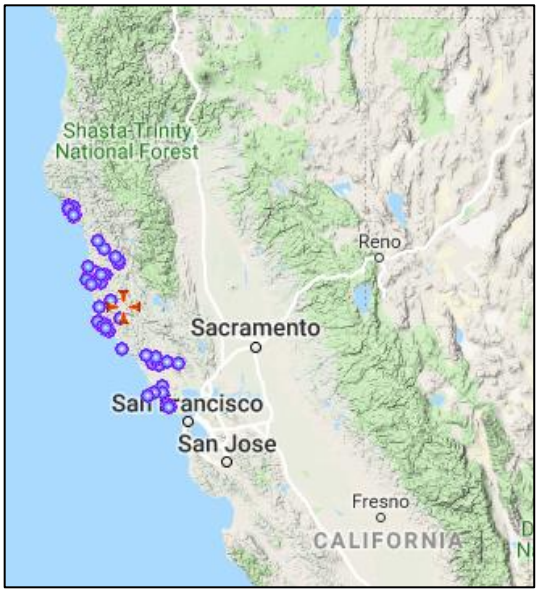
STATUS

Rare Plant Rank	**4.3** **4:** Limited distribution in California **.3:** Not very endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S4** S4: Apparently secure within California
Global Rank	**G4T4** T4: Apparently secure, considering populations outside California. G4: (species) Apparently secure, considering populations outside California
Watershed	**Imperiled:** This plant is close to extirpation on watershed lands

BIOLOGY

Lifeform	Perennial evergreen shrub, <2 m tall
Blooming Period	March–June (August)
Habitat	Chaparral

California distribution of glory brush



Global Distribution: This species can be found from Marin County north to Humboldt County, mainly in coastal areas in sandstone chaparral.

Global Status: **Secure.** Glory brush has a fairly broad range, with many populations on protected lands. Of the hundred-plus observations, about 10 are from within the past 20 years.

Local Distribution: This species only grows at one location on watershed lands.

Local Status: **Imperiled.** This plant is close to extirpation on watershed lands. Glory brush needs fire to germinate, and the last fire was over 70 years ago, which is close to the lifespan of individual plants.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: More information is needed on the genetic relationship to Mason's ceanothus (Hardig et al., 2000) and on germination requirements in the absence of fire.

Specific Threats and Management Recommendations: The lack of fire is a major concern for all maritime chaparral species. In addition, road maintenance may impact populations, but the current practice of flagging plants and training mowing staff to recognize rare ceanothus appears sufficient to prevent accidental cutting.

Additional References:

Hardig, T. M., Soltis, P. S., & Soltis, D. E. (2000). Diversification of the North American shrub genus *Ceanothus* (Rhamnaceae): Conflicting phylogenies from nuclear ribosomal DNA and chloroplast DNA. *American Journal of Botany, 87*(1), 108–123.

RHAMNACEAE

NAME

Scientific Name	*Ceanothus masonii* McMinn
Common Name	Mason's ceanothus
Synonyms	*Ceanothus rigidus* Nutt.
CNDDB Element Code	PDRHA04200
USDA PLANTS Symbol	CEMA3

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/214.html

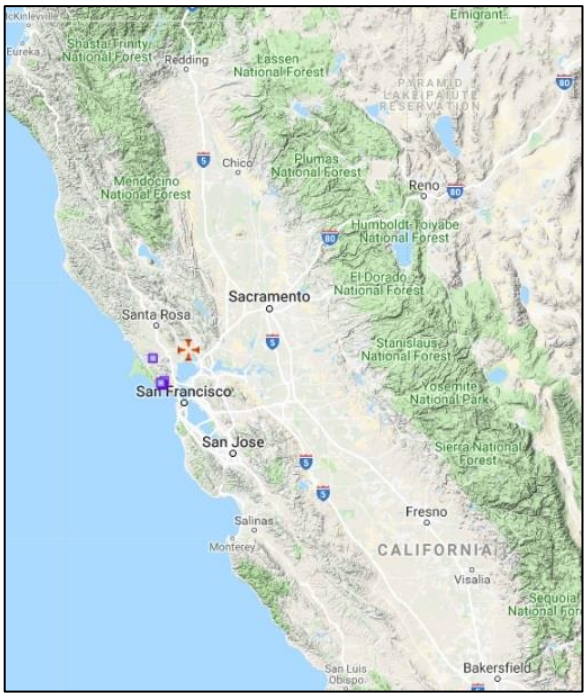
STATUS

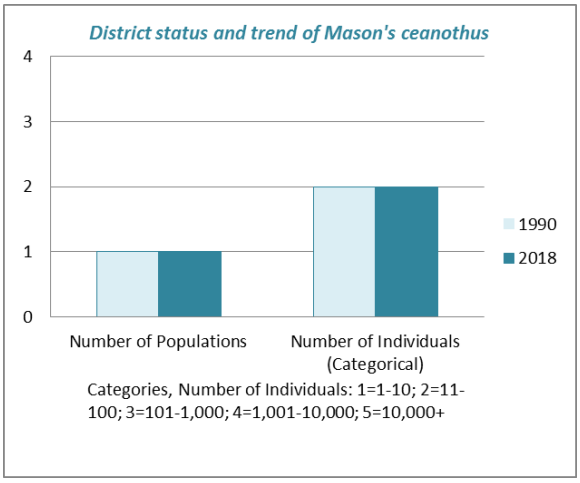
Rare Plant Rank	**1B.2**	**1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**CR**	CR: Rare
Federal Listing Status	**Not Listed**	
State Rank	**S1**	S1: Critically Imperiled
Global Rank	**G1**	G1: Critically Imperiled
Watershed	**Imperiled:** This plant is close to extirpation on watershed lands	

BIOLOGY

Lifeform	Perennial evergreen shrub, <2 m tall
Blooming Period	March–April
Habitat	Chaparral (openings, rocky)

California distribution of Mason's ceanothus





Global Distribution: This species can only be found in Marin County, mainly in sandstone chaparral.

Global Status: **Imperiled.** This plant is close to extirpation; its two main populations (southern and northern Marin) suffer from fire suppression.

Local Distribution: This species only grows at one location in the watershed.

Local Status: **Imperiled.** This plant is close to extirpation on watershed lands. Mason's ceanothus needs fire to germinate, and the last fire was over 70 years ago—approaching the lifespan of individual plants. The taxon, likely of hybrid origin, may also become less of a distinct entity due to back-crossing with one or both of the parent taxa (probably glory brush and buckbrush [*C. ramulosus*]).

Data Gaps: More information is needed on the genetic relationship of Mason's ceanothus to glory brush and other ceanothus to determine hybridization (Hardig et al. 2000). Additional research is also needed on the germination requirements in the absence of fire.

Specific Threats and Management Recommendations: The lack of fire is a major concern for all maritime chaparral species. Road maintenance may impact populations, but the current practice of flagging plants and training mowing staff to recognize rare ceanothus appears sufficient to prevent accidental cutting.

Additional References:

Hardig, T. M., Soltis, P. S., & Soltis, D. E. (2000). Diversification of the North American shrub genus *Ceanothus* (Rhamnaceae): Conflicting phylogenies from nuclear ribosomal DNA and chloroplast DNA. *American Journal of Botany*, *87*(1), 108–123.

NAME

ASTERACEAE

Scientific Name	*Cirsium hydrophilum* (Greene) Jeps. var. *vaseyi* (Gray) J.T. Howell
Common Name	Mt. Tamalpais thistle
Synonyms	*Cirsium vaseyi* Jeps. var. *hydrophilum* Jeps.
CNDDB Element Code	PDAST2E1G2
USDA PLANTS Symbol	CIHYV

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/486.html

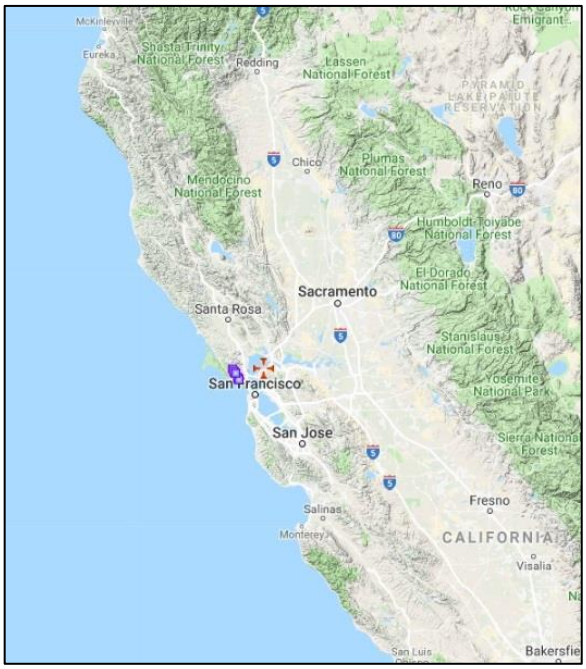
STATUS

Rare Plant Rank	**1B.2**	**1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S1**	S1: Critically Imperiled
Global Rank	**G2T1**	T1: Critically Imperiled. G2: (species) Imperiled
Watershed	**Threatened:** Populations are in decline and will disappear without intervention	

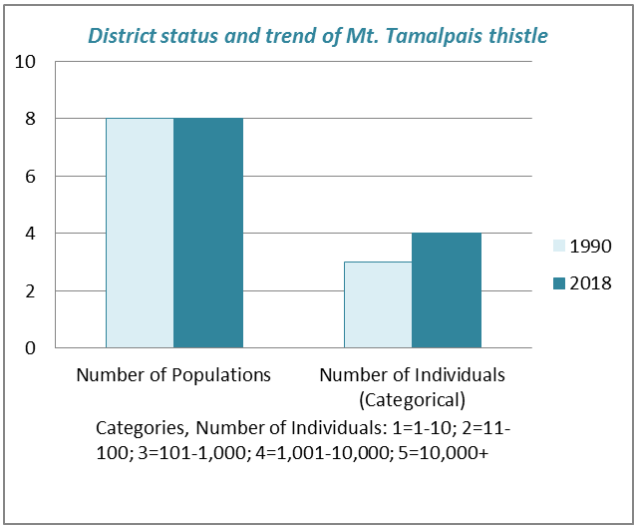
BIOLOGY

Lifeform	Perennial herb, 1–3 m tall
Blooming Period	May–August
Habitat	Broadleafed upland forest, chaparral, meadows and seeps

California distribution of Mt. Tamalpais thistle



report are extirpated and two additional populations have been found. Two recently outplanted sites are not included in numbers reported here.



Global Distribution: This species can only be found in Marin County, mainly in serpentine seeps and wetlands.

Global Status: **Imperiled.** This plant can only be found in southern Marin County. While nearly all the populations are on protected lands, its habitat requirements for moisture and disturbed ground for establishment put it at risk from climate change, invasive species, and natural vegetation succession.

Local Distribution: This species grows along the northwest-southeast seam of serpentine in the watershed.

Local Status: **Threatened.** While the total number of populations has remained steady, two populations from the 1990

Data Gaps: Further explore relationship to Suisun thistle to see if research on this more well-studied subspecies can be applied. Also do additional research into dispersal mechanisms, including whether this thistle has metapopulation dynamics, and under what circumstances population changes occur.

Specific Threats and Management Recommendations: This species should continue to be protected from mowing and road work, and habitat maintained (Douglas-fir and weeds removed). Two introduced populations should continue to be monitored, with lessons learned applied to additional plantings.

NAME

RANUNCULACEAE

Scientific Name	*Delphinium bakeri* Ewan
Common Name	Baker's larkspur
Synonyms	None
CNDDB Element Code	PDRAN0B050
USDA PLANTS Symbol	DEBA

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/550.html

STATUS

Rare Plant Rank	**1B.1**	**1B:** Rare, threatened, or endangered in California and elsewhere **.1:** Seriously endangered in California
State Listing Status	**CE**	CE: Endangered
Federal Listing Status	**FE**	FE: Endangered
State Rank	**S1**	S1: Critically Imperiled
Global Rank	**G1**	G1: Critically Imperiled
Watershed	**Imperiled:** This plant is close to extirpation on watershed lands	

BIOLOGY

Lifeform	Perennial herb, 0.2–1 m tall
Blooming Period	March–May
Habitat	Broadleafed upland forest, coastal scrub, valley and foothill grassland

California distribution of Baker's larkspur

Global Distribution: This species can only be found in Marin County. Sonoma populations are extirpated, and the populations thought to be present in Southern California were misidentifications.

Global Status: **Imperiled.** This plant is close to extinction; the single wild roadside population has fewer than a dozen plants. Outplanting at sites near the wild population has not been very successful, with few plants surviving and even fewer reproducing.

Local Distribution: Three populations were planted around Soulajule Reservoir in 2010–2011.

Local Status: **Imperiled.** This plant is close to extirpation. Although three populations were planted, one site has failed and the others have few plants. Additional plants will be introduced to the first site to boost population levels (Holly Forbes, email July 18, 2018 with Andrea Williams).

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: With only one wild population, the ideal habitat and survival requirements for this plant can only be poorly inferred. Additional work on preventing herbivory—particularly when the plants are reproducing—may be needed.

Specific Threats and Management Recommendations: Dead trees from SOD or other impacts have fallen in the Soulajule sites, but herbivory and climate variability seem the greatest threats. Continue to work on exclosure methods to prevent herbivory.

NAME

THYMELAEACEAE

Scientific Name	*Dirca occidentalis* Gray
Common Name	Western leatherwood
Synonyms	None
CNDDB Element Code	PDTHY03010
USDA PLANTS Symbol	DIOC3

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/567.html

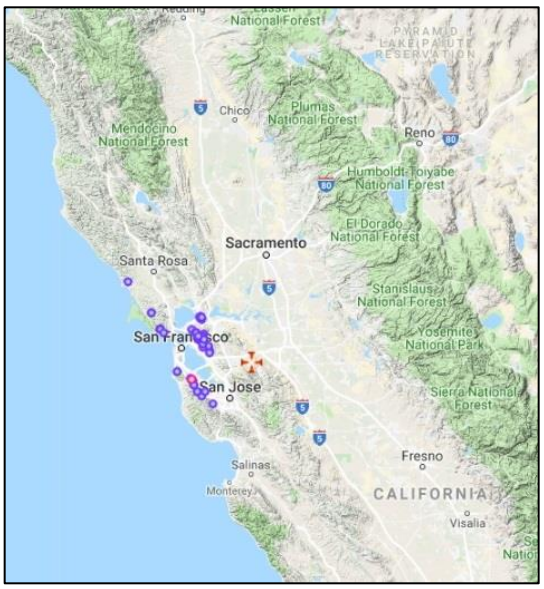
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G2** G2: Imperiled
Watershed	**Threatened:** Populations are in decline and will disappear without intervention

BIOLOGY

Lifeform	Perennial deciduous shrub 1–4 m tall
Blooming Period	January–March (April)
Habitat	Broadleafed upland forest, closed-cone coniferous forest, chaparral, cismontane woodland, North Coast coniferous forest, riparian forest, riparian woodland

California distribution of western leatherwood



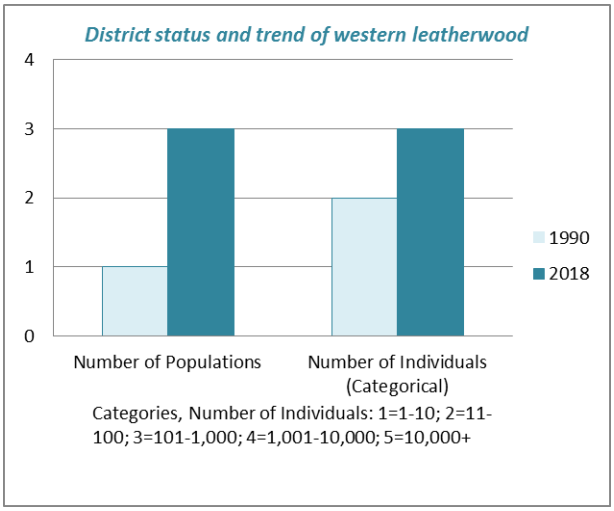
Global Distribution: This species is found almost exclusively in the San Francisco Bay Area, often in mesic sites on rocky greenstone-derived soils in partial shade.

Global Status: **Threatened.** Populations are in decline. In 1990 this plant was a CNPS List 4 (watchlist) species and has since been downgraded to a 1B.2 (fairly endangered), indicating its worsening status.

Local Distribution: Populations in the watershed grow in lower Lagunitas Creek, between Alpine and Peters Dams. More plants can be found below Seeger Dam in Nicasio.

Local Status: **Threatened.** Populations are in decline. Although the total number of populations has increased due to additional searches, one population is extirpated and remaining populations have fewer plants than when monitored in 2004 (internal data).

In 2016, under staff direction, intern Nate Phoravourek analyzed existing population site characteristics and searched likely drainages on watershed lands to find additional populations. While none were found, two excellent potential reintroduction sites were located.



Data Gaps: Research into germination/transplant requirements would help reveal if establishing additional populations is feasible.

Specific Threats and Management Recommendations: SOD is altering at least one site, and invasive French broom is altering another. Continue to remove broom, monitor populations, and explore introductions.

NAME

POACEAE

Scientific Name	*Elymus californicus* (Bol.) Gould
Common Name	California bottle-brush grass
Synonyms	*Hystrix californica*
CNDDB Element Code	PMPOA2H0W0
USDA PLANTS Symbol	ELCA10

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/589.html

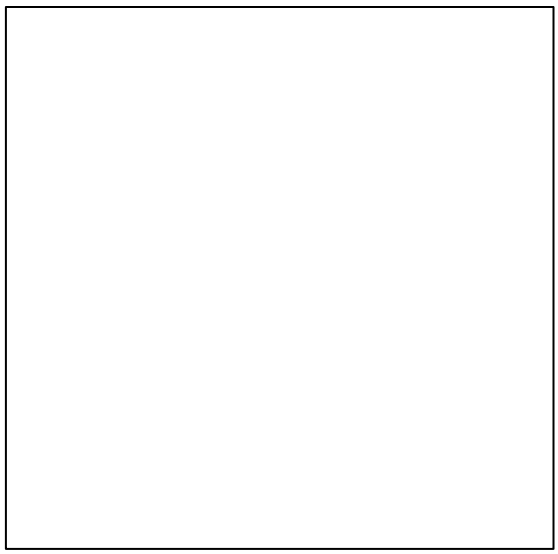
STATUS

Rare Plant Rank	**4.3** **4:** Limited distribution in California **.3:** Not very endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S4** S4: Apparently secure within California
Global Rank	**G4** G4: (species) Apparently secure, considering populations outside California
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Perennial herb, 1–3 m tall
Blooming Period	May–August (November)
Habitat	Broadleafed upland forest, cismontane woodland, North Coast coniferous forest, riparian woodland

California distribution of California bottle-brush grass



Global Distribution: Populations of California bottle-brush grass can be found throughout the San Francisco Bay Area, mainly in the coastal forests of Marin and San Mateo counties.

Global Status: **Secure.** California bottle-brush grass has a broad and probably under-reported distribution.

Local Distribution: Found across the watershed north of the peaks of Mount Tamalpais. Also found at Nicasio Reservoir.

Local Status: **Secure.** Populations are numerous and well-dispersed.

Data Gaps: The full distribution is unknown; it likely occurs in the impenetrable forests of lower Bolinas Ridge. Its tolerance to mowing and response to SOD (are more gaps good or is too much sun bad?) are also unknown.

Specific Threats and Management Recommendations: Climate change and SOD may alter habitats, and invasive broom species may invade and crowd it out. MMWD should continue to pull broom and map populations when found.

NAME **POLYGONACEAE**

Scientific Name	*Eriogonum luteolum* Greene var. *caninum* (Greene) Rev.
Common Name	Tiburon buckwheat
Synonyms	*Eriogonum vimineum* var. *caninum*, *Eriogonum vimineum* var. *californicum*, *Eriogonum caninum*
CNDDB Element Code	PDPGN083S1
USDA PLANTS Symbol	ERLUC

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/733.html

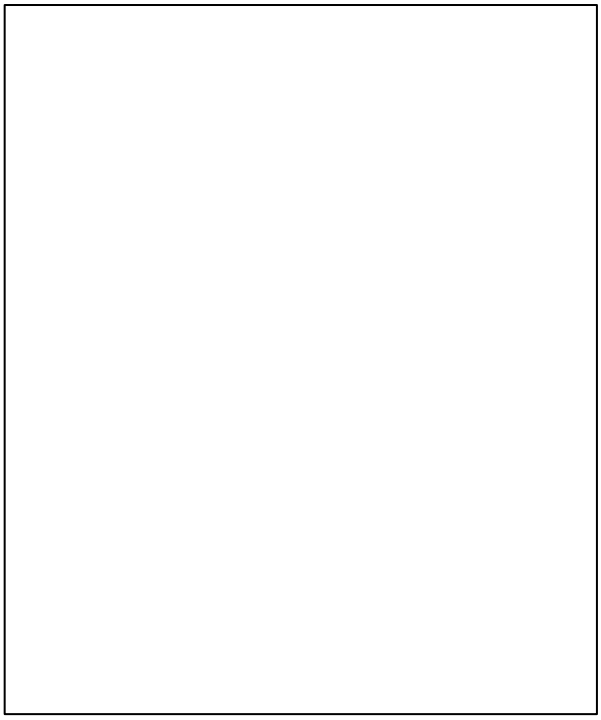
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G5T2** T2: Imperiled G5: (species) Secure, considering populations outside California
Watershed	**Secure**: Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Annual herb, 0.5–3 m tall
Blooming Period	May–September
Habitat	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland

California distribution of Tiburon buckwheat

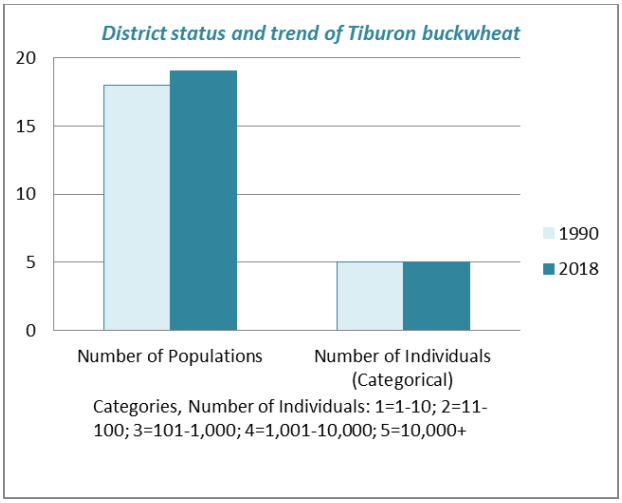


Global Distribution: This species can be found throughout Northern California, but the subspecies is limited to the San Francisco Bay Area.

Global Status: **Secure.** Populations appear healthy and, given their serpentine habitat, are unlikely to be converted to land uses incompatible with their survival. The major question with the taxon is where the subspecies boundary is, as it intergrades with ssp. *caninum* to the north.

Local Distribution: Common in serpentine barrens on Mount Tamalpais watershed lands.

Local Status: **Secure.** This species is common on serpentine barrens. Although its population fluctuations as an annual make tracking numbers difficult, the total population is estimated at over 10,000 plants in over a dozen locations.



Data Gaps: Delineating the subspecies boundary with ssp. *caninum* may help clarify population numbers.

Specific Threats and Management Recommendations: Trampling on serpentine barrens has negatively affected some populations (for example, Little Carson); however, placement of barriers and/or signs may help reduce these impacts.

NAME

LILIACEAE

Scientific Name	*Fritillaria lanceolata* Pursh. var. *tristulis* A.L. Grant
Common Name	Marin checker lily
Synonyms	*Fritillaria affinis* var. *tristulis*
CNDDB Element Code	PMLIL0V0P1
USDA PLANTS Symbol	FRAFT2

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/1681.html

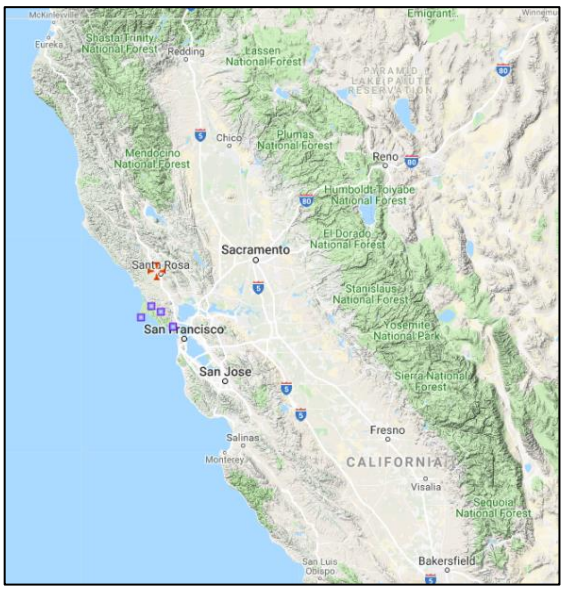
STATUS

Rare Plant Rank	**1B.1** **1B:** Rare, threatened, or endangered in California and elsewhere **.1:** Seriously endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G5T2** T2: Imperiled G5: (species) Secure, considering populations outside California
Watershed	**Imperiled:** This plant is close to extirpation on watershed lands

BIOLOGY

Lifeform	Perennial bulbiferous herb, 1–2 m tall
Blooming Period	February–May
Habitat	Coastal bluff scrub, coastal prairie, coastal scrub

California distribution of Marin checker lily



Global Distribution: This species is only found in Marin County, although there is a record of a population in San Mateo County that may be extirpated.

Global Status: **Imperiled.** This plant is known from only a handful of sites. Plants may only reproduce by offsets (asexually) or arise spontaneously as triploids (Marchant & Macfarlane 1980); however, triploid pollen is usually sterile.

Local Distribution: One population grows around Nicasio Reservoir.

Local Status: **Imperiled.** This plant is known from only a single site, consisting of a few plants. This taxon was not included in the 1990 Patterson report as non-Tamalpais areas were excluded.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: The taxonomy, derivation, and relationship of this plant to other *Fritillaria* need more study to determine the Marin checker lily's taxonomic relationship to these species.

Specific Threats and Management Recommendations: The habitat on Nicasio Island is converting from grassland to scrub and should be burned or grazed to reduce coyote brush and thatch, which would otherwise smother this species and prevent vegetative reproduction.

Additional References:

Marchant, C. J., & Macfarlane, R. M. (1980). Chromosome polymorphism in triploid populations of *Fritillaria lanceolata* Pursh (Liliaceae) in California. *Botanical Journal of the Linnean Society*, *81*(2), 135–154.

NAME **LILIACEAE**

Scientific Name	*Fritillaria liliacea* Lindl.
Common Name	Fragrant fritillary
Synonyms	*Fritillaria recurva*
CNDDB Element Code	PMLIL0V0C0
USDA PLANTS Symbol	FRLI3 (FRRE)

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/824.html

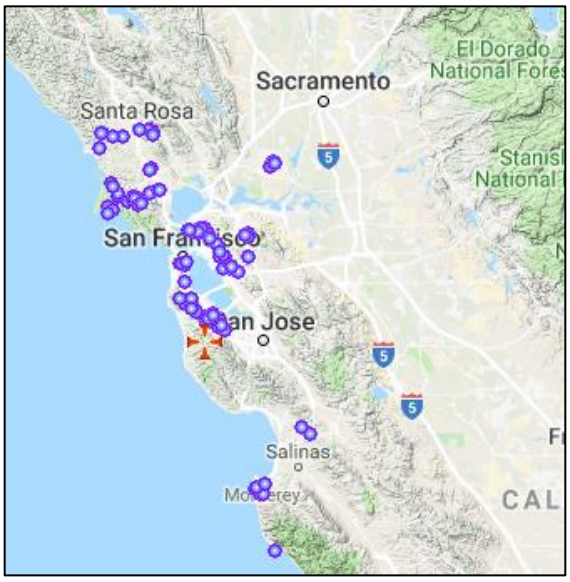
STATUS

Rare Plant Rank	**1B.2**	**1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S2**	S2: Imperiled
Global Rank	**G2**	G2: Imperiled
Watershed	**Threatened:** Populations are in decline and will disappear without intervention	

BIOLOGY

Lifeform	Perennial bulbiferous herb, 0.3–1(2)m tall
Blooming Period	February – April
Habitat	Cismontane woodland, coastal prairie, coastal scrub, valley and foothill grassland

California distribution of fragrant fritillary



Global Distribution: This species can be found throughout the greater San Francisco Bay Area.

Global Status: **Threatened?** Populations appear to be in decline and may disappear without intervention.

Local Distribution: One population grows around Nicasio Reservoir.

Local Status: **Threatened.** This plant is known from only a single site, although there are five patches and several hundred plants in total. Habitat succession from grassland to scrub, as well as invasion by non-native species, threaten these patches. Roadside (non-MMWD) patches are in further decline.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: The taxonomy, derivation, and relationship of this plant to other *Fritillaria* need more study to reveal whether this is a valid taxon.

Specific Threats and Management Recommendations: The habitat on Nicasio Island is converting from grassland to scrub and should be burned or grazed to reduce coyote brush and thatch, which would otherwise smother this species and prevent vegetative reproduction.

NAME

LINACEAE

Scientific Name	*Hesperolinon congestum* (Gray) Small
Common Name	Marin western flax
Synonyms	*Linum congestum* Gray; *Linum californicum* var. *congestum* Jeps.
CNDDB Element Code	PDLIN01060
USDA PLANTS Symbol	HECO12

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/405.html

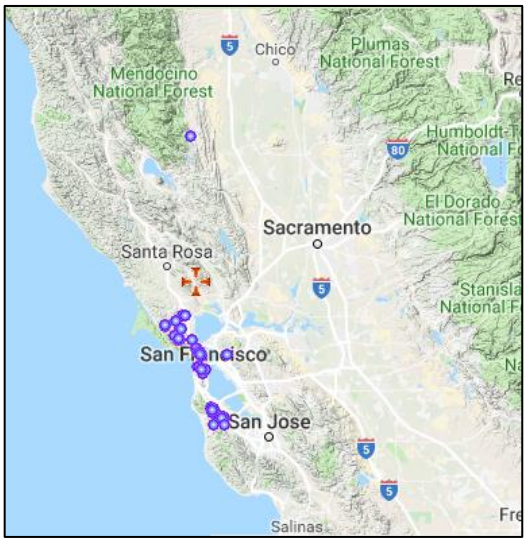
STATUS

Rare Plant Rank	**1B.1**	**1B:** Rare, threatened, or endangered in California and elsewhere **.1:** Seriously endangered in California
State Listing Status	**CT**	G1: Threatened
Federal Listing Status	**FT**	FT: Threatened
State Rank	**S1**	S1: Critically Imperiled
Global Rank	**G1**	G1: Critically Imperiled
Watershed	**Threatened:** Populations are in decline and will disappear without intervention	

BIOLOGY

Lifeform	Annual herb, 0.05–0.15 m tall
Blooming Period	April–July (May–June on MMWD lands)
Habitat	Chaparral, valley and foothill grassland

California distribution of Marin western flax

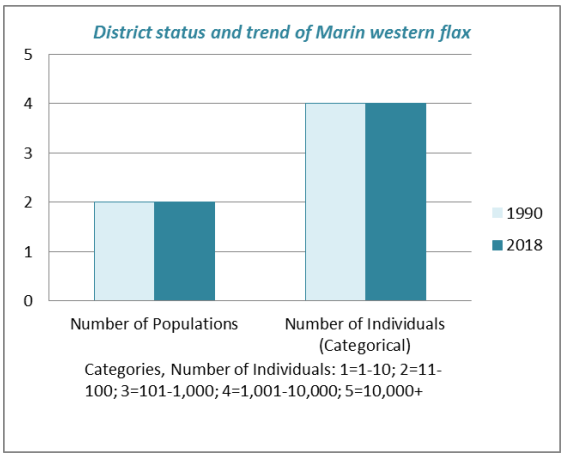


Global Distribution: This species is limited to Marin, San Francisco, and San Mateo counties.

Global Status: **Imperiled**. Fewer than 30 populations are known, and many of these are threatened.

Local Distribution: In serpentine areas from Carson Ridge to Azalea Hill.

Local Status: **Threatened.** Populations are in decline and will disappear without intervention. Although populations were estimated at "a few thousand" in the 1990s, they total just over a thousand today.



Data Gaps: It is not known if populations near Pine Mountain Fire Road consist of one or two different populations, and whether both are extant. Seed bank dynamics and interannual fluctuations are also not understood. Lastly, it is not clear why more serpentine grassland areas are not occupied by this species.

Specific Threats and Management Recommendations: Protect populations at Azalea Hill from trampling and trail work and explore introducing additional populations as well as an appropriate disturbance regime for all populations.

NAME

ROSACEAE

Scientific Name	*Horkelia tenuiloba* (Torr.) Gray
Common Name	Thin-lobed horkelia
Synonyms	*Potentilla micheneri* Greene
CNDDB Element Code	PDROS0W0E0
USDA PLANTS Symbol	HOTE2

Photo by Vernon Smith, CC BY-NC 3.0, via CalPhotos

http://www.rareplants.cnps.org/detail/916.html

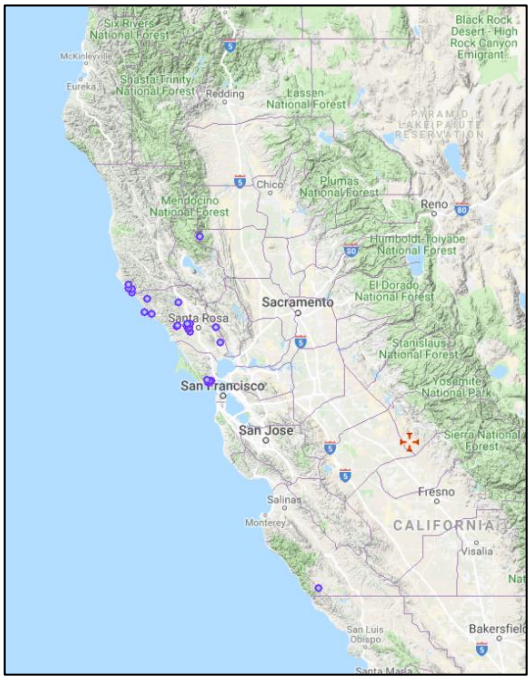
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G2** G2: Imperiled
Watershed	**Threatened:** Populations are in decline and will disappear without intervention

BIOLOGY

Lifeform	Perennial herb, 0.05–0.4 m tall
Blooming Period	April–July (August)
Habitat	Broadleafed upland forest, chaparral, valley and foothill grassland; mesic openings, sandy

California distribution of thin-lobed horkelia

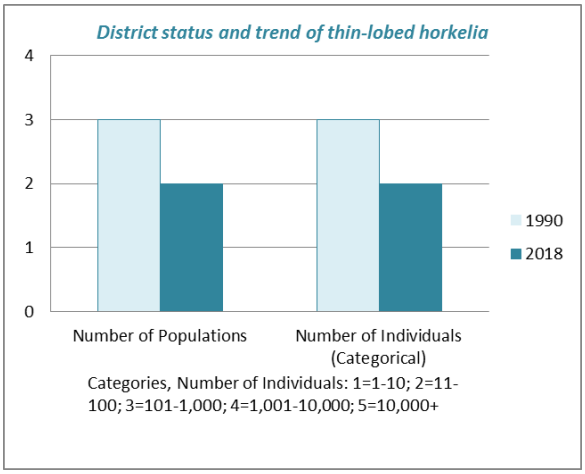


Global Distribution: Limited to Marin, Mendocino, and Sonoma counties.

Global Status: **Imperiled.** This plant is known from only a couple dozen sites, only 11 of which have recent information.

Local Distribution: Populations have been found across watershed lands. While the distribution is broad, these populations are isolated.

Local Status: **Imperiled.** This plant is known from only two sites in the watershed; two of the three sites from the 1990 inventory are extirpated, but an additional small population was found near Lake Lagunitas. The absent populations may have been lost due to shading from Douglas-fir.



Data Gaps: The metapopulation dynamics of this species are unknown, as well as the ideal disturbance regime—both of which would be important for making management decisions to support this species.

Specific Threats and Management Recommendations: The one large population is roadside and must be protected from being parked on and having materials or dirt spoil piles stacked on it. The smaller population is near a social trail and should be monitored for trampling and other impacts.

NAME

FABACEAE

Scientific Name	*Hosackia gracilis* Benth.
Common Name	Harlequin lotus
Synonyms	*Lotus formosissimus*
CNDDB Element Code	PDFAB2A0D0
USDA PLANTS Symbol	LOFO2

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/2089.html

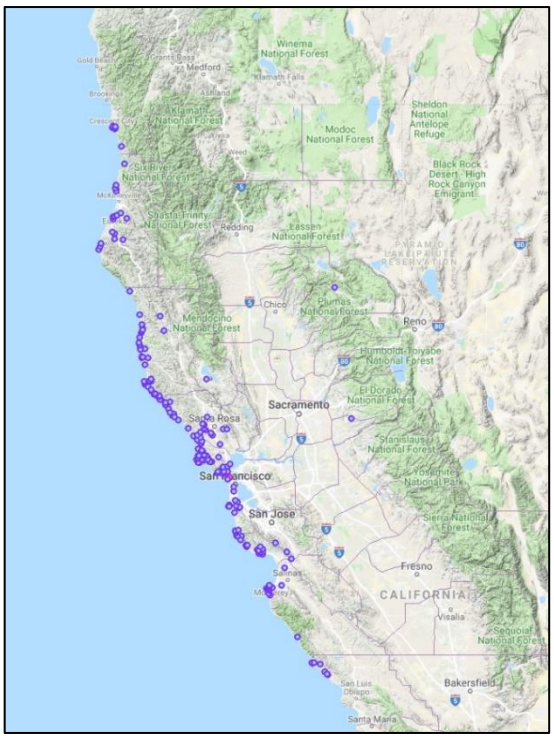
STATUS

Rare Plant Rank	**4.2** **4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S3** S3: Vulnerable
Global Rank	**G4** G4: (species) Apparently secure, considering populations outside California
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Perennial rhizomatous herb, 0.1–0.5 m tall
Blooming Period	March–July
Habitat	Broadleafed upland forest, coastal bluff scrub, closed-cone coniferous forest, cismontane woodland, coastal prairie, coastal scrub, meadows and seeps, marshes and swamps, North Coast coniferous forest, valley and foothill grassland

California distribution of harlequin lotus



Global Distribution: Found in California, Oregon, and Washington. Endangered in Canada.

Global Status: **Secure?** Harlequin lotus is broadly distributed, but its wet-area habitats are declining and vulnerable to climate change. This species is not tracked in a shared database such as CNDDB, so quality information is difficult to find, but there appear to be several hundred locations, sixty of which have recent information.

Local Distribution: This species has been found in most of the large wet meadow complexes on Mount Tamalpais, with more populations possible.

Local Status: **Secure:** The five known populations are away from most road and trail work. While most are fewer than 100 plants, one contains over 1,000 individuals.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Other mesic sites should be searched for additional populations during flowering season in May.

Specific Threats and Management Recommendations: Continue improving wet meadow habitat through woody species and weed removal.

IRIDACEAE

NAME

Scientific Name	*Iris longipetala* Herbert
Common Name	Coast iris
Synonyms	*Iris missouriensis*
CNDDB Element Code	PMIRI092E0
USDA PLANTS Symbol	IRMI

Photo by Vernon Smith, CC BY-NC 3.0, via CalPhotos

http://www.rareplants.cnps.org/detail/3169.html

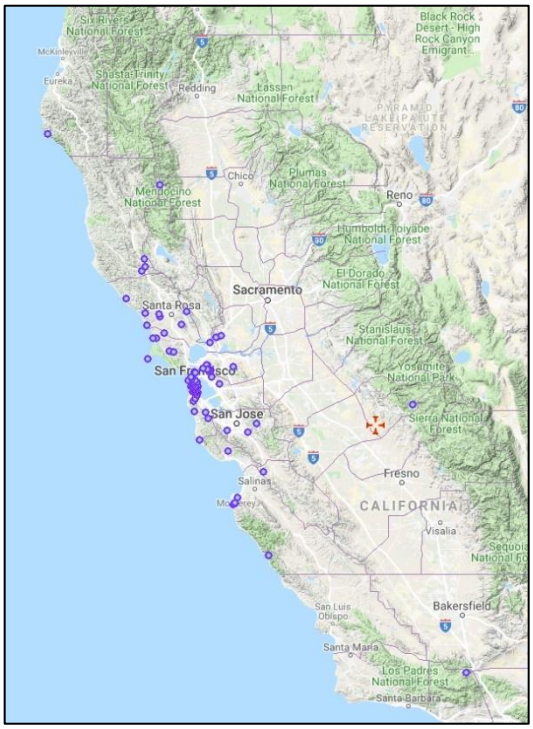
STATUS

Rare Plant Rank	**4.2**	**4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S3**	S3: Vulnerable
Global Rank	**G3**	G3: Vulnerable
Watershed	**Vulnerable:** Populations are not well-dispersed, not imminently threatened	

BIOLOGY

Lifeform	Perennial rhizomatous herb, 0.3–1 m tall
Blooming Period	March–May
Habitat	Coastal prairie, lower montane coniferous forest, meadows and seeps

California distribution of coast iris



Global Distribution: The majority of observations have been made along the Pacific Coast, as far north as King Range National Conservation Area, and as far south as Los Padres National Forest.

Global Status: **Vulnerable?** Coast iris is broadly distributed, but its wet-area habitats are declining and vulnerable to climate change. This species is not tracked in a shared database such as CNDDB, so quality information is difficult to find, but over 100 locations are known.

Local Distribution: A single population, consisting of several clonal patches, can be found on MMWD lands at Nicasio Reservoir.

Local Status: **Vulnerable.** Coast iris is not currently threatened by management; however, its habitat may eventually be impacted by coyote brush or invasive plant incursions. Single populations are always vulnerable to perturbations.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: The relationship of coast iris to blue flag (*I. missouriensis*) is not well understood, and some taxonomists believe they are the same species. If that is the case, then its status as a rare species would need to be revaluated.

Specific Threats and Management Recommendations: The habitat on Nicasio Island is converting from grassland to scrub, which will crowd out coast iris there. The site should be burned or grazed to reduce coyote brush and thatch.

NAME

OROBANCHACEAE

Scientific Name	*Kopsiopsis hookeri* (Walp.) Govaerts
Common Name	Small groundcone
Synonyms	*Boschniakia hookeri*
CNDDB Element Code	PDORO01010
USDA PLANTS Symbol	BOHO

Photo by Vernon Smith,
CC BY-NC-ND 3.0, via CalPhotos

http://www.rareplants.cnps.org/detail/1590.html

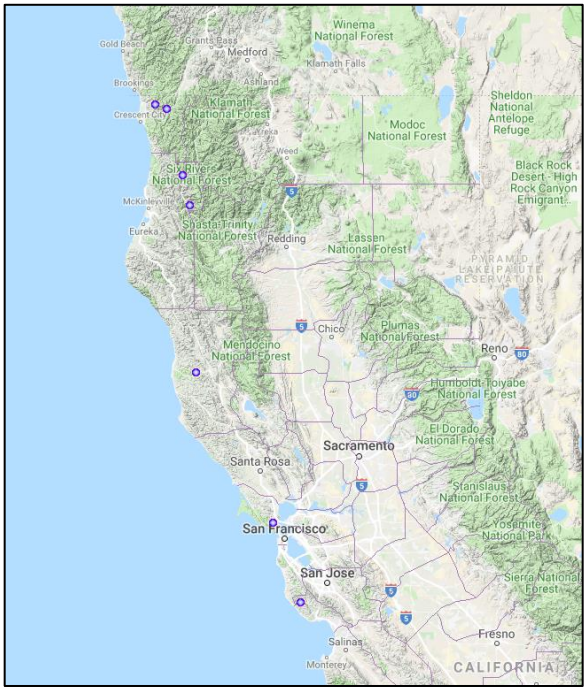
STATUS

Rare Plant Rank	**2B.3** **2B:** Rare or Endangered in California, common elsewhere **.3:** Not very endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S1S2** S1: Critically imperiled S2: Imperiled
Global Rank	**G4?** G4: (species) Apparently secure, considering populations outside California
Watershed	**Vulnerable:** Populations are not well-dispersed, not imminently threatened

BIOLOGY

Lifeform	Perennial rhizomatous herb (parasitic), 0.07–0.2 m tall
Blooming Period	April–August
Habitat	North Coast coniferous forest; parasitic on Ericaceae (usually salal, madrone, huckleberry)

California-Oregon distribution of small groundcone



Global Distribution: Found from Northern California coniferous forests to Oregon and Washington coastal forests

Global Status: **Secure?** Small groundcone is found north into Canada but has been ranked as rare in the four state/provinces it inhabits with the exception of Oregon, where it is under review.

Local Distribution: A single population is confirmed adjacent to MMWD watershed lands; a second population along Swede George may be California groundcone. The two species can be difficult to tell apart even when fresh.

Local Status: **Vulnerable.** Small groundcone is not currently threatened by management; however, its habitat may be impacted by climate change or SOD.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: It is not known if additional populations exist in remote mixed-conifer forests.

Specific Threats and Management Recommendations: Search for additional populations where host plants are present.

Additional References:

NatureServe. (2018). NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. Retrieved July 26, 2018, from http://explorer.natureserve.org

NAME

POLEMONIACEAE

Scientific Name	*Leptosiphon acicularis* (Greene) Jeps.
Common Name	Bristly leptosiphon
Synonyms	*Linanthus acicularis*
CNDDB Element Code	PDPLM09010
USDA PLANTS Symbol	LEAC11

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/1716.html

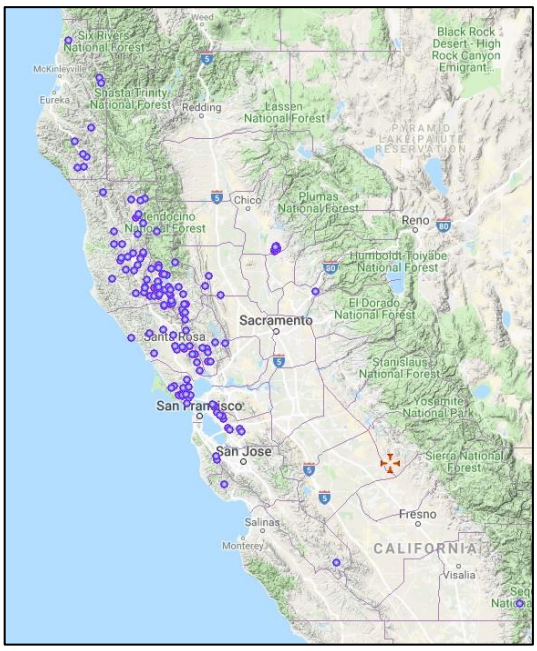
STATUS

Rare Plant Rank	**4.2**	**4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S4?**	S4: Apparently secure within California
Global Rank	**G4?**	G4: Apparently secure, considering populations outside California
Watershed	**Imperiled:** This plant is close to extirpation on watershed lands	

BIOLOGY

Lifeform	Annual herb, 0.03–0.15 m tall
Blooming Period	April–July
Habitat	Chaparral, cismontane woodland, coastal prairie, valley and foothill grassland

California distribution of bristly leptosiphon



Global Distribution: This species is primarily found in the North Coast Range and San Francisco Bay Area.

Global Status: **Secure?** Bristly leptosiphon has over 100 recorded locations, but fewer than 20 have recent information available.

Local Distribution: Two locations have been found along Pine Mountain-Carson Ridge; there is an additional location just off MMWD property in Cascade Canyon and White Hill Open Space Preserves.

Local Status: **Imperiled.** This annual plant has only been seen sporadically and in low numbers. Its preference for open, rocky soil may mean it will appear in larger numbers after disturbances.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Seed bank dynamics are unknown, and populations may be "hiding" underground. Additional populations of this diminutive annual are possible but would be easy to miss during surveys.

Specific Threats and Management Recommendations: Protect known (roadside) populations and search for other populations on watershed lands.

ASTERACEAE

Photo by Vernon Smith, CC BY-NC-ND 3.0, via CalPhotos

NAME

Scientific Name	*Lessingia micradenia* Greene var. *micradenia*
Common Name	Tamalpais lessingia
Synonyms	*Lessingia ramulosa* var. *micradenia*
CNDDB Element Code	PDAST5S063
USDA PLANTS Symbol	LEMIM

http://www.rareplants.cnps.org/detail/1327.html

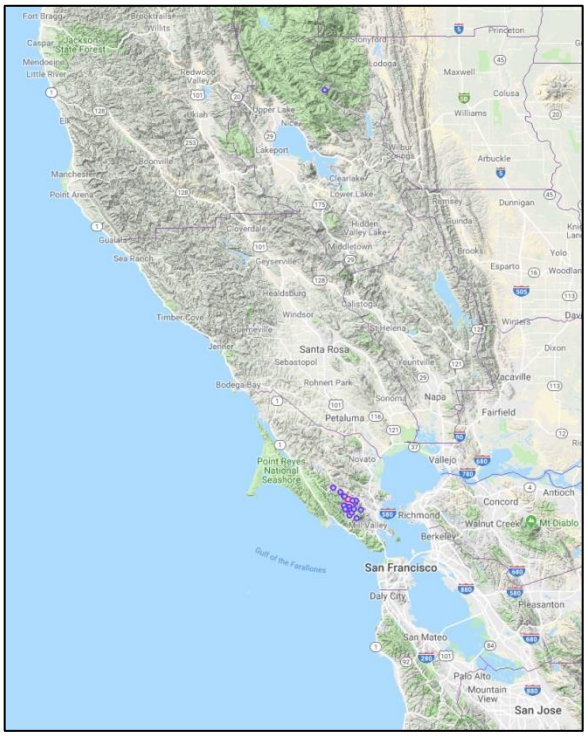
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G2T2** T2: Imperiled G2: (species) Imperiled
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Annual herb, 0.05–0.6 m tall
Blooming Period	(June) July–October
Habitat	Usually serpentinite, often roadside; chaparral, valley and foothill grassland

California distribution of Tamalpais lessingia



Global Distribution: This species is found almost exclusively in the Mount Tamalpais area.

Global Status: **Imperiled.** This annual grows almost entirely on MMWD lands, and species with such restricted ranges are in danger of disappearing. Seeds from MMWD populations were collected and banked with the Rancho Santa Ana Botanical Garden in 2015 as part of the CNPS Rare Plant Rescue Program for *ex situ* conservation of rare plants with few populations/restricted ranges.

Local Distribution: Common in serpentine barrens on Mount Tamalpais watershed lands.

Local Status: **Secure.** This species is common on serpentine barrens. Its population fluctuations as an annual make tracking numbers difficult, but the total population is estimated at over 1,000,000 plants in a couple dozen locations.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Seed bank dynamics are unknown, which limits knowledge about how the numbers of aboveground plants relate to the abundance of seeds.

Specific Threats and Management Recommendations: Protect known populations that are vulnerable to trampling.

NAME

POLEMONIACEAE

Scientific Name	*Navarretia rosulata* Brand
Common Name	Marin County navarretia
Synonyms	*Navarretia heterodoxa* ssp. *rosulata*
CNDDB Element Code	PDPLM0C0Z0
USDA PLANTS Symbol	NARO2

Photo by Vernon Smith, CC BY-NC-ND 3.0, via CalPhotos

http://www.rareplants.cnps.org/detail/1163.html

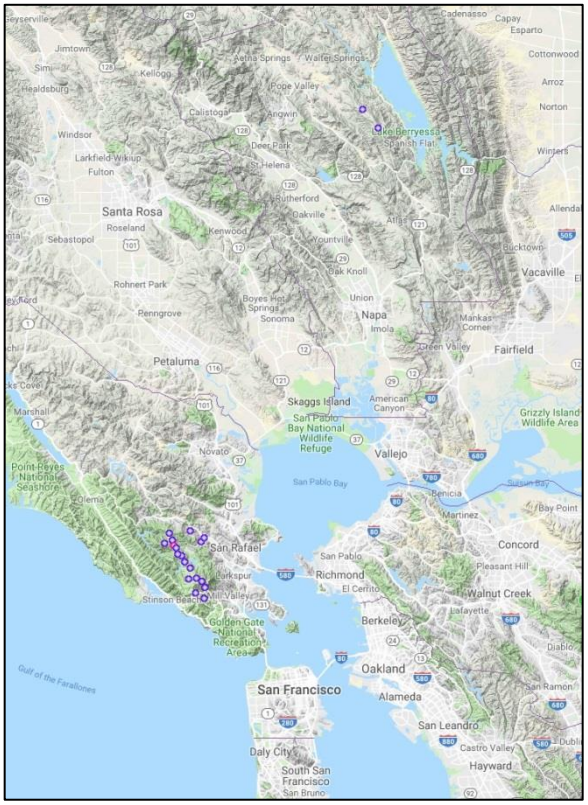
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G2** G2: Imperiled
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Annual herb, 0.05–0.15 m tall
Blooming Period	May–July
Habitat	Closed-cone coniferous forest, chaparral; serpentinite, rocky

California distribution of Marin County navarretia

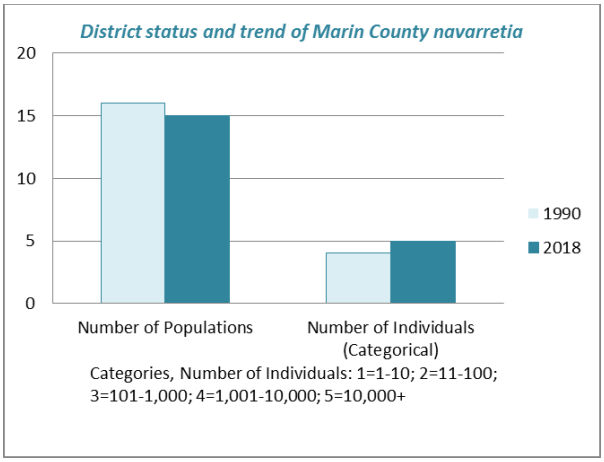


Global Distribution: Limited to Marin and Napa counties.

Global Status: **Imperiled.** This annual grows almost entirely on MMWD lands, and species with such restricted ranges are in danger of disappearing.

Local Distribution: Common in serpentine barrens on Mount Tamalpais watershed lands.

Local Status: **Secure.** This species is common on serpentine barrens. Its population fluctuations as an annual make tracking numbers difficult, but the total population is estimated at just over 100,000 plants in a couple dozen locations.



Data Gaps: Seed bank dynamics are unknown, and populations may be "hiding" underground. Additional populations of this diminutive annual are possible but would be easy to miss during surveys.

Specific Threats and Management Recommendations: None.

NAME

APIACEAE

Scientific Name	*Perideridia gairdneri (*H. & A.) Math. ssp. *gairdneri*
Common Name	Gairdner's yampah
Synonyms	*Carum gairdneri*
CNDDB Element Code	PDAPI1N062
USDA PLANTS Symbol	PEGAG

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/1316.html

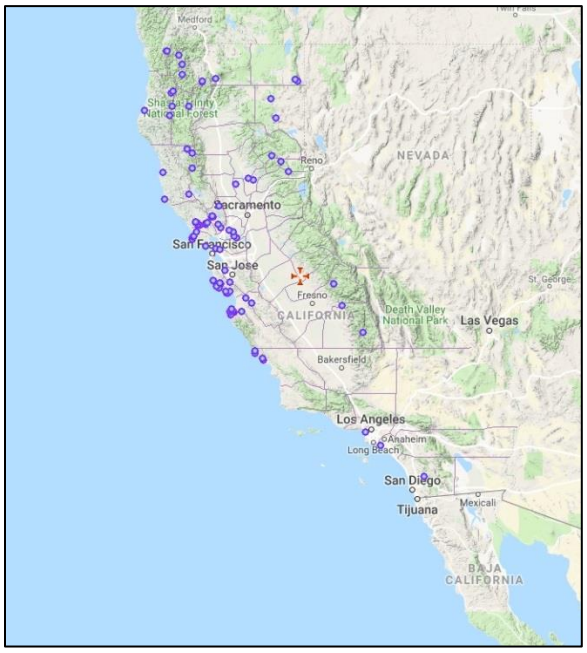
STATUS

Rare Plant Rank	**4.2** **4:** Limited distribution in California **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S3S4** S3: Vulnerable S4: Apparently secure within California
Global Rank	**G5T3T4** T3: Vulnerable T4: Apparently secure, considering populations outside California G5: (species) Secure, considering populations outside California
Watershed	**Vulnerable:** Populations are not well-dispersed, not imminently threatened

BIOLOGY

Lifeform	Perennial herb, 0.3–1.4 m tall
Blooming Period	June–October
Habitat	Broadleafed upland forest, chaparral, coastal prairie, valley and foothill grassland, vernal pools; vernally mesic

California distribution of Gairdner's yampah

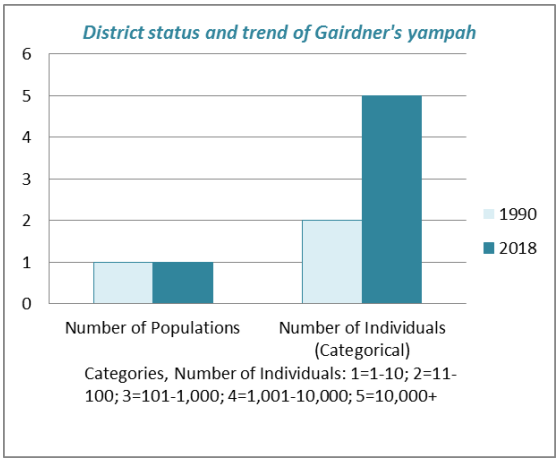


Global Distribution: California endemic, but distributed across state.

Global Status: **Secure?** Gairdner's yampah is broadly distributed, but its wet-area habitats are declining and vulnerable to climate change. This species is not tracked in a shared database such as CNDDB, so quality information is difficult to find. Over 100 locations are known, but only 13 of these are recent records.

Local Distribution: A single population is known on MMWD watershed lands.

Local Status: **Vulnerable.** Gairdner's yampah is not currently threatened by management, but its habitat may be impacted by climate change or woody species invasion.



Data Gaps: Tolerance to mowing and transplanting would help guide habitat management and establishment of additional populations.

Specific Threats and Management Recommendations: Avoid impacts from Sludge Pond operations, continue woody species removal in habitat, and consider establishing additional population(s).

NAME

FAGACEAE

Scientific Name	*Quercus parvula* Greene var. *tamalpaisensis* S.K. Langer
Common Name	Tamalpais oak
Synonyms	None
CNDDB Element Code	PDFAG051Q3
USDA PLANTS Symbol	QUPAT

Photo by Al Keuter, used with permission

http://www.rareplants.cnps.org/detail/1348.html

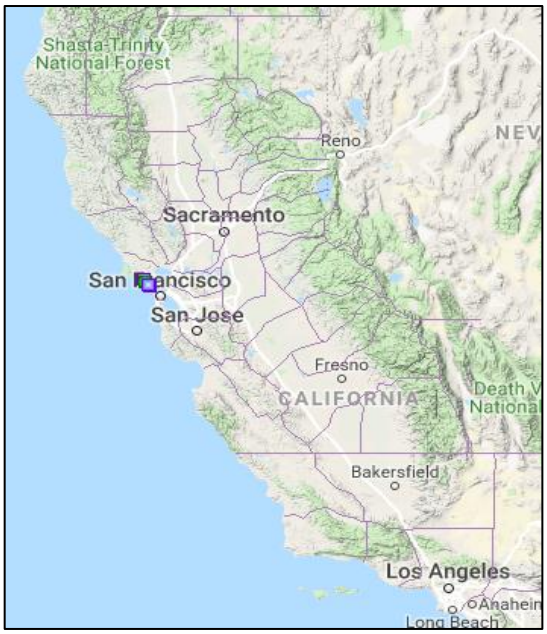
STATUS

Rare Plant Rank	**1B.3** **1B:** Rare, threatened, or endangered in California and elsewhere **.3:** Not very endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G4T2** T2: Imperiled. G4: (species) Apparently secure, considering populations outside California
Watershed	**Unknown:** Populations are not well-mapped; plants difficult to tell from closely related species

BIOLOGY

Lifeform	Perennial evergreen shrub, 1–6 m tall
Blooming Period	March–April
Habitat	Lower montane coniferous forest

California distribution of Tamalpais oak



Global Distribution: This species is limited to Marin County.

Global Status: **Imperiled?** This taxon grows almost entirely on MMWD lands, and species with such restricted ranges are in danger of disappearing. There is no recent population information in CNDDB.

Local Distribution: Grows across watershed lands in mixed hardwood forests.

Local Status: **Unknown:** Populations are not well-mapped. Furthermore, this subspecies is difficult to tell from closely related species and is purported to be of hybrid origin.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: Whether this taxon is valid or becomes a named hybrid needs to be resolved. In a 2017 paper, Hauser et al. proposed invalidating varieties of *Q. parvula* (only recognizing the species) and showing Tamalpais oak as a hybrid of shreve oak and interior live oak. Further study is needed to show if hybrid offspring are fertile and the hybrid a nameable entity.

Specific Threats and Management Recommendations: Populations may be vulnerable to SOD, but if this is a hybrid the parent species are not mortally susceptible. Shading from Douglas-fir encroachment may be negatively affecting some populations. Tamalpais oak resprouts after mowing, but most populations are not roadside. Further hybrid generation may be threatened if phenology of parents shifts away from co-flowering.

Additional References:

Hauser, D. A., Keuter, A., McVay, J. D., Hipp, A. L., and Manos, P. S. (2017). The evolution and diversification of the red oaks of the California Floristic Province (*Quercus* section *Lobatae,* series *Agrifoliae*). *American Journal of Botany, 104*(10), 1-15.

ALISMATACEAE

NAME

Scientific Name	*Sagittaria sanfordii* Greene
Common Name	Sanford's arrowhead
Synonyms	None
CNDDB Element Code	PMALI040Q0
USDA PLANTS Symbol	SASA2

Photo by Todd Plummer, CC BY-NC 4.0, via Calflora

http://www.rareplants.cnps.org/detail/710.html

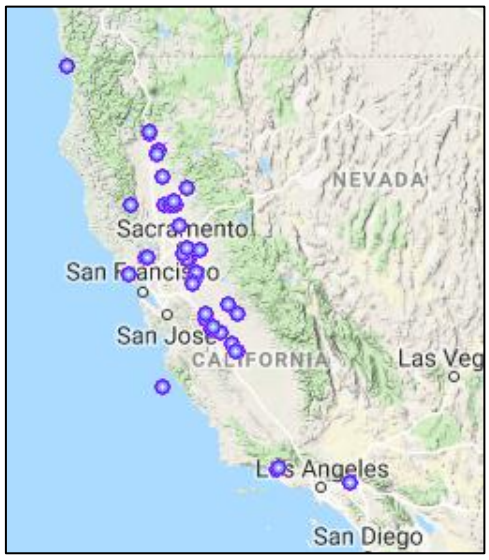
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S3** S3: Vulnerable
Global Rank	**G3** G3: Vulnerable
Watershed	**Unknown:** Populations are not well-mapped; plants difficult to tell from closely related species

BIOLOGY

Lifeform	Perennial rhizomatous herb (emergent), 0.1–1.3 m tall
Blooming Period	May–October (November)
Habitat	Marshes and swamps (assorted shallow freshwater)

California distribution of Sanford's arrowhead



Global Distribution: California endemic, but distributed across state.

Global Status: **Vulnerable.** Sanford's arrowhead is broadly distributed, but its wet-area habitats are declining and vulnerable to climate change. This species is thought to be extirpated from Southern California and parts of the Central Valley, but over 100 locations are known from elsewhere in the state. Over 60 of these are recent records.

Local Distribution: A single population is known from Nicasio Reservoir.

Local Status: **Vulnerable.** Sanford's arrowhead is not currently threatened by management; however, its habitat may change with climate shifts.

INSUFFICIENT INFORMATION TO GENERATE STATUS AND TRENDS GRAPH

Data Gaps: It is not known how this species arrived on watershed lands, or if the species identification is correct. If it is not a natural population, and was introduced via equipment, more detailed aquatic surveys of Nicasio should be performed to check for introductions of other species.

Specific Threats and Management Recommendations: Avoid impacts from alterations to management of Nicasio Reservoir (e.g., level shifts, dredging).

NAME

BRASSICACEAE

Scientific Name	*Streptanthus batrachopus* Morrison
Common Name	Tamalpais jewel flower
Synonyms	None
CNDDB Element Code	PDBRA2G050
USDA PLANTS Symbol	STBA4

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/1491.html

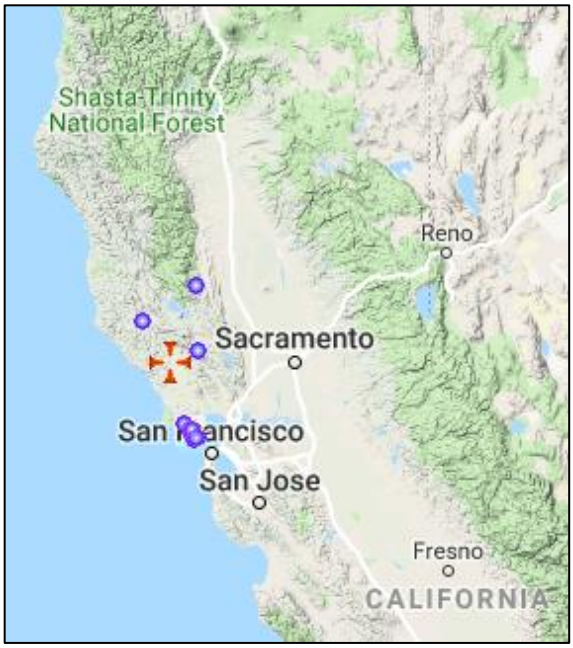
STATUS

Rare Plant Rank	**1B.3**	**1B:** Rare, threatened, or endangered in California and elsewhere **.3:** Not very endangered in California
State Listing Status	**Not Listed**	
Federal Listing Status	**Not Listed**	
State Rank	**S2**	S2: Imperiled
Global Rank	**G2**	G2: Imperiled
Watershed	**Vulnerable:** Populations are not well-dispersed, not imminently threatened	

BIOLOGY

Lifeform	Annual herb, 0.03–0.3 m tall
Blooming Period	April–July
Habitat	Closed-cone coniferous forest, chaparral; serpentine barrens

California distribution of Tamalpais jewel flower

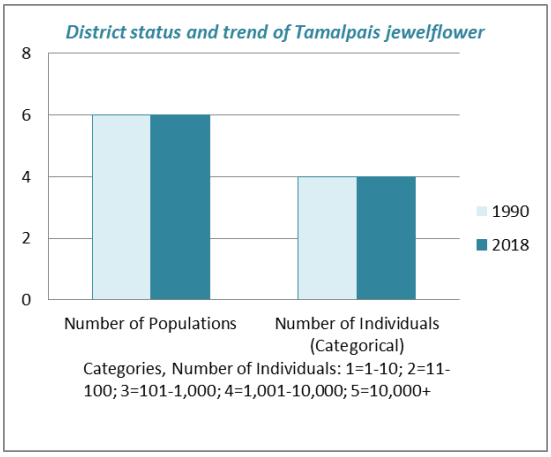


Global Distribution: Limited to Marin County; northern points may be separate species.

Global Status: **Imperiled**. This species is limited to fewer than ten total populations, and numbers appear to be declining.

Local Distribution: Bulk of observations are found east of Pine Mountain Ridge; two are near Barth's Retreat/Middle Peak.

Local Status: **Vulnerable.** Populations are not abundant, but not imminently threatened. One population is apparently extirpated, but another was found. Overall, populations numbers are down—from an estimated 5,000 individuals in the 1990s to about one-quarter of that today.



Data Gaps: Unlike its relative, *S. glandulosus*, populations of this species appear to be declining. Understanding why would help inform future management efforts.

Specific Threats and Management Recommendations: Some populations are threatened by trampling and rock-stacking. Education, barriers, or trail re-routing should be explored as ways to help prevent these impacts.

BRASSICACEAE

NAME

Scientific Name	*Streptanthus glandulosus* Hook. ssp. *pulchellus* (Greene) Kruckeberg
Common Name	Mt. Tamalpais bristly jewelflower
Synonyms	*Streptanthus pulchellus*
CNDDB Element Code	PDBRA2G0J2
USDA PLANTS Symbol	STGLP

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/1499.html

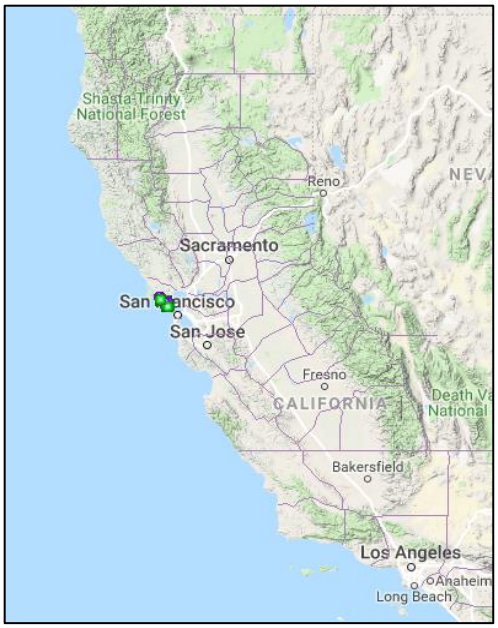
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2** S2: Imperiled
Global Rank	**G4T2** T2: Imperiled. G4: (species) Apparently secure, considering populations outside California
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Annual herb, 0.1–0.4 m tall
Blooming Period	May–July (August)
Habitat	Chaparral, valley and foothill grassland

California distribution of Mt. Tamalpais bristly jewelflower



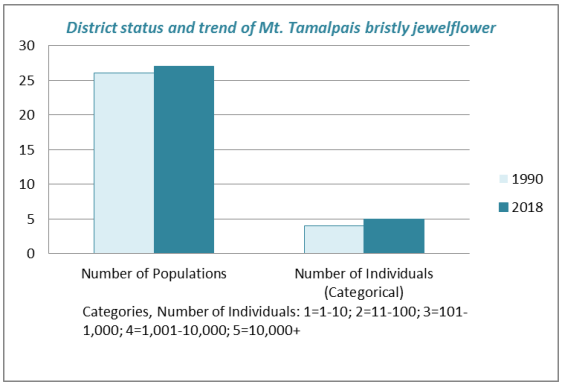
Global Distribution: This species' range is limited to Marin County.

Global Status: **Imperiled.** This taxon grows almost entirely on MMWD lands, and species with such restricted ranges are in danger of disappearing.

Local Distribution: This taxon can be found in serpentine barrens across Mount Tamalpais watershed lands.

Local Status: **Secure.** Although populations fluctuate, the total number of individuals is estimated to be over 10,000.

Seven populations from the 1990 report are presumed to be extirpated, but an additional eight populations were recently found.



Data Gaps: Understanding the subspecies relationships with ssp. *secundus* and a possibly new non-serpentine type could help clarify rarity and population numbers.

Specific Threats and Management Recommendations: Some populations are threatened by trampling and invasive species. Continue pulling weeds and explore whether education, barriers, or trail re-routing would help reduce trampling.

NAME

MELANTHIACEAE

Scientific Name	*Toxicoscordion fontanum* (Eastw.) Zomlefer & Judd
Common Name	Marsh zigandenus
Synonyms	*Zigadenus micranthus* var. *fontanus*, *Zigadenus fontanus*
CNDDB Element Code	PMLIL28050
USDA PLANTS Symbol	TOFO3 (ZIMIF2)

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/2058.html

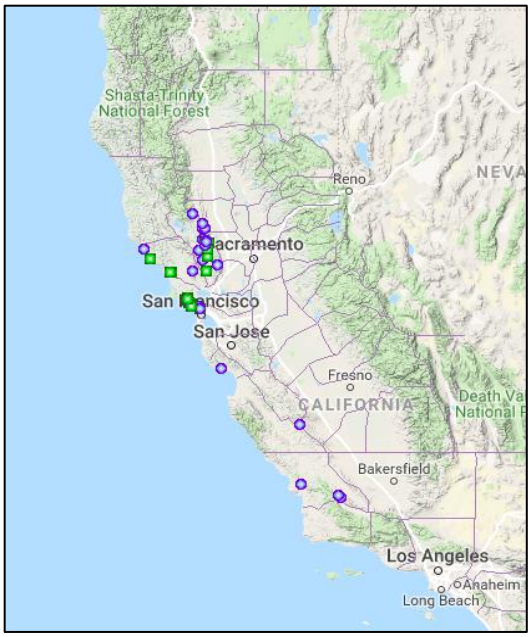
STATUS

Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S3** S3: Vulnerable
Global Rank	**G3** G3: Vulnerable
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management

BIOLOGY

Lifeform	Perennial bubiferous herb, 0.6–1 m tall
Blooming Period	April–July
Habitat	Chaparral, cismontane woodland, lower montane coniferous forest, meadows and seeps, marshes and swamps; often serpentine

California distribution of marsh zigadenus



Global Distribution:

Most observations of small-flowered death camas are found north of the San Francisco Bay Area, with a few in Monterey and San Luis Obispo counties.

Global Status:

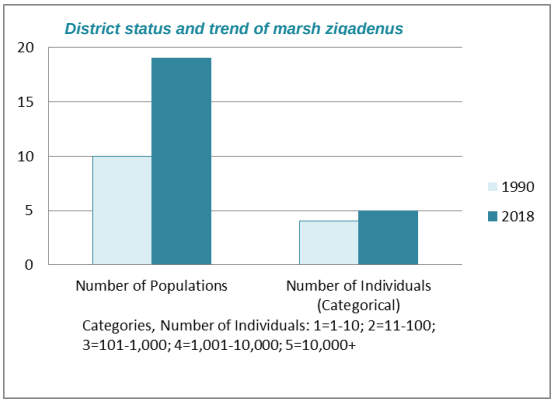
Vulnerable. Small-flowered death camas is broadly distributed, but its wet-area habitats are declining and vulnerable to climate change. Because its ranking is at the lowest level of concern, populations are not tracked in a shared database such as the CNDDB, but between approximately 50 and 100 populations are reported statewide.

Local Distribution:

This taxon can be found in wet areas, often with serpentine influence, across Mount Tamalpais watershed lands.

Local Status:

Secure. Although populations fluctuate, the total number of individuals is estimated to be nearly 20,000. This species was not listed in the 1990 report, but *Marin Flora* (Howell, 1949) has location information, and once the taxon was recognized as rare, additional populations were found in the mid-1990s. Concerted searching and mapping through the efforts summarized earlier in this document yielded a dozen more sites.



Data Gaps:

This taxon is likely under-reported statewide; its status may be more secure than what current data indicates.

Specific Threats and Management Recommendations:

Continue recording new populations as found.

Additional References:

Howell, J. T. (1949). *Marin flora.* Berkeley, CA: University of California Press.

Extirpated Species

Marin is a well-botanized area with a comprehensively documented local flora. Forays by botanists such as Alice Eastwood, Katherine Brandegee, and Willis Lynn Jepson in the late 1800s to early 1900s were followed by John Thomas Howell's surveys and publication of *Marin Flora* in 1949. Supplements in 1970, 1981, and 2007 show taxonomic changes, revisions, and advancements as well as flora expansions largely due to the introduction of non-native species.

Using Howell's descriptive locations in the 1970 version, as well as a search of herbarium specimens from the area, author Andrea Williams compared the list of plants found around Mount Tamalpais to species believed to be present in 2016 after several years of searching and documentation of the local flora (Williams et al., 2017). A draft list was passed around to local experts, as "Tamalpais" includes non-MMWD lands, resulting in a finalized list of 71 plants. Three species have since been found and the taxa are now considered locally rare (see Table 4). Twelve of the species considered extirpated are CNPS-listed taxa, and none were found in 1990.

The current list of MMWD's extirpated species can be found at https://www.calflora.org/entry/plantlist.html#vrid=px557.

The habitat requirements of extirpated species are similar to those of locally rare plants: half the species prefer wet areas; nearly one-third grow in wetlands (primarily perennial species); and one third grow in grasslands (primarily annual species). This was an interesting finding, as so much focus has been put on the effects of changed fire regimes, and not as much on the importance of wet habitats to rare plant species. Surprisingly, just over 10% are fire-followers and 16% are found in chaparral.

Plants are considered "likely extirpated," as species may remain in a belowground seedbank—probable for many fire-followers and annuals—or emerge only occasionally well outside areas normally searched, as is possible for some forest-dwelling or small, annual plants.

Another possible source of error in the list could be plants thought to have grown on MMWD lands that never did. These may be due to a lack of precision in location information [probable for Durango root (*Datisca glomerata*) and large-flowered collomia (*Collomia grandiflora*)] or an identification error (thought to be the case for Franciscan thistle, *Cirsium andrewsii*).

Even given these sources of error, the list serves as an important tool for understanding what may be driving changes to the flora, and a reminder to continue searching for these species (except bitterroot, which is under Alpine Lake).

Locally Rare Species and Habitat Types

"Local rarity" is gaining attention as an important concept in light of range shifts, climate change, and local genetics work. No hard-and-fast rules or guidelines for determining local rarity are prevalent at the time of this writing, but few populations in an area is generally the first threshold. MMWD uses three or fewer populations, but further decisions need to be made around the security/long-term viability of populations. For example, species such as alkali heliotrope (*Heliotropium curassavicum* var. *oculatum*), which reliably emerge in the reservoir drawdown zones, are less vulnerable than stipulate lotus (*Hosackia stipularis*), which has only been found along a single fire road.

Some species may be locally rare due to habitat rarity, and certainly many of the below-listed plants grow in wetlands and wet meadows—creating "hotspots" of rarity at sites such as Potrero Meadow and Lagunitas Meadow. Seeps with serpentine-influenced chemistry, large tracts of redwood and redwood-riparian forests, rock outcrops, and reservoirs (including drawdown areas) account for the habitat preference of approximately 75% of the species on this list.

The current list of MMWD's locally rare species can be found at https://www.calflora.org/entry/plantlist.html#vrid=px456.

Table 4. Locally Rare or Threatened Plants

Scientific Name	Common Name(s)
Acmispon grandiflorus var. grandiflorus	Chaparral lotus
Adiantum aleuticum	Five finger fern, Five finger maidenhair
Agoseris retrorsa	Spearleaf mountain dandelion
Allium unifolium	One leaf onion, Oneleaf onion
Alnus rubra	Oregon alder, Red alder
Amaranthus californicus	California amaranth, California pigweed
Amsinckia intermedia	Common fiddleneck
Amsinckia menziesii	Menzies' fiddleneck, Small flowered fiddleneck
Anaphalis margaritacea	Pearly everlasting
Angelica californica	California angelica
Antirrhinum kelloggii	Climbing snapdragon, Kellogg's snapdragon
Arabis blepharophylla	Coast rock cress

Scientific Name	Common Name(s)
Arctostaphylos virgata	Bolinas manzanita, Marin manzanita
Asarum caudatum	Creeping wild ginger, Longtail wild ginger
Asclepias fascicularis	Mexican whorled milkweed, Narrow leaf milkweed
Astragalus breweri	Brewer's milk vetch, Brewer's milkvetch
Azolla filiculoides	Mosquito fern, Pacific mosquitofern
Beckmannia syzigachne	American sloughgrass, Slough grass
Berberis aquifolium	Mountain grape, Mountaingrape, Oregon grape
Berberis nervosa	Cascades oregon grape, Oregongrape
Boykinia occidentalis	Brook foam, Coastal brookfoam, Western boykinia
Brodiaea terrestris ssp. terrestris	Dwarf brodiaea
Calandrinia breweri	Brewer's calandrinia, Brewer's redmaids
Calochortus amabilis	Golden fairy lantern, Golden globelily, Short lily
Calochortus uniflorus	Large flowered star tulip
Carex amplifolia	Ample leaved sedge, Big leaf sedge
Carex brevicaulis	Short stem sedge
Carex cusickii	Cusick's sedge
Carex exsiccata	Western inflated sedge
Carex harfordii	Harford's sedge, Monterey sedge
Carex praegracilis	Clustered field sedge, Field sedge
Carex subbracteata	Small bract sedge
Carex subfusca	Brown sedge, Rusty slender sedge
Carex utriculata	Beaked sedge, Northwest territory sedge
Castilleja affinis ssp. affinis	Coast indian paintbrush, Wight's indian paint brush
Castilleja ambigua ssp. ambigua	Johnny nip
Castilleja minor ssp. spiralis	Lesser indian paintbrush, Lesser paintbrush
Castilleja subinclusa ssp. franciscana	Franciscan paintbrush, Longleaf indian paintbrush
Castilleja wightii	Wight's indian paint brush, Wight's paintbrush
Caulanthus lasiophyllus	California mustard

Scientific Name	Common Name(s)
Ceanothus gloriosus var. exaltatus	Glory brush, Point Reyes ceanothus
Ceanothus masonii	Bolinas ceanothus, Mason's ceanothus
Chorizanthe membranacea	Pink spineflower
Cicuta douglasii	Western water hemlock
Cirsium quercetorum	Alameda county thistle, Brownie thistle
Clarkia amoena	Farewell to spring
Clarkia unguiculata	Elegant clarkia
Claytonia sibirica	Indian lettuce or candy flower
Cordylanthus pilosus ssp. pilosus	Hairy bird's beak
Cornus sericea ssp. occidentalis	Western dogwood
Cryptantha flaccida	Beaked cryptantha, Flaccid cryptantha
Cryptantha torreyana	Torrey's cryptantha
Drymocallis glandulosa var. wrangelliana	Sticky cinquefoil
Dryopteris expansa	Common wood fern, Spreading wood fern
Elatine brachysperma	Short seed waterwort
Eleocharis rostellata	Beaked spikerush, Walking sedge
Elymus triticoides	Beardless wild rye
Epilobium campestre	Smooth boisduvalia
Epilobium foliosum	California willowherb
Epilobium torreyi	Narrow leaved boisduvalia, Torrey's willowherb
Epipactis gigantea	Giant helleborine, Stream orchid, Stream orchis
Equisetum hyemale ssp. affine	Giant scouring rush
Ericameria ericoides	California goldenbush, Mock heather
Erigeron petrophilus var. petrophilus	Cliff fleabane, Rockloving erigeron
Eryngium aristulatum var. aristulatum	California eryngo, Jepson's button celery
Erysimum capitatum	Sanddune wallflower, Western wallflower
Erysimum franciscanum	Franciscan wallflower, San Francisco wallflower
Euonymus occidentalis var. occidentalis	Western burning bush, Western wahoo

Scientific Name	Common Name(s)
Euphorbia spathulata	Reticulate seeded spurge, Warty spurge
Fremontodendron californicum	California flannelbush, California fremontia
Garrya fremontii	Bearbrush, Fremont's silk tassel
Gaultheria shallon	Salal
Gentiana affinis var. ovata	Gentian, Pleated gentian
Glyceria elata	Fowl mannagrass, Tall mannagrass
Glyceria leptostachya	Davy mannagrass, Manna grass
Gnaphalium palustre	Lowland cudweed, Western marsh cudweed
Heliotropium curassavicum var. oculatum	Alkali heliotrope, Seaside heliotrope
Hemitomes congestum	Coneplant, Gnome plant
Heracleum maximum	Common cowparsnip
Hesperocnide tenella	Western nettle, Western stinging nettle
Hesperolinon congestum	Marin dwarf flax, Marin western flax
Heterocodon rariflorum	Few flowered heterocodon, Western pear flower
Hoita orbicularis	Creeping leather root, Roundleaf leather root
Holozonia filipes	Greene's white crown, Holozonia, Whitecrown
Hordeum brachyantherum	Meadow barley
Horkelia tenuiloba	Santa rosa horkelia, Thin lobed horkelia
Hosackia pinnata	Pinnate lotus
Hosackia stipularis var. stipularis	Stipulate lotus
Hypericum anagalloides	Creeping st. john's wort, Tinker's penny
Hypericum scouleri	Scouler's st john's wort
Isolepis carinata	Keeled bulrush
Isolepis cernua	Low bulrush
Juncus balticus ssp. ater	Baltic rush
Juncus bolanderi	Bolander's rush
Juncus covillei	Coville's rush
Juncus mexicanus	Mexican rush

Scientific Name	Common Name(s)
Juncus phaeocephalus var. phaeocephalus	Brown headed rush, Brownhead rush
Juncus xiphioides	Iris leaved rush, Irisleaf rush
Kopsiopsis hookeri	Small groundcone
Lathyrus torreyi	Redwood pea, Torrey's pea
Layia gaillardioides	Woodland layia, Woodland tidytips
Leptosiphon acicularis	Bristly leptosiphon
Lessingia hololeuca	Woolly headed lessingia
Ligusticum apiifolium	Celery-leaved lovage
Limosella acaulis	Broad leaved mudwort, Owyhee mudwort
Lindernia dubia	False pimpernel
Lomatium californicum	California lomatium, Celery weed
Lupinus formosus var. formosus	Summer lupine, Western lupine
Lupinus microcarpus var. densiflorus	Chick lupine, Whitewhorl lupine
Madia anomala	Plump seeded madia, Tarweed
Maianthemum dilatatum	False lily of the valley, Pacific may lily
Marsilea vestita	Hairy waterclover
Melica geyeri	Geyer's onion grass
Microseris bigelovii	Coast microseris, Coastal silverpuffs
Mimulus congdonii	Congdon's monkeyflower
Mimulus douglasii	Brownies, Purple mouse ears
Mimulus rattanii	Rattan's monkeyflower
Minuartia pusilla	Annual sandwort
Moehringia macrophylla	Large leaved sandwort, Largeleaf sandwort
Montia fontana	Annual water minerslettuce, Water chickweed
Montia parvifolia	Littleleaf minerslettuce, Showy rock montia
Najas guadalupensis	Guadalupe water nymph, Southern waternymph
Navarretia intertexta ssp. intertexta	Interwoven navarretia, Needle leaved navarretia
Nuphar polysepala	Rocky mountain pond-lily

Scientific Name	Common Name(s)
Oemleria cerasiformis	Indian plum, Oso berry
Oenanthe sarmentosa	Pacific oenanthe, Water parsley
Orobanche uniflora	Broomrape, Naked broom rape
Panicum acuminatum var. fasciculatum	Pacific panic grass
Papaver californicum	Fire poppy, Western poppy
Parnassia palustris	Marsh grass of parnassus
Paspalum distichum	Knot grass, Knotgrass
Perideridia gairdneri ssp. gairdneri	Gairdner's yampah
Petasites frigidus var. palmatus	Arctic sweet coltsfoot, Western coltsfoot
Phalaris lemmonii	Lemmon's canarygrass
Philadelphus lewisii	Lewis' mock orange, Wild mock orange
Pilularia americana	American pillwort
Pinus muricata	Bishop pine, Bull pine, Prickle cone pine
Piperia elongata	Dense flowered rein orchid
Plagiobothrys reticulatus	Netted popcornflower, Reticulate popcorn flower
Plagiobothrys tenellus	Pacific popcornflower, Popcorn flower
Plagiobothrys undulatus	Coast allocarya
Platanthera dilatata var. leucostachys	Sierra bog orchid
Plectritis ciliosa	Long spurred plectritis, Longspur seablush
Plectritis macrocera	Long horn plectritis, White plectritis
Polypodium scouleri	Leather fern, Leather leaf fern, Leathery polypody
Polystichum imbricans	Cliff sword fern, Narrow leaved sword fern
Potamogeton nodosus	Long leaved pondweed, Pondweed
Potamogeton pusillus	Small pondweed
Prosartes smithii	Largeflower fairybells
Prunella vulgaris	Common selfheal, Self heal, Selfheal
Prunus emarginata	Bitter cherry
Pseudognaphalium ramosissimum	Pink cudweed

Scientific Name	Common Name(s)
Quercus douglasii	Blue oak
Rafinesquia californica	California chicory, California plumeseed
Ranunculus aquatilis	Whitewater crowfoot
Ranunculus flammula var. ovalis	Greater creeping spearwort
Rhododendron macrophyllum	Coast rhododendron, Pacific rhododendron
Ribes californicum	California gooseberry, Hillside gooseberry
Ribes divaricatum var. pubiflorum	Spreading gooseberry, Straggly gooseberry
Ribes sanguineum var. glutinosum	Blood currant, Flowering currant
Rosa californica	California wild rose, California wildrose
Rubus spectabilis	Salmon berry, Salmonberry
Rumex salicifolius	Willow dock, Willow leaved dock
Ruppia maritima	Ditchgrass or wigeon grass
Sagina decumbens ssp. occidentalis	Western pearlwort
Salix scouleriana	Nuttall willow, Scouler willow
Salix sitchensis	Coulter willow, Sitka willow
Salvia columbariae	Chia sage
Sambucus racemosa	Red elderberry
Sanicula arctopoides	Footsteps of spring, Yellow mats
Scutellaria californica	California skullcap
Scutellaria tuberosa	Danny's skullcap, Scullcap
Setaria parviflora	Marsh bristlegrass
Sidalcea calycosa ssp. calycosa	Annual checkerbloom, Checker mallow
Silene antirrhina	Sleepy catch fly, Sleepy catchfly, Sleepy silene
Silene coniflora	Fire following campion
Solanum xanti	Chaparral nightshade, Purple nightshade
Solidago elongata	West coast canada goldenrod
Stebbinsoseris decipiens	Santa Cruz microseris
Stephanomeria exigua ssp. coronaria	Milk aster, White plume wirelettuce

Scientific Name	Common Name(s)
Stephanomeria virgata	Rod wirelettuce, Tall stephanomeria
Stuckenia pectinata	Sago pondweed
Symphyotrichum subulatum	Eastern annual saltmarsh aster
Synthyris reniformis	Snow queen, Snowqueen
Trifolium barbigerum	Bearded clover
Trifolium ciliolatum	Foothill clover, Tree clover
Trifolium gracilentum	Graceful clover, Pin point clover, Pinpoint clover
Trifolium macraei	Chilean clover, Macrae's clover
Trifolium obtusiflorum	Clammy clover, Creek clover
Trifolium oliganthum	Few flowered clover, Minitomcat clover
Trifolium variegatum var. geminiflorum	Small-flowered variegated clover
Trifolium variegatum var. major	Large variegated clover
Trifolium variegatum var. variegatum	Variegated clover
Trifolium wormskioldii	Coast clover, Cow clover, Cows clover
Triglochin scilloides	Flowering-quillwort
Trillium chloropetalum	Common trillium, Giant wakerobin, Trillium
Triodanis biflora	Venus looking glass, Venus' looking glass
Triteleia peduncularis	Long rayed brodiaea, Marsh triteleia
Veronica americana	American brooklime, American speedwell
Veronica peregrina ssp. xalapensis	Hairy purslane speedwell, Neckweed
Vicia hassei	Hasse's vetch
Viola adunca	Blue violet, Dog violet, Hookedspur violet
Viola glabella	Pioneer violet, Stream violet
Yabea microcarpa	California hedge parsley, False carrot

Bloom Period

Table 5. Bloom Period for Locally Rare or Threatened Plants

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Acmispon grandiflorus var. grandiflorus	Chaparral lotus				X	X	X	X					
Adiantum aleuticum	Five finger fern, Five finger maidenhair			X	X	X	X	X	X	X	X		
Agoseris retrorsa	Spearleaf mountain dandelion				X	X	X						
Allium unifolium	One leaf onion, Oneleaf onion					X	X						
Alnus rubra	Oregon alder, Red alder		X	X									
Amaranthus californicus	California amaranth, California pigweed						X	X	X				
Amsinckia intermedia	Common fiddleneck		X	X	X	X	X						
Amsinckia menziesii	Menzies' fiddleneck, Small flowered fiddleneck			X	X	X							
Anaphalis margaritacea	Pearly everlasting						X	X	X				
Angelica californica	California angelica						X	X					
Antirrhinum kelloggii	Climbing snapdragon, Kellogg's snapdragon			X	X	X							
Arabis blepharophylla	Coast rock cress		X	X	X	X							
Arctostaphylos virgata	Bolinas manzanita, Marin manzanita		X	X									
Asarum caudatum	Creeping wild ginger, Longtail wild ginger			X	X	X							
Asclepias fascicularis	Mexican whorled milkweed, Narrow leaf milkweed						X	X	X	X			
Astragalus breweri	Brewer's milk vetch, Brewer's milkvetch				X	X	X						
Azolla filiculoides	Mosquito fern, Pacific mosquitofern				X	X	X	X	X	X			
Beckmannia syzigachne	American sloughgrass, Slough grass					X	X	X					
Berberis aquifolium	Mountain grape, Mountaingrape, Oregon grape		X	X	X								
Berberis nervosa	Cascades oregon grape, Oregongrape				X	X							
Boykinia occidentalis	Brook foam, Coastal brookfoam,						X	X	X				

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Western boykinia												
Brodiaea terrestris ssp. terrestris	Dwarf brodiaea				X	X	X	X					
Calandrinia breweri	Brewer's calandrinia, Brewer's redmaids			X	X	X	X						
Calochortus amabilis	Golden fairy lantern, Golden globelily, Short lily				X	X	X						
Calochortus uniflorus	Large flowered star tulip				X	X	X						
Carex amplifolia	Ample leaved sedge, Big leaf sedge				X	X	X	X	X	X			
Carex brevicaulis	Short stem sedge			X	X	X	X						
Carex cusickii	Cusick's sedge					X	X	X					
Carex exsiccata	Western inflated sedge					X	X						
Carex harfordii	Harford's sedge, Monterey sedge					X	X	X					
Carex praegracilis	Clustered field sedge, Field sedge					X	X						
Carex subbracteata	Small bract sedge				X	X	X						
Carex subfusca	Brown sedge, Rusty slender sedge			X	X	X	X	X					
Carex utriculata	Beaked sedge, Northwest territory sedge						X	X	X	X			
Castilleja affinis ssp. affinis	Coast indian paintbrush, Wight's indian paint brush						X						
Castilleja ambigua ssp. ambigua	Johnny nip			X	X	X	X	X	X				
Castilleja minor ssp. spiralis	Lesser indian paintbrush, Lesser paintbrush						X	X	X	X	X		
Castilleja subinclusa ssp. franciscana	Franciscan paintbrush, Longleaf indian paintbrush			X	X	X	X	X	X	X			
Castilleja wightii	Wight's indian paint brush, Wight's paintbrush			X	X	X	X	X	X				
Caulanthus lasiophyllus	California mustard			X	X	X	X						
Ceanothus gloriosus var. exaltatus	Glory brush, Point Reyes ceanothus			X	X	X	X						
Ceanothus masonii	Bolinas ceanothus, Mason's ceanothus			X	X								

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ceratophyllum demersum	Coon's tail, Hornwort						X	X	X				
Chorizanthe membranacea	Pink spineflower				X	X	X						
Cicuta douglasii	Western water hemlock					X	X						
Cirsium quercetorum	Alameda county thistle, Brownie thistle					X	X	X					
Clarkia amoena	Farewell to spring						X	X	X				
Clarkia unguiculata	Elegant clarkia						X	X	X	X			
Claytonia sibirica	Indian lettuce or candy flower				X	X							
Cordylanthus pilosus ssp. pilosus	Hairy bird's beak							X	X	X			
Cornus sericea ssp. occidentalis	Western dogwood						X	X	X				
Cryptantha flaccida	Beaked cryptantha, Flaccid cryptantha			X	X	X							
Cryptantha torreyana	Torrey's cryptantha				X	X	X						
Drymocallis glandulosa var. wrangelliana	Sticky cinquefoil				X	X	X	X	X	X			
Dryopteris expansa	Common wood fern, Spreading wood fern			X	X	X	X	X	X				
Elatine brachysperma	Short seed waterwort				X	X	X	X	X	X			
Eleocharis rostellata	Beaked spikerush, Walking sedge					X	X						
Elymus triticoides	Beardless wild rye						X	X					
Epilobium campestre	Smooth boisduvalia						X	X	X				
Epilobium foliosum	California willowherb				X	X	X	X	X				
Epilobium torreyi	Narrow leaved boisduvalia, Torrey's willowherb				X	X	X	X					
Epipactis gigantea	Giant helleborine, Stream orchid, Stream orchis					X	X	X					
Equisetum hyemale ssp. affine	Giant scouring rush			X	X	X	X	X	X	X			
Ericameria ericoides	California goldenbush, Mock heather									X	X	X	
Erigeron petrophilus var. petrophilus	Cliff fleabane, Rockloving erigeron							X	X				

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eryngium aristulatum var. aristulatum	California eryngo, Jepson's button celery							X					
Erysimum capitatum	Sanddune wallflower, Western wallflower			X	X	X	X	X					
Erysimum franciscanum	Franciscan wallflower, San francisco wallflower			X	X	X	X						
Euonymus occidentalis var. occidentalis	Western burning bush, Western wahoo				X	X	X						
Euphorbia spathulata	Reticulate seeded spurge, Warty spurge			X	X	X							
Fremontodendron californicum	California flannelbush, California fremontia				X	X	X						
Garrya fremontii	Bearbrush, Fremont's silk tassel	X	X	X	X								
Gaultheria shallon	Salal				X	X							
Gentiana affinis var. ovata	Gentian, Pleated gentian							X	X	X			
Glyceria elata	Fowl mannagrass, Tall mannagrass							X	X				
Glyceria leptostachya	Davy mannagrass, Manna grass					X	X						
Gnaphalium palustre	Lowland cudweed, Western marsh cudweed					X	X	X	X	X			
Heliotropium curassavicum var. oculatum	Alkali heliotrope, Seaside heliotrope					X	X	X					
Hemitomes congestum	Coneplant, Gnome plant					X	X	X	X				
Heracleum maximum	Common cowparsnip						X	X					
Hesperocnide tenella	Western nettle, Western stinging nettle		X	X	X	X	X						
Hesperolinon congestum	Marin dwarf flax, Marin western flax				X	X	X	X					
Heterocodon rariflorum	Few flowered heterocodon, Western pear flower					X	X	X					
Hoita orbicularis	Creeping leather root, Roundleaf leather root				X	X	X	X	X				
Holozonia filipes	Greene's white crown, Holozonia, Whitecrown								X	X	X		
Hordeum brachyantherum	Meadow barley						X	X					

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Horkelia tenuiloba	Santa rosa horkelia, Thin lobed horkelia					X	X	X					
Hosackia pinnata	Pinnate lotus						X	X	X				
Hosackia stipularis var. stipularis	Stipulate lotus				X	X	X						
Hypericum anagalloides	Creeping st. john's wort, Tinker's penny						X	X					
Hypericum scouleri	Scouler's st john's wort						X	X	X	X			
Isolepis carinata	Keeled bulrush				X	X	X						
Isolepis cernua	Low bulrush				X	X	X	X	X	X			
Juncus balticus ssp. ater	Baltic rush					X	X						
Juncus bolanderi	Bolander's rush						X	X	X	X			
Juncus covillei	Coville's rush						X	X	X	X			
Juncus mexicanus	Mexican rush			X	X	X							
Juncus phaeocephalus var. phaeocephalus	Brown headed rush, Brownhead rush				X	X	X						
Juncus xiphioides	Iris leaved rush, Irisleaf rush					X	X	X					
Kopsiopsis hookeri	Small groundcone				X	X	X	X	X				
Lathyrus torreyi	Redwood pea, Torrey's pea				X	X	X	X					
Layia gaillardioides	Woodland layia, Woodland tidytips				X	X							
Leptosiphon acicularis	Bristly leptosiphon				X	X	X	X					
Lessingia hololeuca	Woolly headed lessingia						X	X	X	X	X		
Ligusticum apiifolium	Celery-leaved lovage						X	X					
Limosella acaulis	Broad leaved mudwort, Owyhee mudwort					X	X	X	X	X	X		
Lindernia dubia	False pimpernel							X	X				
Lomatium californicum	California lomatium, Celery weed			X	X								
Lupinus formosus var. formosus	Summer lupine, Western lupine						X	X	X	X	X		
Lupinus microcarpus var. densiflorus	Chick lupine, Whitewhorl lupine					X	X						
Madia anomala	Plump seeded madia, Tarweed				X	X	X						
Maianthemum dilatatum	False lily of the valley, Pacific may lily					X	X						

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Marsilea vestita	Hairy waterclover				X	X	X	X	X				
Melica geyeri	Geyer's onion grass				X	X	X	X					
Microseris bigelovii	Coast microseris, Coastal silverpuffs				X	X	X	X					
Mimulus congdonii	Congdon's monkeyflower			X	X	X							
Mimulus douglasii	Brownies, Purple mouse ears		X	X	X								
Mimulus rattanii	Rattan's monkeyflower					X	X	X					
Minuartia pusilla	Annual sandwort			X	X								
Moehringia macrophylla	Large leaved sandwort, Largeleaf sandwort				X	X	X						
Montia fontana	Annual water minerslettuce, Water chickweed			X	X	X	X						
Montia parvifolia	Littleleaf minerslettuce, Showy rock montia					X	X	X	X				
Najas guadalupensis	Guadalupe water nymph, Southern waternymph						X	X	X				
Navarretia intertexta ssp. intertexta	Interwoven navarretia, Needle leaved navarretia				X	X	X	X					
Nuphar polysepala	Rocky mountain pond-lily			X	X	X							
Oemleria cerasiformis	Indian plum, Oso berry			X	X	X							
Oenanthe sarmentosa	Pacific oenanthe, Water parsley					X	X	X					
Orobanche uniflora	Broomrape, Naked broom rape				X	X	X	X					
Panicum acuminatum var. fasciculatum	Pacific panic grass					X	X	X	X	X	X		
Papaver californicum	Fire poppy, Western poppy				X	X							
Parnassia palustris	Marsh grass of parnassus							X	X				
Paspalum distichum	Knot grass, Knotgrass								X	X			
Perideridia gairdneri ssp. gairdneri	Gairdner's yampah						X	X	X	X	X		
Petasites frigidus var. palmatus	Arctic sweet coltsfoot, Western coltsfoot			X	X	X							
Phalaris lemmonii	Lemmon's canarygrass				X	X	X						
Philadelphus lewisii	Lewis' mock orange, Wild mock orange					X	X						

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pilularia americana	American pillwort			X	X	X	X						
Pinus muricata	Bishop pine, Bull pine, Prickle cone pine				X	X							
Piperia elongata	Dense flowered rein orchid					X	X	X					
Plagiobothrys reticulatus	Netted popcornflower, Reticulate popcorn flower					X	X	X					
Plagiobothrys tenellus	Pacific popcornflower, Popcorn flower			X	X	X							
Plagiobothrys undulatus	Coast allocarya				X	X							
Platanthera dilatata var. leucostachys	Sierra bog orchid						X	X	X				
Plectritis ciliosa	Long spurred plectritis, Longspur seablush			X	X								
Plectritis macrocera	Long horn plectritis, White plectritis			X	X	X							
Polypodium scouleri	Leather fern, Leather leaf fern, Leathery polypody		X	X	X	X	X	X	X	X	X		
Polystichum imbricans	Cliff sword fern, Narrow leaved sword fern				X	X	X	X	X	X	X		
Potamogeton nodosus	Long leaved pondweed, Pondweed							X	X				
Potamogeton pusillus	Small pondweed					X	X						
Prosartes smithii	Largeflower fairybells		X	X									
Prunella vulgaris	Common selfheal, Self heal, Selfheal							X	X				
Prunus emarginata	Bitter cherry				X	X							
Pseudognaphalium ramosissimum	Pink cudweed						X	X	X				
Quercus douglasii	Blue oak			X	X	X							
Rafinesquia californica	California chicory, California plumseed				X	X	X	X					
Ranunculus aquatilis	Whitewater crowfoot				X	X	X	X					
Ranunculus flammula var. ovalis	Greater creeping spearwort							X	X				
Rhododendron macrophyllum	Coast rhododendron, Pacific rhododendron			X	X	X							
Ribes californicum	California gooseberry, Hillside gooseberry	X	X	X									

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ribes divaricatum var. pubiflorum	Spreading gooseberry, Straggly gooseberry			X	X	X							
Ribes sanguineum var. glutinosum	Blood currant, Flowering currant	X	X	X									
Rosa californica	California wild rose, California wildrose					X	X	X	X				
Rubus spectabilis	Salmon berry, Salmonberry		X	X									
Rumex salicifolius	Willow dock, Willow leaved dock						X	X	X	X			
Ruppia maritima	Ditchgrass or wigeon grass				X	X							
Sagina decumbens ssp. occidentalis	Western pearlwort			X	X								
Salix scouleriana	Nuttall willow, Scouler willow		X	X									
Salix sitchensis	Coulter willow, Sitka willow			X									
Salvia columbariae	Chia sage			X	X	X	X						
Sambucus racemosa	Red elderberry							X	X				
Sanicula arctopoides	Footsteps of spring, Yellow mats		X	X	X	X							
Scutellaria californica	California skullcap						X	X					
Scutellaria tuberosa	Danny's skullcap, Scullcap			X	X	X	X	X					
Setaria parviflora	Marsh bristlegrass					X	X	X	X	X			
Sidalcea calycosa ssp. calycosa	Annual checkerbloom, Checker mallow				X	X	X	X	X	X			
Silene antirrhina	Sleepy catch fly, Sleepy catchfly, Sleepy silene				X	X	X	X	X				
Silene coniflora	Fire following campion				X	X	X						
Solanum xanti	Chaparral nightshade, Purple nightshade		X	X	X	X	X	X					
Solidago elongata	West coast canada goldenrod							X	X	X			
Stebbinsoseris decipiens	Santa Cruz microseris				X	X							
Stephanomeria exigua ssp. coronaria	Milk aster, White plume wirelettuce						X	X	X	X	X	X	
Stephanomeria virgata	Rod wirelettuce, Tall stephanomeria							X	X	X	X		
Stuckenia pectinata	Sago pondweed					X	X	X					
Symphyotrichum	Eastern annual saltmarsh aster							X	X	X	X		

Scientific Name	Common Name(s)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
subulatum													
Synthyris reniformis	Snow queen, Snowqueen		X	X	X	X	X						
Trifolium barbigerum	Bearded clover		X	X	X	X							
Trifolium ciliolatum	Foothill clover, Tree clover				X	X							
Trifolium gracilentum	Graceful clover, Pin point clover, Pinpoint clover				X	X	X						
Trifolium macraei	Chilean clover, Macrae's clover			X	X	X							
Trifolium obtusiflorum	Clammy clover, Creek clover				X	X	X	X					
Trifolium oliganthum	Few flowered clover, Minitomcat clover				X	X							
Trifolium variegatum var. geminiflorum	Small-flowered variegated clover			X	X	X	X	X					
Trifolium variegatum var. major	Large variegated clover			X	X	X	X	X					
Trifolium variegatum var. variegatum	Variegated clover			X	X	X	X	X					
Trifolium wormskioldii	Coast clover, Cow clover, Cows clover					X	X						
Triglochin scilloides	Flowering-quillwort			X	X	X	X	X	X	X	X		
Trillium chloropetalum	Common trillium, Giant wakerobin, Trillium		X	X	X	X	X						
Triodanis biflora	Venus looking glass, Venus' looking glass				X	X	X						
Triteleia peduncularis	Long rayed brodiaea, Marsh triteleia					X	X	X					
Veronica americana	American brooklime, American speedwell							X	X				
Veronica peregrina ssp. xalapensis	Hairy purslane speedwell, Neckweed			X	X	X	X	X					
Vicia hassei	Hasse's vetch			X	X	X							
Viola adunca	Blue violet, Dog violet, Hookedspur violet				X	X	X	X	X				
Viola glabella	Pioneer violet, Stream violet				X	X	X	X					
Yabea microcarpa	California hedge parsley, False carrot				X	X	X						

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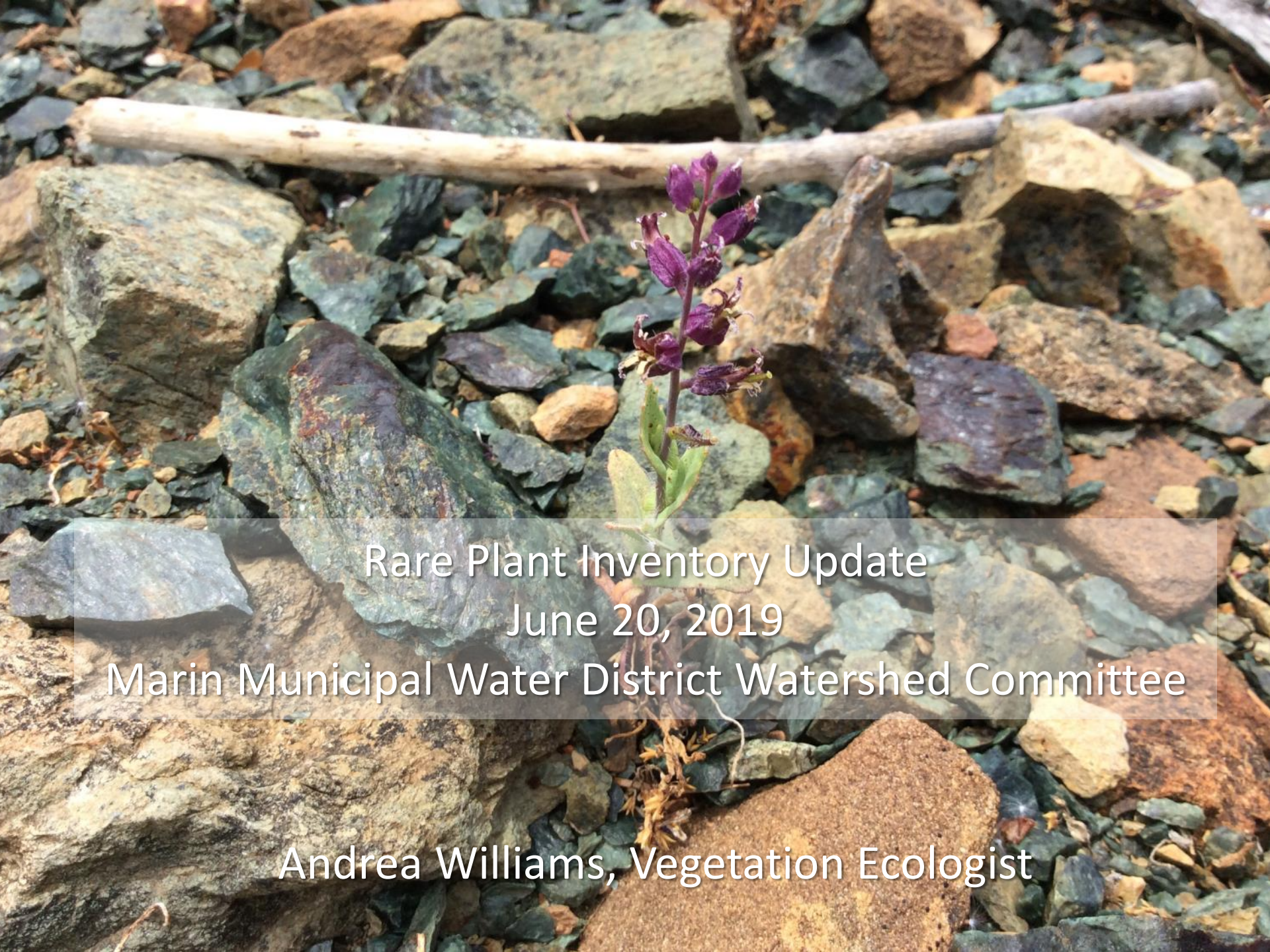
Appendix 1 - Detailed Species and Population Accounts

This appendix is included as a separate document as it contains detailed accounts by species, including sensitive information, such as population locations and background on searches or plantings.



Rare Plant Inventory Update

June 20, 2019

Marin Municipal Water District Watershed Committee

Andrea Williams, Vegetation Ecologist

Overview

- Why inventory rare plants?
- The 1990 Sensitive Plant Survey
- Search targets and results
- Current status and trends
- Extirpated and locally rare species
- Next steps

Marin Municipal Water District

Marin Municipal Water District Mission

To sustainably manage our natural resources, and to provide our customers with reliable, high-quality water at a reasonable price.

Marin Municipal Water District

Why Inventory Rare Plants?

- Can’t manage what you don’t know
- Comply with regulations and permit conditions
- Contribute to understanding of condition/rarity
- Increase stewardship of district resources

Rare Plant Treasure Hunt with California Native Plant Society, 2012

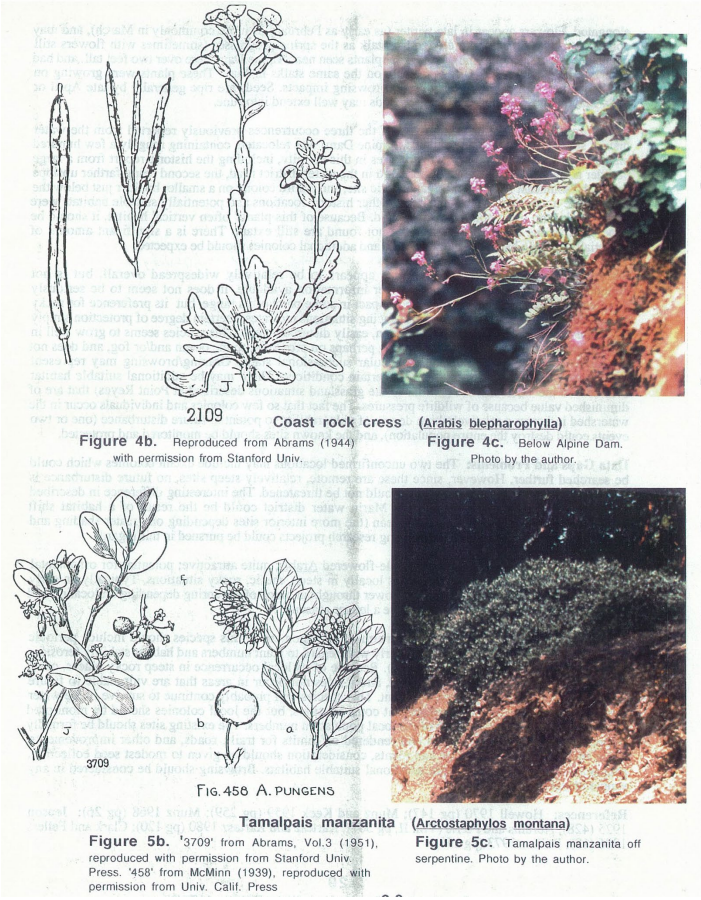
Marin Municipal Water District

Baseline Information

1990 Sensitive Plant Survey of the Marin Municipal Water District (Charles A. Patterson) last comprehensive field-based survey

2001 California Native Plant Society published updated Inventory of Rare and Endangered Plants of California

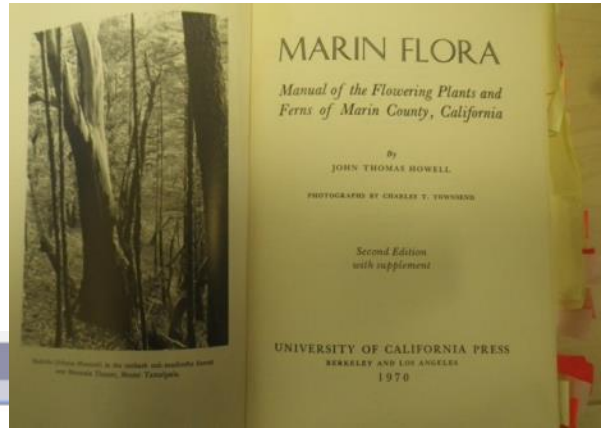
2009 Biodiversity Management Plan for Marin Municipal Water District Lands (Garcia and Associates) updated lists of rare plants based on current rarity ranks



MARIN MUNICIPAL WATER DISTRICT

Baseline Information

A local, comprehensive flora: J.T. Howell's Marin Flora (Second Edition, 1970) details locations of species



Herbarium specimens searchable online

http://ucjeps.berkeley.edu/consortium/

Consortium of California Herbaria

Participants News Search About

Comments/suggestions pertaining to CAS111251

Comments in white are have been addressed by the home institution of the record

Mon Jun 24 10:35:45 2013	Ryan O'Dell	Other	This species has not been documented in Marin county since the collection by Wickes at Mt. Tamalpais in 1917. Likely extirpated.					
Original	CAS111251	Cypripedium californicum	Miss Eastwood	May 98	s.n.	Marin	*	38.0909 -122.6597
Modification	CAS111251	Cypripedium californicum	Miss Eastwood	May 98	s.n.	Marin	&42;	

Click on this link to draw a map.
Examine all comments/suggestions pertaining to CAS

- Intermittent rare plant surveys by CNPS and MMWD
- California Natural Diversity Database backlogged, no List 4 plants
- Calflora, iNaturalist observation searches

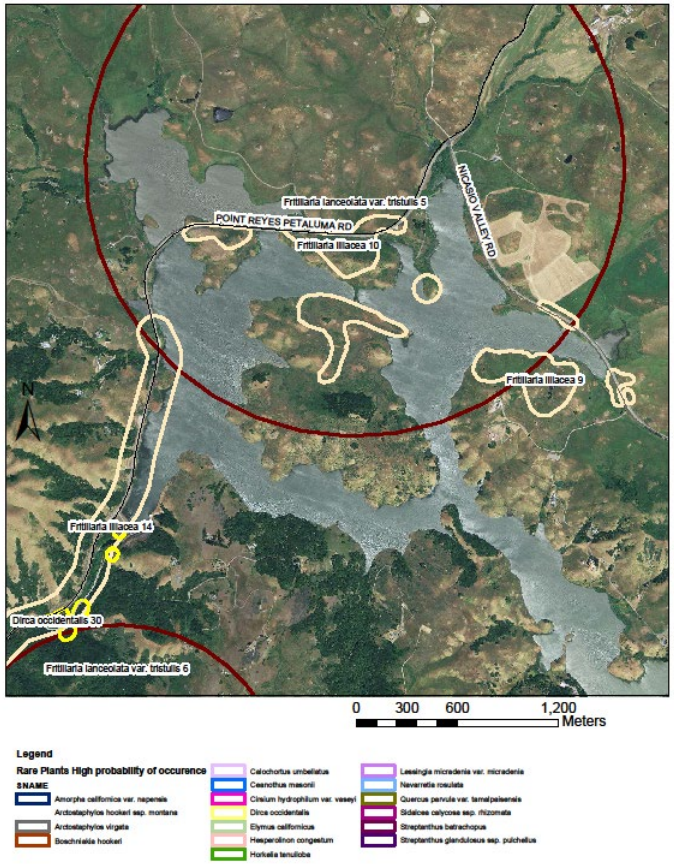
Marin Municipal Water District

Search Targets

- 70 plant taxa known or with potential to occur
- 235 mapped patches from CNDDB
- Paper maps from 1990 survey
- Soil maps (serpentine species)

Fragrant fritillary,
Fritillaria liliacea

RPTH OVERVIEW MAP: NICASIO ISLAND



MARIN MUNICIPAL WATER DISTRICT

CALIFORNIA ACADEMY OF SCIENCES

BioBlitz

Mt Tamalpais

MARIN MUNICIPAL WATER DISTRICT

A snapshot in time…

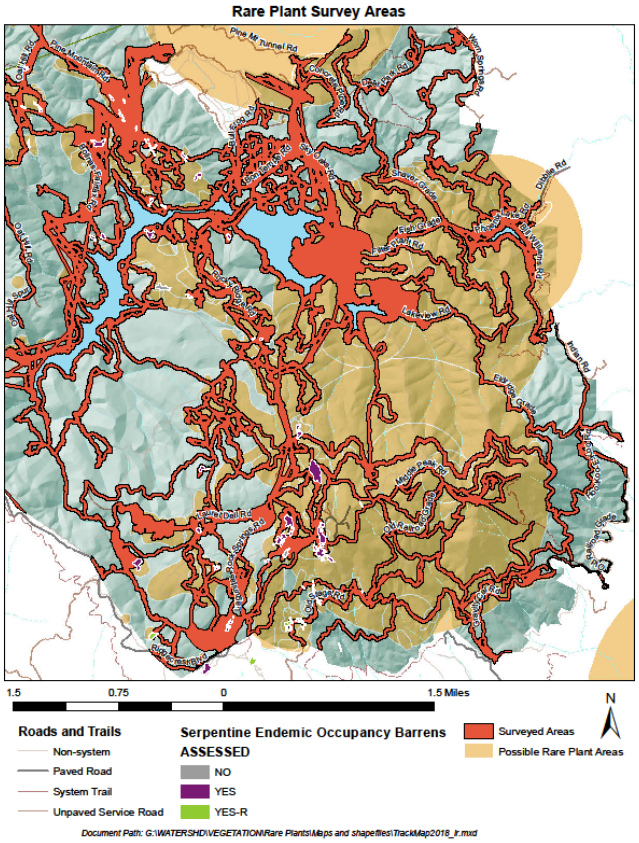
Key Goals

- Document current state of flora on Mt. Tamalpais
- Fill taxonomic gaps in collections
- Establish tool for studying our changing landscape
- Increase local expertise and engagement

A Century of Service & Stewardship
100th Anniversary
1912-2012
Marin Municipal Water District

Search Results, 2012-2018

- 35 plant taxa known, 30 with potential to occur; 69 believed extirpated (12 rare)
- 407 mapped patches
- GIS shapefile with updated information
- Mapped search areas (nearly 5,000 acres)



MARIN MUNICIPAL WATER DISTRICT

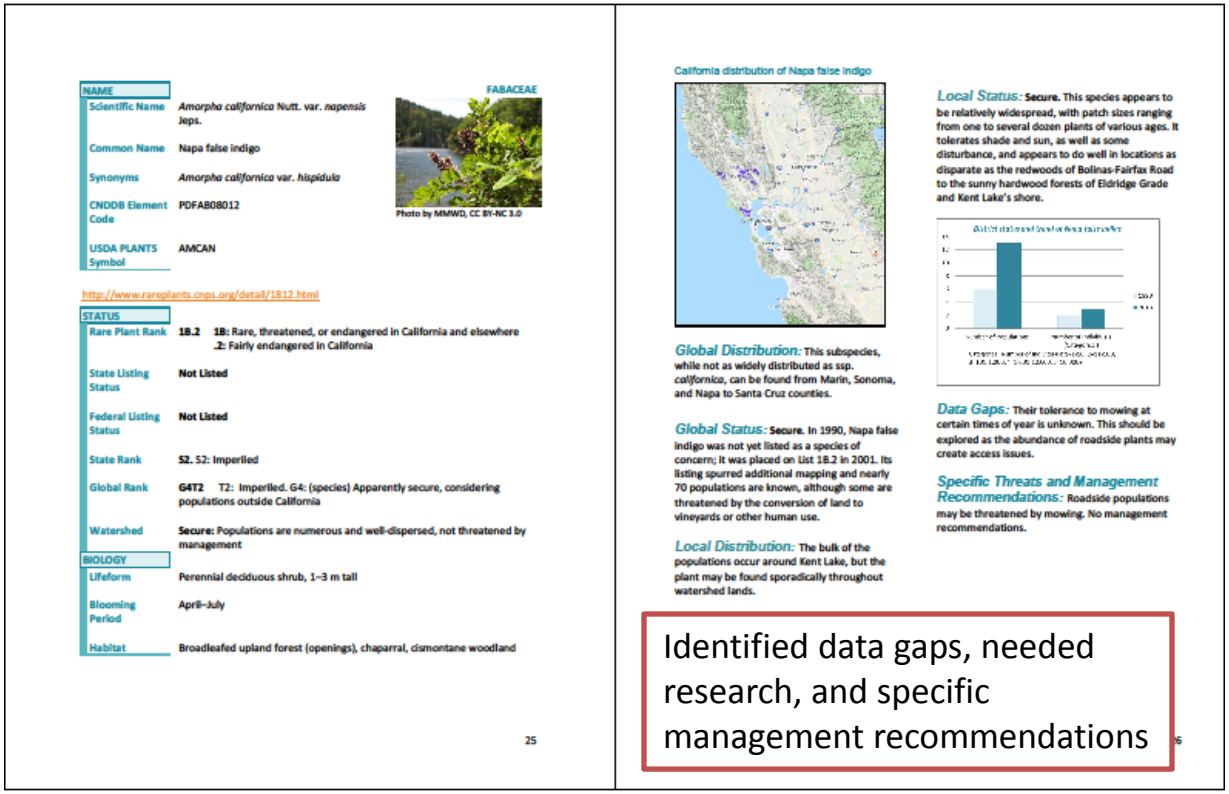
A 2010 boat survey of Kent Lake yielded dozens of new patches of Napa false indigo, *Amorpha californica* var. *napensis*

Report Format

- Introduction
- Methods
- Rare Plant Species and Ranges
- Species Accounts (35 species)
- Extirpated Species
- Locally Rare Species

Summary of global and local information with link to CNPS Inventory

California distribution map; global and local narrative with comparison to 1990 report



NAME	
Scientific Name	*Amorpha californica* Nutt. var. *napensis* Jeps.
Common Name	Napa false indigo
Synonyms	*Amorpha californica* var. *hispidula*
CNDDB Element Code	PDFAB08012
USDA PLANTS Symbol	AMCAN

FABACEAE

Photo by MMWD, CC BY-NC 3.0

http://www.rareplants.cnps.org/detail/1812.html

STATUS	
Rare Plant Rank	**1B.2** **1B:** Rare, threatened, or endangered in California and elsewhere **.2:** Fairly endangered in California
State Listing Status	**Not Listed**
Federal Listing Status	**Not Listed**
State Rank	**S2.** S2: Imperiled
Global Rank	**G4T2** T2: Imperiled. G4: (species) Apparently secure, considering populations outside California
Watershed	**Secure:** Populations are numerous and well-dispersed, not threatened by management
BIOLOGY	
Lifeform	Perennial deciduous shrub, 1–3 m tall
Blooming Period	April–July
Habitat	Broadleafed upland forest (openings), chaparral, cismontane woodland

25

California distribution of Napa false indigo

Local Status: **Secure.** This species appears to be relatively widespread, with patch sizes ranging from one to several dozen plants of various ages. It tolerates shade and sun, as well as some disturbance, and appears to do well in locations as disparate as the redwoods of Bolinas-Fairfax Road to the sunny hardwood forests of Eldridge Grade and Kent Lake's shore.

Global Distribution: This subspecies, while not as widely distributed as ssp. *californica*, can be found from Marin, Sonoma, and Napa to Santa Cruz counties.

Global Status: **Secure.** In 1990, Napa false indigo was not yet listed as a species of concern; it was placed on List 1B.2 in 2001. Its listing spurred additional mapping and nearly 70 populations are known, although some are threatened by the conversion of land to vineyards or other human use.

Local Distribution: The bulk of the populations occur around Kent Lake, but the plant may be found sporadically throughout watershed lands.

Data Gaps: Their tolerance to mowing at certain times of year is unknown. This should be explored as the abundance of roadside plants may create access issues.

Specific Threats and Management Recommendations: Roadside populations may be threatened by mowing. No management recommendations.

Identified data gaps, needed research, and specific management recommendations

Marin Municipal Water District

Comparison to 1990 Report

1990	2019
• 53 taxa CNPS-listed , 19 found	• 70 taxa CNPS-listed , 35 found
• 84 of local concern, 25 found	• 190 of local concern, all found
• 77 potentially occurring	• 35 potentially occurring

Only 2 of 44 plants found in 1990 are no longer present

Snow brush
Ceanothus velutinus
© 2012 Aaron Arthur

Showy milkweed
Asclepias speciosa
©2009 Barry Breckling

Marin Municipal Water District

Comparison to 1990 Report

In 2015, 1 of 2 remaining Marin manzanita populations was confirmed to have Sudden Oak Death, furthering the demise of this fire-dependent species

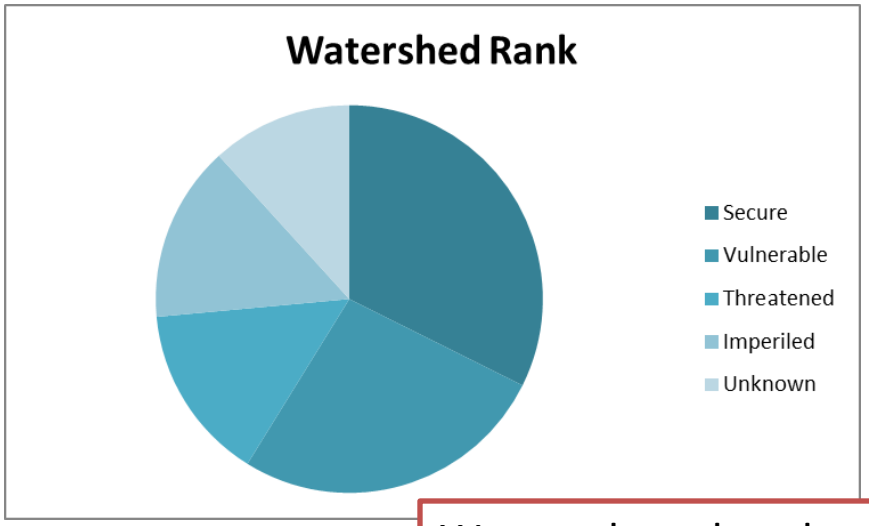
- 20 of 35 taxa have enough information to determine trend
- Marin manzanita (*Arctostaphylos virgata*) lost 5 of 7 populations, thin-lobed horkelia (*Horkelia tenuiloba*) and Marin County navarretia (*Navarretia rosulata*) each lost 1 population
- 25 taxa showed no net change in total populations; 7 increased
- Total number of individuals stable or increased except Marin manzanita , thin-lobed horkelia, Brewer's milk-vetch (*Astragalus breweri*)

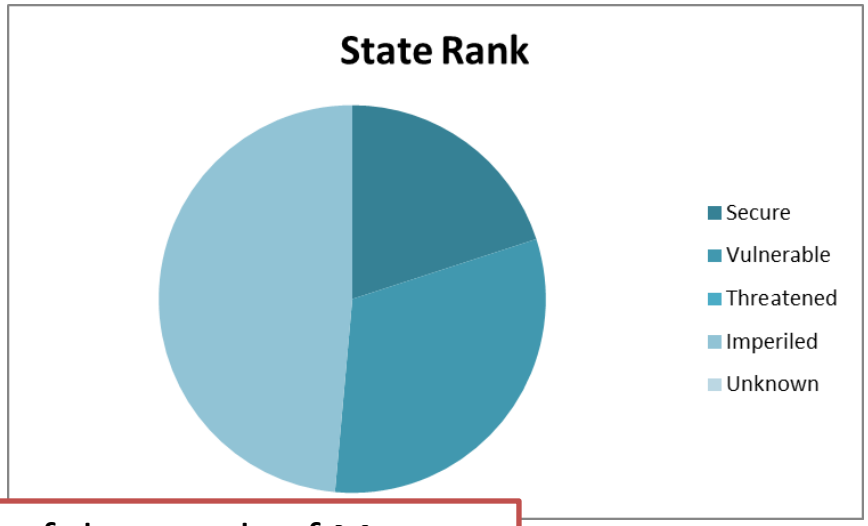
Marin Municipal Water District

Local vs. State Status

What is the status of the species in the area of concern?

- Number of populations and area covered, number of individuals
- How broadly dispersed the populations are
- How many of the populations are threatened, site conditions





We may have hundreds of thousands of Mt. Tamalpais manzanita or Tamalpais lessingia, but that is the world's population of these plants

Marin Municipal Water District

Presumed Extirpated – 68 Plants

Graphic representations of loss of wetlands, grasslands, and fire

- 48% moisture-loving species
- 28% grassland species
- 12% fire-dependent species
- 19% already CNPS/CRPR rare

Lifeform	Rare	Moisture-dependent	Fire-follower	None of the Above
Annual	6	10	5	12
Fern		3		
Perennial	6	18	1	5
Shrub, Tree	1	1	1	4
Grand Total	**13**	**32**	**8**	**21**
% of Total	**19%**	**48%**	**12%**	**31%**

Lifeform	Open areas	Rock outcrops	Chaparral	Chaparral, riparian	Wetlands	Grasslands	Woodlands	Forest gaps	Forests	Grand Total	% of Total
Annual	3		7		6	14	1			**31**	**46%**
Fern					2				1	**3**	**4%**
Perennial	1	1	1		13	5		2	2	**25**	**37%**
Shrub, Tree			3	1				2	2	**8**	**12%**
Grand Total	4	1	11	1	21	19	1	4	5	**67**	**100%**
% of Total	**6%**	**1%**	**16%**	**1%**	**31%**	**28%**	**1%**	**6%**	**7%**		

Marin Municipal Water District

Halfway to Extinction

The loss of individual populations is halfway along the trajectory to extinction

- Climate change?
- Invasive plants?
- Loss of fire?
- Disease altering forest structure and microclimates?
- Combinations of all these?

Enchanter's nightshade
©2013 Debra L. Cook

Golden-eyed grass
©2011 Vernon Smith

Bicknell's geranium
©2012 RT Hawke

Showy Indian clover
©2009 Doreen L. Smith

Marin Municipal Water District

Locally rare species

- Three or fewer populations known or documented on MMWD lands
- Southern or northern terminus, or disjunct population
- Clear “hotspots” of rarity: Potrero and Lagunitas Meadows; Lag Creek between Alpine and Kent
- Currently at 206 plants, or 28% of native plants on MMWD list
- Detailed analysis not done, but numbers/distribution of habitats and life forms appears similar to extirpated species list

Marin Municipal Water District

Current or Planned Work

- Remove weeds, augment natives, and other restoration
- Reintroduce natural processes and species or fake them
- Keep using best management practices: pre-work surveys, avoidance measures, staff training
- Continue searching for and documenting rare and locally rare plants
- Next step: monitoring plan

MARIN MUNICIPAL WATER DISTRICT

Acknowledgements

Michelle O'Herron for editing and formatting the report, Rachel Kesel, David Greenberger and other One Tam staff for additional data. Many thanks to the California Academy of Sciences, the S.D. Bechtel, Jr. Foundation for initial bioblitz funding, and to Doreen Smith and CNPS, Chris Qian, Yumi Igarashi, Elliot Gunnison, Emily West, KevinDick, Anna Schlosser, Dominique Sevi, Shelly Benson, Alan Castner, C. Jones, Kevin Dick, Carissa Brand, and Alison Titus; and thanks to all our staff and volunteers in the field

MARIN MUNICIPAL WATER DISTRICT

ITEM NO. 3
MEETING DATE: June 20, 2019
MEETING: Board of Directors

STAFF REPORT

SUBJECT: Award of Professional Services Agreement with ESA for On-Call Environmental Compliance Services

SUBMITTED BY: Shaun Horne, Natural Resources Program Manager
Crystal Yezman, Facilities and Watershed Division Manager

RECOMMENDED ACTION: For review and referral to a regular meeting of the Board of Directors with recommendation to approve authorizing the General Manager to execute a Professional Services Agreement with ESA for a two-year contract to provide Environmental Compliance Services, on an as-needed basis, for a not-to-exceed amount of $250,000 for each fiscal year

EXECUTIVE SUMMARY:

The District requires consultant services to support environmental compliance for water resources, water supply and watershed projects. Specifically, the contract will support projects requiring CEQA/NEPA, environmental permitting, biological surveys, cultural resources assessments, hydrologic analysis, and geomorphic monitoring. Environmental compliance support is necessary for the District to implement various infrastructure and watershed maintenance projects including upkeep of trails, upgrades to water distribution infrastructure, and to support vegetation management for wildfire fuel reduction. Staff is requesting that the Board approve a two-year agreement with ESA for Environmental Compliance Services as needed for a not-to-exceed amount of two hundred fifty thousand dollars for each fiscal year.

FISCAL IMPACT: **YES** X **NO** ____ **FISCAL YEAR:** 2020

EXPENDITURES

Budgeted Amount	$250,000
Budget Augmentation Requested	$
	$
	$
TOTAL EXPENDITURES	**$250,000**

FUNDING SOURCES

Operating Fund	$250,000
Capital Fund	$
Other	$
Operating Reserves	$
TOTAL SOURCES	**$250,000**

FISCAL IMPACT NARRATIVE:

Staff anticipates a multi-year agreement with $250,000 allocation from FY 20 budget and $250,000 from FY 21.

BACKGROUND:

ESA has been providing environmental consulting services in the Bay Area since 1969 and has worked on numerous MMWD projects in the past. Their core service area is CEQA/NEPA documentation, permitting, monitoring, environmental hydrology, and sustainability services. ESA has a robust team of professionals with experience providing these core services to water municipalities throughout the Bay Area. The District has a range of future projects that will require environmental compliance support from initial project scoping, to CEQA documentation, to project specific biological monitoring. In the past the District has utilized outside consulting firms with success to complete similar environmental compliance work.

The agreement proposed is a fee for service contract with no minimum or maximum amount of work guaranteed to the firm. The agreement also contains a termination clause which allows the District to terminate the agreement at any time. Actual costs will depend on future project needs and will be billed to projects within the Watershed and Facilities Division and Environmental Services and Engineering Division.

Staff is requesting the Board of Directors approve and authorize the General Manager to execute an agreement with ESA in an amount not to exceed $250,000 annually for a two-year term with an option to extend for an additional two-year term.

Proposal Selection Process

Staff sent a request for proposals to five San Francisco Bay Area firms that were identified as having sufficient in-house expertise to address all of the components of the District's scope of work. Specifically, these service providers have staff qualified and skilled in CEQA/NEPA documentation, environmental permitting, biological monitoring, environmental hydrology, and sustainability services. The five firms were Horizon Water and Environment, Panorama, Dudek, Amy O. Skewes Cox with Environmental Collaborative, and ESA.

The review of proposals and selection of a service provider occurred between February and May 2019. The Watershed and Facilities Division worked in coordination with the Environmental Services and Engineering Division to review proposals. The District selected to interview four qualified firms. The District's selection criteria included a demonstrated understanding of the work required, thoroughness of the proposal, technical expertise and qualifications of personnel identified to do the work—specifically with experience working on water infrastructure and watershed management projects. Upon review of proposals and through in-person interviews staff identified ESA as the most suitable firm for MMWD's upcoming projects.

STRATEGIC PLAN ALIGNMENT:

The requested action aligns with the District's Strategic Plan Goal 4 (Environmental Stewardship), Strategy 3 (Enhance ecosystem resiliency), Objective 1 (Implement vegetation management plan actions to protect communities and habitats from wildfire).

REVIEWED BY:	A.S.D Manager/Treasurer	X	NA	
	General Counsel	X	NA	
	General Manager	X	NA	

ATTACHMENTS:

None.

MARIN MUNICIPAL WATER DISTRICT

ITEM NO. 4
MEETING DATE: June 20, 2019
MEETING: Board of Directors

STAFF REPORT

SUBJECT: Grazing Feasibility Study

SUBMITTED BY: Andrea Williams, Vegetation Ecologist
Shaun Horne, Natural Resources Program Manager
Crystal Yezman, Facilities and Watershed Division Manager

RECOMMENDED ACTION: Discussion

EXECUTIVE SUMMARY:

In March 2017 the District requested consultant services for a grazing feasibility study to explore whether grazing could be used to reduce the cover of fuels and weeds and improve grassland health in an economically and environmentally sustainable fashion. Sixteen target areas and 12 priority weed and rare plant species were considered during the study. The report concluded contract grazing may be used in conjunction with current vegetation management practices, with moderate effectiveness within identified grazing areas. Moving forward, a site-specific grazing plan and monitoring protocol should be completed prior to pursuing grazing.

FISCAL IMPACT: **YES** _____ **NO** X **FISCAL YEAR:** _____

FISCAL IMPACT NARRATIVE:

None—funds were spent in FY17-18.

BACKGROUND:

The District has used and tested various types of manual and mechanical removal methods over the last decade to remove invasive plant species and reduce fuel loads, as well as previous grazing trials with goats and sheep. As part of the focus provided by the draft Biodiversity, Fire and Fuels Integrated Plan (BFFIP) and an increase in use of contract grazing by public and private land managers to achieve similar goals, the District requested proposals to study the feasibility of using grazing to meet management outcomes.

LD Ford, Rangeland Conservation Science, a consulting firm based in Felton, California, was selected based on their extensive expertise in grazing and other rangeland management practices. The team reviewed literature, background information provided by the District, and interviewed local grazers and ranchers.

The District provided a list of priority weed and rare plant species based on distribution and potential grazing impact:

- Barbed goatgrass, *Aegilops triuncialis*, invasive annual grass

- Common velvet grass, *Holcus lanatus*, invasive perennial grass
- Eggleaf spurge, *Euphorbia oblongata*, invasive perennial forb
- French broom, *Genista monspessulana*, invasive perennial shrub
- Harding grass, *Phalaris aquatica*, invasive perennial grass
- Harlequin lotus, *Hosackia gracilis*, rare perennial forb
- Marin western flax, *Hesperolinon congestum*, rare annual forb
- Marsh Zigadenus, *Toxicoscordion fontanum*, rare perennial forb
- Mt. Tamalpais thistle, *Cirsium hydrophilum* var*. vaseyi*, rare perennial forb
- Poison hemlock, *Conium maculatum*, invasive perennial forb
- Tall fescue, *Festuca arundinacea*, invasive perennial grass
- Yellow starthistle, *Centaurea solstitialis*, invasive annual forb

Sixteen areas of grassland and fuelbreak were identified as potential grazing areas and analyzed for expected effectiveness in meeting management objectives and cost effectiveness. One area, Poison Spring Grasslands, ranked high, but is a low priority for treatment as it contains no target species and is not a fuelbreak. Seven others ranked Medium; the table below is in priority treatment order for the District.

Potential Grazing Area	**Rank for Expected Effectiveness in Meeting Mgmt Objectives**	**Rank for MMWD Cost Effectiveness**	**Combined Rank**
1. Sky Oaks	Medium	Medium	Medium
2. Porteous-Ross Reservoir-Worn Spring Middle	Medium	Low	Low+
3. Pilot Knob	Low	Low	Low
4. Ridgecrest-Rock Spring-Potrero	Low	Medium	Low+
5. Pumpkin Pine-Fish-Lag Meadows	Medium	Medium	Medium
6. Deer Park-Worn Spring North	Medium	Low	Low+
7. Bill Williams-Indian Crown	Medium	Low	Low+
8. Fawn Ridge-Deer Park	Medium	Low	Low+
9. Azalea Hill	Medium	Medium	Medium
10. Pine Mountain South Gate	Medium	Medium	Medium
11. Bathtub Gap-Carson Ridge	High	Medium	Medium+
12. Poison Spring Grasslands	High	High	High
13. Kent Pump Beginning	Low	Low	Low
14. Grassy Knoll	N/A	Low	N/A
15. Cascade Creek	Medium	Medium	Medium
16. Midpoint Meadows	High	Medium	Medium+

The report details animal-specific, area-specific, and target-plant-specific considerations as well as overall environmental considerations that would be analyzed as part of a grazing plan.

The lack of existing infrastructure, site constraints, and complex objectives (removal of target species without damaging native systems or waterways) make grazing unappealing to ranchers, so contract grazing/browsing would need to be employed. High per-acre costs, questionable success of grazing/browsing for management of target species, and likely need for repeat treatments each year make this tool less appealing than current successful tools.

It may be possible to use contract grazing in combination with mechanical removal in some areas, but a site-specific grazing plan would need to be prepared to ensure the protection of water quality and sensitive species.

STRATEGIC PLAN ALIGNMENT:

This activity aligns with the District's Strategic Plan Goal 4 (Environmental Stewardship), Strategy 3 (Enhance ecosystem resiliency), Objective 1 (Implement vegetation management plan actions to protect communities and habitats from wildfire).

REVIEWED BY:				
	A.S.D Manager/Treasurer		NA	X
	General Counsel	X	NA	
	General Manager	X	NA	

ATTACHMENTS:

1. Grazing Feasibility Report

Grazing Feasibility Study for the Mt. Tamalpais Watershed, Marin Municipal Water District, California

Prepared for:
Marin Municipal Water District
220 Nellen Avenue, Corte Madera, CA 94925-1169

Prepared by:
LD Ford Rangeland Conservation Science
5984 Plateau Drive, Felton, CA 95018

and
Ecosystems West Consulting Group
180 Seventh Avenue, Suite 201, Santa Cruz, CA 95062

Final Draft: June 30, 2018

Grazing Feasibility Study for the Mt. Tamalpais Watershed, Marin Municipal Water District, California

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1. Executive Summary and Key Findings

For many years, the Marin Municipal Water District (MMWD) has used various types of manual labor and heavy equipment—and until 2005, herbicide application—to manage invasive weed species that degrade plant and wildlife habitats and interfere with staff access and public recreation. These same tools have also been used to reduce fire fuel loads, especially in designated fuelbreak areas. Although MMWD has only experimented with domestic livestock grazing a couple of times in the past, this practice has been increasingly used by both public and private lands management agencies to achieve some of the same vegetation management outcomes as mechanical and chemical methods.

In February 2017, MMWD released a request for proposals for a feasibility study to determine whether livestock grazing can be successfully used to augment its existing vegetation management program. LD Ford, Rangeland Conservation Science, a consulting firm based in Felton, California, was selected based on their extensive expertise in grazing and other rangeland management practices.

Dr. Lawrence Ford assembled a team of leading qualified experts who spent the spring and summer of 2017 interviewing livestock operators and MMWD staff, as well as reviewing relevant published and unpublished documents, maps, and aerial photographs of MMWD's Mount Tamalpais Watershed lands (MTW Lands).

Scientific literature provided the theoretical basis for recommendations about grazing and its expected effects on targeted MTW resources such as rare plants and priority weed species. A telephone survey of 13 contract graziers[1] and livestock ranchers (Section 6) offered a more practical understanding of how vegetation management could be accomplished with grazing and browsing animals. Results of these interviews and known physical site constraints reveal limitations that temper the promise offered by academic studies and theoretical research. These results are briefly summarized here and then described in full in the body of this report.

Weed Management

Phone surveys revealed that site constraints, complex grazing objectives, and lack of permanent infrastructure make MTW Lands unappealing to ranchers who make their living by producing animal products (Section 6). Therefore, contract graziers who charge a fee to provide grazing/browsing services would be required. However, contract grazing/browsing is likely unrealistic as an overall weed management tool on MTW Lands because of high per-acre costs, probable need for repeated grazing/browsing treatments each year, and questionable success of grazing/browsing for management of many of MMWD's target weed species (Section 7).

While using livestock to manage some weed species has been successful in controlled experimental settings, transferring experimental techniques to MTW Lands where there are complex and in some cases competing objectives is not practical. For example, there are many sites where the goal is to both protect rare plants and manage weeds and/or where there are multiple weed species that would require different grazing timing or frequency. Furthermore, some grazing animals either cannot tolerate certain weeds or graze so broadly that they consume desirable species as well (Section 5). The idea of

[1] A person who raises livestock on grazing land, used here to those who raise animals on browsing land where woody plants are the predominant feed. This term is used to refer to people who own livestock for contract vegetation management, rather than being traditional ranchers who raise livestock to produce animal products.

training livestock to consume unfamiliar weed species has been popularized in recent years, but data regarding actual control of many species are lacking.

Livestock will undoubtedly consume *some portion* of most of the high-priority weed species on MTW Lands, but grazing or browsing is unlikely to provide the full desired level of control. Although it may not completely remove targeted weeds, grazing can be managed to help reduce weed mass and seed production—if timed effectively and repeated frequently. If not managed properly though, browsing or grazing may cause branching of flowering heads and production of additional seeds, which could actually lead to weed expansion.

Fuelbreak Maintenance

Section 5 describes grazing and browsing habits of domestic livestock. Browsing by sheep and goats may be useful for control of fire fuels in the high priority fuelbreak areas, which are shown in the MMWD *Draft Biodiversity, Fire, and Fuels Integrated Plan* (Panorama Environmental, Inc. 2016: Figures 3-11 to 3-14). However, woody plant removal by equipment and hand crews is more effective to remove larger stems and is more selective, allowing better protection of non-target plants. The combination of browsing and mechanical/manual treatments, applied repeatedly in rotation through priority areas, would be more effective and efficient than either treatment alone.

Rare Plant Species

Carefully planned and executed grazing would likely be useful for enhancing habitats for native grassland species, including the priority rare species (Section 3 and Appendix 1), on some of the 16 Potential Grazing Areas identified by MMWD staff (Section 4 and Appendix 2).

Cost Considerations

Cost effectiveness of grazing and browsing methods for vegetation management in comparison to mechanical and manual methods[2] indicates a cost advantage for grazing for the following actions (Section 6, Table 2):

- Existing fuelbreak retreatment (only where plants are palatable and wood diameter is small)
- Roadside mowing (especially for herbaceous vegetation)
- Dam maintenance
- Accumulated fuels and brush reductions (only where wood is small diameter)
- Yellow starthistle management (only if timed correctly and for large areas combined into one project)
- General grassland and thatch management for selected special-status plants (very effective with proper timing, but no costs of mechanical methods to compare to)

Combined Weed Management and Cost Effectiveness Analysis

The study team evaluated the expected effectiveness of targeted grazing to meet MMWD's conservation objectives at each of the Potential Grazing Areas identified in Section 7. Using this, plus cost effectiveness analyses, Table 3 ranks the priority of Potential Grazing Areas for MMWD to consider if they decide to proceed with grazing.

In summary, only one of the 16 Potential Grazing Areas appears to have no feasibility for grazing, and thus should not be considered further:

- Grassy Knoll

[2] Actions and Projected Costs from Panorama Environmental, Inc. 2016, Table 7-2. p. 7-5.

Only one ranked *high* in expected management effectiveness and cost-effectiveness:

- Poison Spring Grasslands

Seven others ranked *medium* in expected effectiveness:

- Sky Oaks
- Pumpkin Pine-Fish-Lag Meadows
- Azalea Hill
- Pine Mountain South Gate
- Bathtub Gap-Carson Ridge (medium+)
- Cascade Creek
- Midpoint Meadows (medium+)

Priority grazing areas that include the target species should be evaluated individually and grazing plans and monitoring protocols should be developed before grazing is initiated. If MMWD is interested in pursuing grazing, the study team recommends they start with testing at one or more of the most promising grazing areas.

2. Project Background

The MMWD Grazing Feasibility Study team included Dr. Lawrence Ford, Principal and Senior Natural Resource Scientist (California Certified Rangeland Manager license #M70); Lisa Bush, Agriculture and Range Management Specialist (California Certified Rangeland Manager license #M18); Pete Van Hoorn, Rangeland Ecologist (California Certified Rangeland Manager license #M101), all of LD Ford Rangeland Conservation Science; and Justin Davilla, Special Resource Ecologist and Botanist, of EcoSystems West Consulting Group. They were supervised by and collaborated with Andrea Williams, MMWD Plant Ecologist, and Janet Klein, MMWD Natural Resources Program Manager.

An initial meeting between A. Williams, J. Klein, L. Ford, and L. Bush helped to identify highest priority objectives for a potential grazing program. These included fuelbreak maintenance, meadow restoration (thatch reduction and management of exotic perennial grasses) and enhancement, weed suppression and eradication, and possible management of tanoak resprouts in Sudden Oak Death-affected areas. Ms. Williams subsequently identified priority rare plants and weeds to potentially target with grazing through telephone conversations and in the memo titled "Grazing Species Selection Final" (Appendix 1).

Due to budget constraints, the only on-site reconnaissance was one half-day visit by L. Bush with A. Williams in March 2017. A follow-up meeting in June 2017 between MMWD staff, L. Ford, and L. Bush refined the scope of work. Several subsequent teleconferences also occurred. MMWD staff provided detailed information about MTW Lands, including a memo about priority species to target and maps of potential grazing areas, which are referenced and appended to this report.

MMWD asked specifically for analysis of "the feasibility of using limited scale, limited duration grazing to reduce brush and weeds in designated fuel load reduction zones as well as to improve grassland health in an economically and environmentally sustainable fashion" in their February 2017 request for proposals. Grazing is being considered as a potential vegetation management action (notably as an alternative to herbicides) in the *MMWD Draft Biodiversity, Fire, and Fuels Integrated Plan* (Panorama Environmental, Inc. 2016). In addition to the vegetation management goals noted above, MMWD recognizes the particular importance of maintaining water quality and minimizing conflicts with scenic open space and recreational opportunities associated with grazing.

Generally, this analysis focuses on the potential use of grazing and browsing for targeted beneficial management of specific plants or types of vegetation. It should be noted though that livestock grazing can also be used to achieve broader ecosystem goals such as improving habitat for native grassland birds, amphibians, rodents, and invertebrates by reducing cover and obstruction of non-native grassland plants, increasing grassland structural heterogeneity, and reducing thatch. Grazing can also be managed to target zones of higher risk fire fuels, avoid areas of special habitat use during sensitive times, and avoid or minimize potential impacts to water quality and recreational opportunities.

3. Grazing Management to Benefit Selected Rare Plants and Control Selected Weeds

3.1 Management Considerations, Recommendations, and Feasible Grazing Management for Rare Plants, Special-Status Habitats/Natural Communities, and Weeds

Selected rare plants include Mount Tamalpais thistle (*Cirsium hydrophilum* var. *vaseyi*), Marin western flax (*Hesperolinon congestum*), harlequin lotus (*Hosackia gracilis*), and marsh zigadenus (*Toxicoscordion fontanum*). Weed species selected for consideration include barbed goatgrass (*Aegilops truincialis*), yellow starthistle (*Centaurea solstitialis*), poison hemlock (*Conium maculatum*), eggleaf spurge (*Euphorbia oblongata*), reed fescue (*Festuca arundinacea*), French broom (*Genista monspessulana*), common velvet grass (*Holcus lanatus*), and Harding grass (*Phalaris aquatica*). Ms. Williams' full memo is attached as Appendix 1. The memo also lists plants that were *not* selected.

To summarize, the following text is excerpted:

> "MMWD stewards over 20,000 acres of watershed lands, supporting over 1,000 plant species, water for 190,000 residents, and recreation for millions of visitors. State or federal government or the California Native Plant Society consider more than 50 of these plants to be rare; over 100 are listed as invasive by the California Invasive Plant Council. In order to limit the scope of the contract, a maximum of 12 plant species are to be considered in potential grazing scenarios.
>
> I made selections of priority species based on how prevalent the species was on watershed lands potentially subject to grazing; whether the species may serve as a representative for other similar species; and whether the population may be influenced by grazing. MMWD staff also decided to remove Nicasio and Soulajule lands from consideration, which further reduced potential species selection. These lands—Nicasio in particular—may be evaluated for grazing at a future date. Additionally, if grazing is shown to be feasible and beneficial on watershed lands, grazing plans will provide an additional opportunity to examine potential effects on species not currently included in this study.
>
> *Rare Plants Selected (Table 1 [in Appendix 1])*:
> Mt. Tamalpais thistle is a biennial plant that grows in wet, serpentine-influenced sites. Approximately 12 sites are extant in the county, nine of which are on watershed lands. This species is declining for several reasons: changes in hydrology, shading at forest edge sites, and lack of bare ground in wet meadow sites. Well-meaning but ignorant individuals may be killing plants, but other than a planted site we have no direct evidence of this. Mt. Tam thistle was chosen as a broadly distributed but rare and declining species, endemic and emblematic of the watershed, which may benefit from well-managed grazing.
>
> Marin western flax is our only extant federally listed species within the area of focus. It can be found in three sites on watershed lands in serpentine grassland and edges of chaparral. Thought to be on the decline due to competition from other plants, it may also benefit from well-managed grazing.
>
> Harlequin lotus grows in wet meadows on seven sites across the watershed. A low-growing, short-lived perennial, this species overlaps at one site with Mt. Tam thistle but otherwise is

found in non-serpentine wet meadows on the watershed. It may be declining from a combination of hydrologic changes and competition from invasive plants (particularly perennial grasses).

Marsh zigadenus is another wet-meadow species, but it can be found in chaparral as well, and has an affinity to serpentine soils. So far it has been mapped at 18 locations across the watershed. A geophyte, and poisonous, it is unknown how the species will respond to grazing.

Rare Plants Not Selected (Table 2 [in Appendix 1]):
Most of the rare taxa were excluded from consideration because they were too uncommon, or grew in habitats unlikely to be grazed.

Weed Species Selected (Table 3 [in Appendix 1]):
Weedy plants were difficult to narrow down, but species chosen were those on which we currently spend the most time and/or money on, and those which are affecting the most high-quality habitat.

Weed Species Not Selected (Tables 4 and 5 [in Appendix 1]):
With over 100 weeds included on the Cal-IPC of Invasive Plant Inventory, giving a rationale for each would be time-consuming. Species that were uncommon or rare (Table 5) were not selected based on their low abundance; Table 4 contains rationales for more common species. Several of these were excluded simply due to lack of space on the priority list.

Native Species:
Not included are native woody species tanoak (*Notholithocarpus densiflorus*), coyote brush (*Baccharis pilularis*), and chaparral pea (*Pickeringia montana*), which also make up a large portion of our fuel reduction work. If there is time, some or all of these may be added to the list of species considered."

With guidance from the study team, Ms. Williams also prepared maps of the 16 most suitable potential grazing areas (Appendix 2), which are described in Section 4. These areas either include target plants that may benefit from grazing (rare plants) or that may be negatively affected by grazing (weeds) or that are priority fuelbreak areas.

The remainder of this section describes various aspects of the rare plants and weeds selected by A. Williams for potential targeting with grazing (Appendix 1). It also includes information on special-status habitats and natural communities identified by J. Davilla. It is primarily based on review of published scientific literature, but also relies on some unpublished professional papers as well as personal observations by members of the study team.

3.1.1 Rare Plants

Mt. Tamalpais thistle (*Cirsium hydrophilum* var. *vaseyi*)

Ranking and status	**Federal[3]/ State[4]/ CNPS[5]:** None/None/1B.2 **MTW Lands**: Common. Endemic to Marin County and the Mt. Tamalpais watershed with only 12 recorded occurrences, nine of which were found on MTW Lands. Presently six extant, small occurrences, many of which are in decline and several additional occurrences have been extirpated since 1990 (Panorama Environmental, Inc. 2016).
Habitat requirements—General[5,6] and on MTW Lands[7]	**General:** Meadows and seeps with serpentine soils. Considered "obligate" wetland species occupying areas with prolonged soil saturation and/or inundation although not typically found in areas with deep standing water (i.e., stockponds). 240-620 meters elevation. **MTW Lands:** Limited to serpentine seeps and meadows in broadleaf upland forest and chaparral. Mapped occurrences generally less than five acres with fewer than 250 individuals. Typically associated with native obligate wetland species, with seep margins dominated by woody vegetation including coast live oak (*Quercus agrifolia*), coyote brush, coffeeberry (*Frangula californica*), Douglas-fir (*Pseudotsuga menziesii*), chaparral pea, and California blackberry (*Rubus ursinus*).
Vulnerabilities for protection and management—Foliage growth and flowering periods[6], regeneration/ re-sprouting after defoliation, seedbank	Biennial (occasionally short-lived perennial) herb. May–August (September) flowering period. No direct studies of Mt. Tamalpais thistle response to grazing but presumed to respond similarly to Mt. Hamilton thistle (*Cirsium fontinale* var. *campylon*; CNPS 1B.1); a rare biennial serpentine endemic occurring in seeps and meadows in southern Santa Clara County. Mt. Hamilton thistle is somewhat tolerant of grazing but is susceptible to trampling (HT Harvey et al. 2008).

[3] U.S. Fish and Wildlife Service (2017) FT = Threatened: Threatened of becoming endangered within the foreseeable future throughout all, or a significant portion of its range.
[4] CDFW (2017) ST = Threatened: A native species or subspecies that, although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts.
[5] Tibor (2001); California Native Plant Society (2017); CNPS Lists: List 1A: Presumed extinct in California. List 1B: Rare, Threatened, or Endangered in California and elsewhere. List 2: Rare, Threatened, or Endangered in California, more common elsewhere. List 3: Plants about which more information is needed. List 4: Plants of limited distribution: a watch list. Threat Code extensions: 1: Seriously endangered in California. 2: Fairly endangered in California. 3: Not very endangered in California.
[6] California Natural Diversity Database (2017).
[7] Memo prepared by A. Williams (Appendix 1) and GIS site analysis and resultant maps prepared by A. Williams (Appendix 2).

Forage considerations—Quality, palatability, quantity	Spiny, fibrous perennial forb with poor palatability to grazers. Spiny flowers likely to be avoided by sheep and cattle, but goats likely to consume Mt. Tamalpais thistle, especially if other woody browse is lacking.
Grazing effects—General and on MTW Lands	**MTW Lands:** None of these populations are known to have been grazed by domestic livestock for many years, if ever. **General:** Response to grazing is unknown but presumed to be similar to other native thistles endemic to serpentine seeps and meadows. The closest likely analog is the Mt. Hamilton thistle (see above), several populations of which have been actively grazed for habitat enhancement. HT Harvey and Associates (2008) reported that spring grazing impacts were minimal as cattle consume other more desirable green forage, and trampling was also reported to have minimal long-term effects. Nevertheless, grazing directly in serpentine seeps supporting Mt. Tamalpais thistle is likely to be detrimental to this species as excessive trampling in mucky soils may injure or uproot existing plants prior to seed set and facilitate infestations of undesirable invasive plants (J. Davilla, co-author, personal observation).
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing/Exclusion**. Early season, moderate intensity cattle grazing has had positive benefits to native species richness and cover in studies conducted in southern Santa Clara County (Coyote Valley/Kirby Canyon) by decreasing competition from exotic annual grasses (Weiss 1999, Weiss et al. 2007). Grazing may also mediate the effects of nitrification from automobiles and industry and climate change. However, it is likely that trampling and alteration to the hydrologic regime may adversely affect Mt. Tamalpais thistle. Its spiny, fibrous morphology means that it is likely to be mostly avoided by cattle and sheep, especially when flowering. However, goats are likely to browse flowering plants, limiting seed production. Exclusion from grazing or short duration, early-season grazing is recommended.

Marin western flax (*Hesperolinon congestum*)

Ranking and status	**Federal**[3]**/ State**[4]**/ CNPS**[5] FT/ST/1B.1 **MTW Lands:** Rare. Two extant occurrences on MTW Lands in serpentine grassland and chaparral.

Habitat requirements—General[5,6] and on MTW Lands[7]

General: Grasslands and chaparral (ecotone/openings) on serpentine soils. Often found along ridgetops and on well drained, south or east facing aspects. 5–370 meters elevation.

MTW Lands: Mostly occurring in serpentine chaparral with several populations co-occurring with Mt. Tamalpais manzanita (*Arctostaphylos montana* ssp. *montana*; CNPS List 1B.3).

Vulnerabilities for protection and management—Foliage growth and flowering periods[6], regeneration/ re-sprouting after defoliation, seedbank

Annual herb. April–July flowering period. No existing studies on regeneration after defoliation but species is low-growing and likely to be avoided/unaffected by early season grazing. Marin western flax likely co-evolved with grazing herbivores, including tule elk (*Cervus canadensis nannodes*), pronghorn antelope (*Antilocapra americana*), and mule deer (*Odocoileus hemionus*). Therefore, compatibility with appropriately managed grazing regimes is expected. There are no demographic studies evaluating soil seedbank and reproductive habits (e.g., mating, pollination).

Forage considerations—Quality, palatability, quantity

Marin western flax is considered palatable to livestock as it does not contain toxic compounds or other vegetative features (e.g., spines) that grazing animals would avoid. Although low-growing, its abundant flowers per individual may attract livestock during periods where grasses have been grazed low and forage is otherwise limited (USFWS 2011). Marin western flax tends to grow in dense patches, although overall patch size is usually small (less than 0.5 acres).

Grazing effects—General and on MTW Lands

Near to MTW Lands: There are six occurrences of Marin dwarf flax on nearby Golden Gate National Recreation Area (GGNRA) grazing lands. Point Reyes National Seashore staff, who are responsible for special-status plant monitoring on GGNRA lands concluded that "Marin dwarf flax may benefit from a moderate level of cattle grazing through the reduction of taller competing vegetation as the flax is subject to shading by competing grasses or may be suppressed by buildup of thatch from previous year's herbage if left ungrazed." (USNPS 2001).

General: Studies in Santa Clara Valley show moderate cattle grazing will reduce competition for resources from invasive, non-native grasses and may benefit native annual forbs (Weiss 1999, Weiss et al. 2007). Increased nitrification due to automobile exhaust and industry (smog) favors many of these exotic grasses leading to unfavorable conditions for native species, in particular annual forbs, but cattle grazing has been shown to mediate this response (Weiss 1999).

There are no published studies evaluating the effects of goats, sheep or other domestic livestock on serpentine endemics. Due to forage preference for woody browse and grasses, goats are unlikely to adversely affect Marin western flax; however, sheep preference for forbs would likely lead to detrimental impacts to the species.

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing/Intensity**. Early season grazing prior to the April–July flowering period would most likely avoid damaging this plant. Moderate intensity cattle grazing may benefit existing populations by decreasing competition from exotic grasses including Italian ryegrass (*Lolium multiflorum*), brome grasses, and wild oats. Grazing intensity should be sufficient to remove standing biomass of exotic grasses but also maintain desirable levels of RDM[8] to support native annual forbs and minimize impacts to established native perennial bunchgrasses. Grazing effects on Marin western flax have not been studied in detail and so any grazing on MTW Lands should be undertaken carefully with annual monitoring and implementation of adaptive management strategies. Sheep grazing is not recommended due to their preference for forbs.

Harlequin lotus (*Hosackia gracilis*)

Ranking and status	**Federal[3]/ State[4]/ CNPS[5]:** None/None/4.2 **MTW Lands:** Common. Six extant occurrences; one occurrence overlaps with Mt. Tamalpais thistle but otherwise occurs in non-serpentine areas.
Habitat requirements—General[5,6] and on MTW Lands[7]	**General:** Wetlands and roadsides; broad-leafed upland forest, coastal bluff scrub, closed-cone coniferous forest, cismontane woodland, coastal prairie, coastal scrub, meadows and seeps, marshes and swamps, North Coast coniferous forest, valley and foothill grassland. 0–700 meters elevation. **MTW Lands:** Mostly occurring in mesic, well developed grasslands/meadows bordering trails and roadsides. Largest occurrence is in Potrero Meadow near Laurel Dell Road.
Vulnerabilities for protection and management—Foliage growth and flowering periods[6], regeneration/ re-sprouting after defoliation, seedbank	Perennial rhizomatous herb. March–July flowering period. Short-lived perennial only reproducing from seed, but new seedlings are relatively uncommon. Requires cross pollination to produce viable seeds. Underground stems are not true rhizomes as plant is unable to reproduce vegetatively. Seeds exhibit relatively low viability with only 7–30% germination in one greenhouse study. Other field studies have shown germination in the field ranges from 0–6.5%. Seeds disperse explosively from ruptured seed pods and may be transported by grazing ungulates. However, the majority of viable seed remains within several meters of the parent plant. Plants are expected to regrow after defoliation where underground shoots remain intact (COSEWIC 2010).

[8] Residual Dry Matter (RDM). RDM refers to the dry mass (and height) of plant matter left on the ground from previous growth before the start of the next winter growing season (September/October). The amount and species of forage that is produced in a growing season is largely dependent on the environment of soil and RDM during the previous late autumn. This affects seed germination and seedling growth, and will be optimized under the indicated range of herbaceous mass and height. The RDM standards are based on Bartolome et al. (2006).

Forage considerations—Quality, palatability, quantity	No evidence that harlequin lotus in unpalatable, and other species in the same genera are palatable to livestock. As a showy, flowering herb, it may be targeted by sheep but is unlikely to be excessively grazed by cattle or goats, particularly if more desirable forage is present. Individual plants are prostrate/spreading with low overall density.
Grazing effects—General and on MTW Lands	**General:** Unlikely to be impacted by low to moderate grazing intensity and may benefit from decreased competition from exotic annual grasses and woody plant encroachment. Low growing species with extensive root network unlikely to be excessively damaged by trampling. Moderate levels of grazing by cattle will likely target taller species leaving more prostrate harlequin lotus unaffected. However, grazing by sheep may adversely impact harlequin lotus due to their preference for forbs.
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Intensity.** Because most extant occurrences of harlequin lotus within MTW Lands are in grassland and meadows with well developed (loamy) soils, moderate intensity spring grazing by cattle may reduce competition from exotic annual grasses and prevent further encroachment of woody shrubs and trees (i.e., coyote brush, French broom, Douglas-fir). Sheep are not recommended due to their preference for forbs. Goats may be useful for vegetation management in meadows supporting harlequin lotus where woody plant encroachment is problematic.

Marsh zigadenus (*Toxicoscordion fontanum*)

Ranking and status	**Federal[3]/ State[4]/ CNPS[5]:** None/None/4.2 **MTW Lands:** Common. 10 extant occurrences on MTW Lands. Additional mapped occurrences beyond MTW Lands in areas not evaluated here for grazing feasibility.
Habitat requirements—General[5,6] and on MTW Lands[7]	**General:** Vernally wet areas. Meadows and seeps, usually in serpentine chaparral. 15–1000 meters elevation. **MTW Lands:** Widely distributed throughout MTW Lands, limited entirely to vernally wet areas, usually serpentinite, including seeps and small meadows within or immediately adjacent to serpentine grassland and/or chaparral. Most mapped occurrences in close proximity to roads and trails, although some are in fairly remote areas. Largest occurrences are in Potrero Meadow and north of Pine Mountain Road.

Vulnerabilities for protection and management—Foliage growth and flowering periods[6], regeneration/ re-sprouting after defoliation, seedbank	Perennial bulbiferous herb (geophyte). April–July blooming period. Limited entirely to vernally wet areas, usually serpentinite. Grows to nearly one meter in height and produces many large flowers. Ability to resprout after grazing or cutting if meristematic tissues are undamaged and sufficient soil moisture. Annual seed production and seedbank viability is currently unknown.
Forage considerations—Quality, palatability, quantity	Species of the genera *Toxicoscordion* are generally considered unpalatable to domestic livestock due to the presence of zygacine, a neurotoxic steroidal alkaloid. Plants may grow in dense patches, particularly where competing vegetation is limited (Panter et al. 1989).
Grazing effects—General and on MTW Lands	**General:** Grazing exclusion is recommended for all kinds and classes of livestock in areas supporting marsh zigadenus, particularly early in the growing season when more palatable forage is lacking. In wet meadows and seeps supporting marsh zigadenus with infestations of French broom or other invasive weeds, hand removal and offsite disposal of weeds is recommended.
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Exclusion.** Marsh zigandenus is highly toxic to livestock at all phenological life stages. Exclusion may be accomplished using temporary and/or permanent wildlife-friendly fencing or by timing grazing to occur outside of the bolting or flowering period (March–July) for sparser populations. Livestock are most likely to consume marsh zigadenus when confined to areas with dense patches or where other more palatable forage is unavailable.

3.1.2 Special-Status Habitats/Natural Communities

Upland Serpentine Grassland	
Ranking and status	**Special-status[9] (State/Local):** California Department of Fish and Wildlife (CDFW) high priority habitat for certain plant alliances and associations. **MTW Lands**: Rare. Approximately 101 acres mapped within MTW Lands (Evens and Kentner 2006).
Habitat requirements—General[10] and on MTW Lands[7]	**General:** Low fertility grasslands on ultramafic soils, often on south facing aspects. Typically found on hillslopes and ridgetops.

[9] CDFW List of Vegetation Alliances and Associations (2010).

MTW Lands: Serpentine soils occur along a series of northwest to southeast trending ridgelines in the central portion of MTW Lands. Serpentine grasslands are found in a mosaic of habitat types and are often bordered by shrub-dominated serpentine chaparral. Most patches of serpentine grassland are less than one acre, with the largest patch mapped at 10.6 acres immediately north of Alpine Lake (Evens and Kentner 2006).

Vulnerabilities for protection and management[11]—Foliage growth period, regeneration/ re-sprouting after defoliation

Low productivity grassland with high native forb composition. Serpentine grasslands have high rates of endemic plants, many of which are considered rare or endangered. Productivity is generally low due to decreased nutrient availability and high rates of soil infiltration and drainage.

RDM[8] levels are typically recommended at 500 lbs/acre (Brownsey et al. 2016). In general, desirable native species will recover from low- to moderate-intensity grazing but may be adversely affected by high-intensity grazing as low levels of RDM and bare/open areas may promote the establishment of exotic annual grasses (i.e., barbed goatgrass) and other invasive species. Excessive grazing, particularly during the flowering period for endemic forbs, is likely to reduce seed production and germination and decrease native species richness and cover.

Forage considerations—Quality, palatability, quantity

High quality and palatability. Low overall productivity and forage compared to non-serpentine grasslands. Typically higher percentage of forbs, many of which are endemic native species.

Grazing effects—General and on MTW Lands

General: Grazing may be beneficial to serpentine grasslands under well-managed regimes. Studies have shown grazing may mediate the effects of climate change and anthropogenic nitrogen deposition (smog) by reducing the abundance of exotic annual grasses, thereby favoring native perennial grasses and endemic forbs (Weiss 1999). Short duration, moderate intensity late winter/early spring (February–April) cattle grazing has increased richness and abundance of desirable native perennial grasses and annual forbs in coastal grasslands (D'Antonio et al. 2001, Hayes and Holl 2003, Stahlheber and D'Antonio 2013).

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)

Timing/Intensity. Must carefully consider suitable RDM[8] levels and avoid grazing during flowering periods of special-status forbs. Short duration, moderate intensity cattle grazing would reduce cover and abundance of exotic annual grasses. Horses may cause increased erosion and substrate damage. Sheep are likely to overgraze desirable native forbs. Goat grazing in serpentine grasslands is understudied and may result in uneven grazing or overgrazing of desirable forbs and native subshrubs.

[10] Barbour et al. (2007).
[11] Sawyer et al. (2009).

Serpentine Chaparral

Ranking and status	**Special-status[9] (State/Local):** CDFW high priority habitat for certain plant alliances and associations. **MTW Lands:** Rare. Approximately 326 acres mapped within MTW Lands (Evens and Kentner 2006).
Habitat requirements—General[10] and on MTW Lands[7]	**General:** Occurring on ultramafic (serpentine) on south facing slopes, typically in a mosaic with serpentine grassland. Often occurring on moderate to steep slopes with rocky outcrops. **MTW Lands:** Serpentine chaparral is situated in a mosaic with serpentine grassland throughout much of the north-central portion of MTW Lands. Dominated by sclerophyllous, woody shrubs including manzanitas, ceanothus, and chamise (*Adenostoma fasciculatum*). The largest contiguous patches of serpentine chaparral are located northwest of Bon Tempe Lake and Alpine Lake.
Vulnerabilities for protection and management[11]—Foliage growth period, regeneration/ re-sprouting after defoliation	Serpentine chaparral is a shrub-dominated community occurring in low-fertility, ultramafic substrates with high rates of endemism. The herbaceous understory is sparse with widely scattered subshrubs, grasses, and forbs. This community supports several species considered rare and endangered including Marin western flax, marsh zigadenus, and Mt. Tamalpais manzanita. Serpentine chaparral is vulnerable to browsing as many of the shrubs lack burls and will only regenerate from seed. Moreover, seed productivity and germination rates in serpentine substrates are low, limiting recovery from defoliation and trampling.
Forage considerations—Quality, palatability, quantity	Limited herbaceous forage available for grazers. Generally restricted to woody browse, although dominated by native, often endemic species.
Grazing effects—General and on MTW Lands	**General:** Grazing adjacent serpentine and non-serpentine grasslands will inhibit woody shrub establishment and prevent expansion of serpentine chaparral. **MTW Lands:** Native shrubs, several of which are rare endemics, dominate serpentine chaparral within MTW Lands. Cattle grazing in adjacent grassland is not expected to impact serpentine chaparral other than to prevent encroachment of shrubs into grassland. The dense assortment of nearly impenetrable shrubs is generally unpalatable or not preferable to livestock. The presence of large rocks presents a tripping hazard, serving as a further deterrent.

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Exclusion (Timing/Intensity).** Grazing is not recommended. In the absence of grazing adjacent serpentine grasslands, chaparral may be expanding due to succession on MTW Lands. Goats should not be used to manage French broom and other invasive weeds in serpentine chaparral unless the infestation is monospecific as they are non-selective browsers and will harm the desirable native vegetation, and may also promote the establishment of invasive weeds.

Wetlands, Meadows, and Seeps (Non-Serpentine)

Ranking and status	**Special-status[9](State/Local):** CDFW high priority habitat for certain plant alliances and associations. Wetlands are protected under various federal, state, and local laws and designated for resource protection under the Marin Countywide Plan (County of Marin 2007). **MTW Lands:** Very rare. Approximately 15 acres mapped within MTW Lands (Evens and Kentner 2006).
Habitat requirements—Genera[10] and on MTW Lands[7]	**General:** Occurring where surface or groundwater is perched or saturated within the upper 12 inches of the soil profile. Typically found in topographic depressions or channels where water accumulates for several weeks or more and supports a preponderance of hydrophytic vegetation. **MTW Lands:** Most wetland features are flat to gently sloped meadows or seeps situated on hillslopes where groundwater intercepts the surface. Meadows and seeps are rare but widespread throughout MTW Lands. Sky Oaks meadow north of Bon Tempe Lake is the largest wetland complex in MTW Lands and supports a large population of harlequin lotus.
Vulnerabilities for protection and management[11]—Foliage growth period, regeneration/ re-sprouting after defoliation	Wet meadows and seeps in well-developed soils typically support an array of hydrophytic perennial grasses and forbs, with a high percentage of non-native grasses in areas with seasonal hydrology. Grazing in wet meadows may reduce competition from these non-native annual grasses and increase species richness although trampling and excessive grazing may degrade water quality. Trampling may also adversely affect perennial species.
Forage considerations—Quality, palatability, quantity	High forage quality and palatability. Low available quantity. High percentage of native and endemic species, many of which are considered rare.
Grazing effects—General and on MTW Lands	**General:** Grazing can either benefit or impact wetlands depending on the type of wetland (i.e., seasonal, vernal pool, emergent), plant species composition, and timing/intensity of grazing activities. Seasonal wetlands generally respond favorably to spring grazing regimes by reducing cover of

	hydrophytic exotic grasses and forbs (e.g., common velvet grass, Harding grass, bird's foot trefoil [*Lotus corniculatus*], bristly oxtongue [*Picris echioides*]) and promoting increased native species richness and cover (Marty 2005). However, areas with prolonged inundation are generally dominated by perennial species that are susceptible to tramping and excessive grazing pressure.
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Exclusion (Timing/Intensity)**. Grazing should only occur in seasonal wetlands with high percentage cover of exotic annual grasses and forbs. Cattle grazing in seasonal wetlands has decreased abundance of exotic annual species and increased richness and abundance of native wetland forbs (Marty 2005). Moderate intensity grazing could occur in mid–late spring when seasonal wetlands are mostly dry and when annual grasses are in flower are likely to be targeted by grazing animals.

Wet Meadows and Seeps (Serpentine)

Ranking and status	**Special-status[9](State/Local):** CDFW high priority habitat type. Wetlands are protected under various federal state and local laws, and are designated for resource protection under the Marin Countywide Plan (County of Marin 2007). **MTW Lands:** Very rare. Limited to just seven serpentine wet meadows and seeps totaling 1.5 acres within MTW Lands (Evens et al. 2006).
Habitat requirements—General[10] and on MTW Lands[7]	**General:** Shallow depressions, swales, and channels where surface water is at or near the ground surface for several weeks or more. Seeps typically occur where subsurface groundwater daylights on or near the toe of hillslopes. Serpentine seeps occur in areas with ultramafic soils often within serpentine grassland or chaparral. **MTW Lands:** Most serpentine meadows and seeps within MTW Lands as small (< 0.6 acres) and occur in a mosaic of serpentine grassland, chaparral, and Sargent cypress (*Hesperocyparis sargentii*) woodland.
Vulnerabilities for protection and management[11]—Foliage growth period, regeneration/ re-sprouting after defoliation	Wetlands in serpentine soils support a unique array of plant species, several of which are rare endemics including Mt. Tamalpais thistle and marsh zigadenus. In general, species are intolerant of trampling and excessive grazing pressure.
Forage considerations, Grazing effects, and Grazing management considerations	Same management considerations and recommendations for grazing as noted above for non-serpentine wet meadows and seeps. Unlikely to be grazed due to very rare occurrence.

Oak Woodlands

Ranking and status	**Special-status[9](State/Local):** CDFW high priority for certain dominant plant species alliances and associations, and also covered under the 2004 California Oak Woodlands Protection Act. **MTW Lands:** Common. Approximately 2,496 acres of oak woodlands within MTW Lands (Evens and Kentner 2006).
Habitat requirements—General[10] and on MTW Lands[7]	**General:** Widespread throughout California, composed of many dominant species of oak. In Marin County, coast live oak is the dominant species in oak woodlands and commonly associated with California bay laurel (*Umbellularia californica*), madrone (*Arbutus menzeisii*), tanoak, buckeye (*Aesculus californica*), and Douglas-fir. Often occurring on north and west facing aspects. **MTW Lands:** Widespread throughout MTW Lands. The majority of oak woodlands are associated with other dominant trees including California bay laurel, madrone, and tanoak. The canopy is partly open to mostly closed and typically occurs on moderate to steep slopes in well developed, non-serpentine soils. Many contiguous patches are relatively large (>10 acres), with the largest mapped at 122 acres (Evens and Kentner 2006).
Vulnerabilities for protection and management[11]—Foliage growth period, regeneration/ re-sprouting after defoliation	Oak woodlands have varying amounts of herbaceous understory species richness and cover depending on canopy cover, slope, aspect, and hydrology. Oak regeneration is a primary concern related to grazing in oak woodlands. Seedlings are sensitive to trampling and excessive grazing, particularly outside of the spring growing season when other more desirable forage is lacking.
Forage considerations—Quality, palatability, quantity	High forage quality and palatability. Variable understory productivity depending on substrate, slope, canopy cover (light availability), and precipitation. Quantity restricted by abundance and composition of available understory herbaceous species.
Grazing effects—General and on MTW Lands	**General:** Grazing is feasible in areas where desirable grassy forage is sufficient. However, in more closed-canopy systems (40–60% cover), understory productivity decreases and unpalatable non-native thistles (Italian thistle [*Carduus pycnocephalus*], milk thistle [*Silybum marianum*]) are common (J. Davilla, co-author, personal observation). Selective avoidance of thistles may degrade the understory and trampling may increase erosion and prevent the establishment of oak seedlings.

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing.** Grazing is recommended in oak woodlands with suitable herbaceous understory productivity and composition to support livestock without significant potential for erosion, invasive weed infestation, or oak seedling mortality. RDM[8] standards to achieve the desired conditions should be carefully followed based on soil type and slope (Bartolome et al. 2006).

Willow Riparian

Ranking and status	**Special-status[9](State/Local):** CDFW high priority habitat, and designated for resource protection under the Marin Countywide Plan (County of Marin 2007). **MTW Lands:** Very rare. Approximately 2.1 acres of willow riparian habitat within MTW Lands (Evens et al. 2006).
Habitat requirements—General[10] and on MTW Lands[7]	**General:** Embankments of ephemeral to perennial drainages and creeks in full sun to partial shade. **MTW Lands:** Within MTW Lands, willow riparian habitat is widely dispersed and patches are small (< 0.5 acres) (Evens and Kentner 2006). Willow riparian generally occurs on ephemeral or intermittent drainages with flat to gentle slopes in full sun.
Vulnerabilities for protection and management[11]—Foliage growth period, regeneration/ re-sprouting after defoliation	Willow riparian habitat is susceptible to grazing impacts from trampling. Cattle and sheep will not consume willows but may congregate in riparian habitat for watering and shade. Willow riparian scrub is generally impenetrable with few herbaceous understory species.
Forage considerations—Quality, palatability, quantity	Limited herbaceous forage available for grazers. Generally restricted to woody browse. Willows are usually the sole dominant species, particularly in areas classified as willow scrub.
Grazing effects—General and on MTW Lands	**General:** Grazing livestock can affect riparian habitats through trampling, herbivory, nutrient loading, and direct and indirect impacts to water quality. During the winter and spring, animals in adjacent grasslands will generally graze preferred green herbaceous forage in uplands. In the summer and fall, as plants dry out, grazing animals may be attracted to the persistent green vegetation in riparian areas and may use woody cover for shading. This leads to increased erosion and degradation of the vegetation due to herbivory and trampling.

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Exclusion.** Grazing and browsing should be excluded from willow riparian areas to the extent feasible using temporary fencing or by orienting grazing pastures in a manner that does not include this habitat type. The drawbacks to grazing exclusion include increased fire hazards and potential infestations of non-native invasive plants.

Coastal Prairie/Native Perennial Grassland

Ranking and status	**Special-status[9](State/Local):** CDFW includes most native grass alliances and associations as high priority habitat. **MTW Lands:** Rare. Approximately 61.5 acres of native perennial grassland within MTW Lands (Evens and Kentner 2006).
Habitat requirements—General[10] and on MTW Lands[7]	**General:** Coastal prairie and native grasslands in well-developed soils occur in close proximity to the coast where there is direct influence from fog and annual precipitation averaging 30 inches or more. These grasslands are typically dominated by native bunchgrasses including purple needlegrass (*Nassella pulchra*), red fescue (*Festuca rubra*), California oatgrass (*Danthonia californica*), meadow barley (*Hordeum brachyantherum*), and pine bluegrass (*Poa secunda*). **MTW Lands:** The majority of grasslands in well-developed soils are dominated by non-native annual grasses. Coastal prairie and native perennial grassland are minor components of MTW Lands with most contiguous patches less than one acre. The largest patch is approximately 19 acres on a west facing aspect immediately east of Kent Lake (Evens and Kentner 2006).
Vulnerabilities for protection and management[11]—Foliage growth period, regeneration/ re-sprouting after defoliation	Coastal prairie and native perennial grasslands in well-developed soil generally respond favorably to moderate intensity spring grazing. Cattle grazing has been shown to reduce exotic annual grasses while increasing native species richness and abundance (D'Antonio et al. 2001, Hayes and Holl 2003, Stahlheber and D'Antonio 2013). Common perennial grasses including purple needle grass, California oatgrass, and red fescue have later flowering periods and are largely undamaged by spring grazing. Increased light and water availability due to reduced cover of annual grasses also favors germination of native forbs.
Forage considerations—Quality, palatability, quantity	High-quality and quantity of herbaceous forage. With the exception of certain weeds (e.g., thistles, aromatics), the majority of vegetation is palatable to all kinds and classes of livestock.

Grazing effects—General and on MTW Lands

General: Cattle grazing at moderate intensity in late winter and early spring may increase native species richness and cover while reducing non-native annual grasses. The benefits of grazing native perennial grasslands are maximized when non-native annuals are flowering, prior to seed set (D'Antonio 2001, Stahlheber and D'Antonio 2013, Skaer et al. 2014). Reduced competition from annual grasses allows for native perennial grasses to compete for available light and soil moisture, and openings promote the establishment of native annual forbs. Moderate intensity winter and spring grazing generally does not negatively impact established perennial bunchgrasses (Hatch et al. 1999, Hayes and Holl 2003, Bartolome et al. 2004).

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)

Timing/Intensity. Continuous moderate intensity late winter to spring grazing is beneficial for reducing non-native annual grass density while increasing native species richness and cover (Hatch 2004, D'Antonio et al. 2001, Hayes and Holl 2003, Bartolome et al. 2004, Stahlheber and D'Antonio 2013, Skaer et al. 2014). RDM[8] standards to achieve the desired conditions should be carefully followed based on soil type and slope (Bartolome et al. 1980, 2006).

3.1.3 Weed Management

Barbed goatgrass (*Aegilops triuncialis*)

Pest rating (Cal-IPC[12] CDFA[13])	**Cal-IPC:** High; A, A, B **CDFA:** List B
Habitat requirements—General[12] and on MTW Lands[7]	**General:** Grasslands and disturbed areas, often serpentinite. **MTW Lands:** Not widespread but limited to serpentine and adjacent grasslands. Existing populations are relatively large (>3 acres). Potential for existing populations to expand in the absence of management or due to improper grassland management.
Vulnerabilities for control and management[12]—Foliage growth and flowering periods, regeneration/ re-sprouting after defoliation, seedbank	Annual grass. Early winter germination with mid-spring bolting (boot) period and May–June flowering. Produces two types of seeds, with jointed seeds remaining viable for two years. Only susceptible to grazing during two- to three-week bolting phase (Brownsey et al. 2016). Requires high-intensity, targeted grazing as low to moderate stocking rates or grazing during the unpalatable flowering period is likely to exacerbate infestation due to selective avoidance by livestock. Increased soil nitrification due to grazing may further promote establishment of barbed goatgrass.

[12] Cal-IPC: California Invasive Plant Council Inventory (2006).

High	Severe ecological impacts on physical processes, plant and animal communities and vegetation structure
Moderate	Substantial and apparent, but generally not severe, ecological impacts on physical processes, plant and animal communities, and vegetation structure
Limited	Ecological impacts are minor on a statewide level or there was not enough information to justify a higher score
Alert	Species with the potential to rapidly invade unexploited ecosystems

Cal-IPC assessment of ecological impact levels- Impact, Invasiveness, Distribution:

A	Severe, possibly irreversible, alteration or disruption of an ecosystem process
B	Moderate alteration of an ecosystem process
C	Minor alteration of an ecosystem process
D	Negligible perceived impact on an ecosystem process
U	Unknown

[13] CDFA: California Department of Food and Agriculture (2017)-

A	Action required
B	Action required at discretion of Agriculture Commissioner
C	Action only when found in a nursery at discretion of Agriculture Commissioner

Forage considerations—Quality, palatability, quantity	Poor to low forage quality. Only palatable to cattle during the early growth, vegetative period prior to flowering. Often forms nearly monospecific stands if unmanaged (DiTomaso et al. 2013). Goats will likely consume goatgrass when in flower when other more palatable vegetation is lacking.
Grazing effects—General and on MTW Lands	**General:** Very difficult to control without herbicide application. May be controlled using properly timed, repeated prescribed fire, or by short-duration, high-intensity cattle grazing. Grazing exclusion is necessary during flowering periods when plants are unpalatable to livestock to avoid seed spread. Selective avoidance by grazing livestock will lead to rapid expansion and may result in dense, monospecific stands within several growing seasons.
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing/Intensity**. If possible, areas with heavy infestations of barbed goatgrass should be temporarily fenced and grazed by cattle at a rate of two cows per acre continuously for two to three weeks (Brownsey et al. 2006). Because goatgrass produces seeds that are viable for two years, grazing must occur annually to achieve effective control. Grazing in only one season is likely to exacerbate an infestation. RDM[8] levels should not exceed 500 lbs/acre following grazing treatment. Goatgrass often occurs in serpentine soils that support rare and endangered plant species. Management objectives for these species may conflict with the required short duration, high-intensity grazing regime required for barbed goatgrass control.

Yellow starthistle (*Centaurea solstitialis*)

Pest rating (Cal-IPC[12] CDFA[13])	**Cal-IPC:** High; A, B, A **CDFA:** List C
Habitat requirements—General[12] and on MTW Lands[7]	**General:** Open annual grassland and disturbed areas (e.g., roadcuts, fallow agriculture land). **MTW Lands:** Widespread throughout MTW Lands and typically found in disturbed grassland with well-developed soils, as well as ruderal areas in close proximity to roads and other development. Largest infestations within and immediately east of Ridgecrest-Rock Spring-Potrero, which is a potential grazing area in open grassland.

Vulnerabilities for control and management[12]—Foliage growth and flowering periods, regeneration/ re-sprouting after defoliation, seedbank

Annual herb (occasionally biennial). May–October flowering period. Winter germination most prevalent in nutrient rich, deep, well drained soils. Not usually in areas with serpentine soils. Deep taproots (≥1m) form early below a leafy basal rosette. Stiff, branched stems emerge in early–mid spring.

Ray flowers produce two types of seeds, one with pappus and one without, both requiring insect pollination. Barbed pappus bristles easily attach to clothing, fur, and hair and are spread by humans and animals. Wind distribution is limited to several feet from parent plant. Will resprout or produce stems and flowers after grazing if soil moisture is available. Grazing will limit flowering if continued just prior to, or beyond bolting and flowering. Only goats will continue to consume yellow starthistle after flower buds have produced spines (DiTomaso et al. 2006).

Forage considerations—Quality, palatability, quantity

Low to moderate forage quality. Toxic to sheep and horses. Cattle will only consume yellow starthistle during the vegetative period prior to production of thorny flower heads. Goats will readily consume yellow starthistle during all phenological stages (DiTomaso 2001, DiTomaso et al. 2006).

Grazing effects—General and on MTW Lands

General: Early season short-duration, high-intensity cattle grazing just prior to flowering has been shown to limit the number of flowering individuals and decrease overall seed production (DiTomaso 2001, DiTomaso et al. 2006). Cattle will not consume yellow starthistle in flower due to the presence of stiff spines surrounding the flowering heads. Cattle should be excluded from grazing once plants are in flower as selective avoidance will increase the density of yellow starthistle and may spread seed to unoccupied areas.

Prolonged high-intensity grazing is likely to impact desirable native vegetation. Short duration, high-intensity goat grazing can be very effective in controlling flowering yellow starthistle, as goats will consume spines (DiTomaso et al. 2006). Moreover, yellow starthistle flowers after most desirable grassland species have set seed. Repeated goat grazing treatments are often required to control yellow starthistle infestations to target resprouting and later blooming individuals.

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)

Timing/Intensity/Frequency. Short-duration, high-intensity goat grazing may be used where feasible to control infestations of yellow starthistle. Goats should be allowed to forage once yellow starthistle have bolted and begin to produce flowers prior to seed set. Goats should be removed once the majority of yellow starthistle flowers have been consumed and before RDM[8] levels are too low. Goats can be returned to the pasture to control later flowering individuals as necessary. Cattle grazing is not recommended as high-intensity grazing is likely to impact native vegetation and trampling may increase seed germination and spread. Moreover, yellow starthistle will readily occupy bare areas created by heavy cattle grazing.

Poison hemlock (*Conium maculatum*)

PEST RATING (CAL-IPC[12] CDFA[13])	**Cal-IPC:** Moderate; B, B, B **CDFA:** None
HABITAT REQUIREMENTS—GENERAL[12] AND ON MTW LANDS[7]	**General:** Ruderal. Disturbed areas in mesic grasslands or wet meadows. **MTW Lands:** Not well mapped. Generally widespread along roadsides, and disturbed areas in wet meadows and non-serpentine grasslands.
VULNERABILITIES FOR CONTROL AND MANAGEMENT[12]—FOLIAGE GROWTH AND FLOWERING PERIODS, REGENERATION/ RE-SPROUTING AFTER DEFOLIATION, SEEDBANK	Biennial (occasionally perennial) herb. April–September flowering period. Occupies mesic, often disturbed areas including ruderal areas, roadsides, and annual grassland. Prolific seed production with one plant capable of producing up to 39,000 seeds, about which 80% are viable. Seeds do not have dormancy restrictions and may germinate in the first year of production. Cattle or other livestock will not graze poison hemlock unless no other is forage available. This species is highly toxic and consumption will cause severe injury or death. Pitcher (1989), DiTomaso (1999), and Pokorny and Sheley (2012) concluded that excessive grazing in areas with poison hemlock may result in the increased rate of establishment and spread into unoccupied areas due to selective avoidance and trampling. However, L. Bush (co-author) has observed for many years and in many locations in Marin County, that poison hemlock does not generally occur in areas that are regularly grazed.
FORAGE CONSIDERATIONS—QUALITY, PALATABILITY, QUANTITY	Toxic/poisonous to all kinds and classes of livestock. There is anecdotal evidence that it is tolerable to goats (Davison et al. 2007).
GRAZING EFFECTS—GENERAL AND ON MTW LANDS	**General:** Toxic to grazing livestock due to alkaloid compounds. Grazing should be avoided in areas with dense poison hemlock infestations. Some anecdotal reports that goats may safely consume poison hemlock but this is largely discouraged in current scientific literature (Pitcher 1989, Davison 2007). High-intensity grazing in close proximity to hemlock populations may exacerbate the spread of this species and increase the size of infestations due to selective avoidance, decreased competition, trampling, and soil nitrification.

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Exclusion.** Published scientific literature supports the idea of grazing exclusion in areas supporting dense occurrences of poison hemlock because poison hemlock is not only toxic to all kinds and classes of livestock, but selective avoidance may increase the size of existing infestations (Pokorny and Sheley 2012, DiTomaso et al. 2013). However, L. Bush (co-author) has observed for many years and in many locations in Marin County, that poison hemlock does not generally occur in areas that are regularly grazed.

Eggleaf spurge (*Euphorbia oblongata*)

Pest rating (Cal-IPC[12] CDFA[13])	**Cal-IPC:** Limited; C, C, B **CDFA:** None
Habitat requirements—General[12] and on MTW Lands[7]	**General:** Ruderal/disturbed areas including waste places, roadsides, and pastures although may establish and persist in relatively undisturbed areas if introduced. **MTW Lands:** Disturbed areas in many different habitat types but typically in close proximity to roads and trails with full sun or partial shade.
Vulnerabilities for control and management[12]—Foliage growth and flowering periods, regeneration/ re-sprouting after defoliation, seedbank	Perennial herb. May–August flowering period. May form dense, monospecific stands. Evidence that allelopathic, dense roots prevent germination and persistence of native species. Can reproduce by seed or by plant division where crown buds develop at the base of stems and can produce new shoots or roots. Seed typically falls directly beneath or near parent plant with little other forms of dispersal. Dormancy and long-term viability of the seedbank is currently unstudied. Eggleaf spurge will readily resprout following cutting, burning, or grazing.
Forage considerations—Quality, palatability, quantity	The milky sap of eggleaf spurge is a mildly toxic irritant and generally avoided by cattle and horses. Goats and sheep have been shown to prefer the related species leafy spurge (*Euphorbia esula*), and have been used to control it elsewhere (Johnston and Peake 1960, DiTomaso et al. 2013).
Grazing effects—General and on MTW Lands	**General:** Because eggleaf spurge often forms dense, monospecific patches, targeted high-intensity goat or sheep grazing during the flowering period may control and reduce populations of this species. However, in areas where spurge is not dominant, goats and sheep may consume other more desirable vegetation including native shrubs and forbs.

Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing/Intensity/Frequency**. Current recommendations are to stock goats at a rate of approximately 12–16 animals/acre and sheep at approximately three to six animals/acre during the flowering period (DiTomaso et al. 2013). Grazing will not eradicate perennial spurge but will significantly reduce the seedbank, limiting spread and allowing for the establishment of other desirable native species. Grazing animals should be returned to the infested area periodically as plants are flowering to prevent seed production and dispersal.

Tall fescue (*Festuca arundinacea*)

Pest rating (Cal-IPC[12] CDFA[13])	**Cal-IPC:** Moderate; C, B, A **CDFA:** None
Habitat requirements—General[12] and on MTW Lands[7]	**General:** Grasslands, wet meadows, savannah, ruderal/disturbed areas. **MTW Lands:** Widespread throughout well-developed grasslands, meadows, and ruderal areas within MTW Lands. Most occurrences are patchy and relatively small although several support dense monospecific stands of tall fescue. An occurrence of tall fescue is currently expanding within Potrero Meadow which supports important rare plants like Mt. Tamalpais thistle, harlequin lotus, and marsh zigadenus.
Vulnerabilities for control and management[12]—Foliage growth and flowering periods, regeneration/ re-sprouting after defoliation, seedbank	Perennial grass. May–June flowering period. Tufted, cool season, sod grass often planted for pasture, turf, hay, and/or erosion control. Easily escapes into natural areas although newer cultivar varieties may not be as invasive. Deep, fibrous root system extends to 0.6 meters and tufts enlarge around the perimeter by rhizomes and tillers. Can reproduce from seed or vegetatively from rhizome fragments remaining after cutting or grazing. New plants do not produce viable seeds in the first year. Once present, seeds germinate in the first year after production and may be viable under certain conditions for up to 19 years. Tall fescue is often infected by an endophytic fungus which is toxic to livestock, although it is not usually fatal (Walsh 1995, Henson 2001).
Forage considerations—Quality, palatability, quantity	High-quality forage palatable to all kinds and classes of livestock. Most preferred by cows and horses. However, stands infected with endophytic fungus render tall fescue poisonous to livestock (Henson 2001, Batcher 2004, DiTomaso and Healy 2007).

Grazing effects—General and on MTW Lands	**General:** Studies have shown nearly 75% of tall fescue stands are infected with an endophytic fungus that may cause sickness to grazing livestock (Henson 2001). In general, grazing animals will avoid tall fescue when other, more desirable forage is available. This is likely to exacerbate the infestation, and over time could result in monospecific patches of tall fescue that are nearly impossible to control. Dense patches may be targeted by high-intensity grazing during the summer flowering period which may inhibit the spread of an existing infestation. However, in the absence of a native seedbank in the vicinity, this is unlikely to improve species richness and cover of more desirable vegetation.
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Exclusion (Timing/Intensity).** For areas with dense, contiguous patches of tall fescue (>2 acres), targeted high-intensity grazing during the flowering period may prevent development and germination of seed thereby reducing the rate of spread. However, full eradication will require planning and implementation of control measures in addition to grazing.

French broom (*Genista monspessulana*)

Pest rating (Cal-IPC[12] CDFA[13])	**Cal-IPC:** High; A, A, B **CDFA:** C
Habitat requirements—General[12] and on MTW Lands[7]	**General:** Woodlands, grassland, scrub, chaparral; disturbed areas, often along road cuts, trails, and riverbanks. **MTW Lands:** Most widespread and problematic weed species on MTW Lands. Over 1,400 acres infested, several occurrences are larger than 20 contiguous acres. French broom is most prevalent in the eastern portion of MTW Lands north and east of Bon Tempe Lake, Phoenix Lake, and Lake Lagunitas and along the MTW Lands' urban interface.
Vulnerabilities for control and management[12]—Foliage growth and flowering periods, regeneration/ re-sprouting after defoliation, seedbank	Perennial shrub. March–May flowering period. Individuals can live up to 20 years and reach a maximum height of 10 feet. Forms dense, nearly impenetrable monospecific stands. Disturbance dependent and can occupy a wide range of soil types and plant communities. French broom typically occupies the ecotone of two adjacent dissimilar plant communities (i.e., woodland and grassland) and in disturbed areas along roads and trails. It is deeply rooted and readily resprouts from cut or browsed stems. It produces prolific amounts of seed that are dispersed explosively from ruptured seed pods. A medium sized plant can produce up to 8,000 seeds that may remain viable in the seedbank for 50 years or more. Seedling densities often exceed 100 per square foot and plants may flower and produce seeds within two years when they reach a height of approximately two feet. Soil disturbance and fire

	stimulates germination, and seeds may pass through the digestive track of sheep undamaged (Hoshovsky 1986).
Forage considerations—Quality, palatability, quantity	Goats will readily consume French broom, particularly when immature. Sheep will consume flowers and seedpods but seeds pass through digestive tract undamaged. Cattle will not graze woody broom but may consume new seedlings. French broom is mildly toxic to cattle, sheep and horses but does not seem to affect goats (Hoshovsky 1986, Bossard et al. 2000, DiTomaso and Healy 2007, DiTomaso et al. 2013).
Grazing effects—General and on MTW Lands	**General:** Cattle, sheep and horses will not graze or browse mature French broom; however, trampling may inhibit the establishment and long-term success of seedlings in areas adjacent to an infestation. Goats will browse French broom and are most effective for control prior to plants reaching maturity (Hoshovsky 1986, Bossard et al. 2000, DiTomaso et al. 2013), as effective management requires them to consume flowering individuals prior to the development of viable seeds. Goat browsing on younger broom is likely an effective method for preventing spread and decreasing overall infestation density. However, goats are not effective in clearing dense, mature stands of broom. Goat browsing is unlikely to cause mortality to mature French broom as it will resprout from cut stems, even when browsed almost to ground height.
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing/Intensity.** Where feasible, targeted high-intensity goat browsing throughout the spring flowering period prior to seed production may be effective. Goats are non-selective and will browse native vegetation, including rare species such as Mt. Tamalpais manzanita. Therefore, using goats for broom control should be limited to monospecific stands where goats can easily be corralled and managed using temporary fencing or other shepherding techniques. These techniques may be infeasible for many areas supporting French broom.

Common velvet grass (*Holcus lanatus*)

Pest rating (Cal-IPC[12] CDFA[13])	**Cal-IPC:** Moderate; B, B, A **CDFA:** None
Habitat requirements—General[12] and on MTW Lands[7]	**General:** Mesic grasslands; escaped cultivar, wetland-riparian. **MTW Lands:** Currently not widespread but early infestations observed in valuable wet meadow habitat. Largest mapped occurrence in Lagunitas Meadow which is also supports extant harlequin lotus and marsh zigadenus.

Vulnerabilities for control and management[12]—Foliage growth and flowering periods, regeneration/ re-sprouting after defoliation, seedbank	Perennial grass. June–August flowering period. Introduced cultivar planted as forage crop and occasionally as turf grass. Although not rhizomatous, common velvet grass can reproduce from decumbent tillers. It is a prolific seed producer and seeds may remain viable in the seedbank for several years. However, the majority of seeds germinate in the first year with an 87% germination rate for seeds on the soil surface but just 5% germination of seeds two centimeters deep or more (Pitcher and Russo 1988, Gucker 2008). Common velvet grass will readily resprout after grazing defoliation as low as two centimeters above the ground if meristems are undamaged and soil moisture is available (Pitcher and Russo 1988).
Forage considerations—Quality, palatability, quantity	Theoretically high-quality forage palatable to all kinds and classes of livestock; however, L. Ford and L. Bush (co-authors) have made conflicting observations about its palatability.
Grazing effects—General and on MTW Lands	**General:** Common velvet grass will readily spread into surrounding areas without ongoing management and control. It may be controlled by higher intensity grazing for longer durations (Gucker 2008, DiTomaso et al. 2013) but eradication of the species is unlikely using grazing due the perennial nature of plant and the ability to regenerate from decumbent tillers (Pitcher and Russo 1988). Common velvet grass is a "low fertility species" and increased nitrogen from cattle may reduce abundance (Pitcher and Russo 1988, DiTomaso et al. 2013).
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing/Intensity.** High-intensity cattle or sheep grazing during the flowering period may prevent further spread and establishment of common velvet grass (Gucker 2008). However, high-intensity grazing is non-specific and so grazing in mesic coastal prairie grasslands with a significant native bunchgrass component could be detrimental as these species typically flower at the same time as common velvet grass. Grazing for common velvet grass control should only be implemented where large infestations are nearly monospecific and grazing can be targeted directly to that patch.

Harding grass (*Phalaris aquatica*)

Pest rating (Cal-IPC[12] CDFA[13])	**Cal-IPC:** Moderate; B, B, B **CDFA:** None
Habitat requirements—General[12] and on MTW Lands[7]	**General:** Annual grassland and coastal prairie, mesic areas. **MTW Lands:** Although not well-mapped within the MTW Lands, existing populations are extensive with the largest occurrences in the Sky Oaks Region adjacent to Bullfrog Road and in open grassland in Bathtub Gap.

Vulnerabilities for control and management[12]—Foliage growth and flowering periods, regeneration/ re-sprouting after defoliation, seedbank	Perennial grass. February–March flowering period. Forms large clumps with rhizomes around the base. Prolific seed production but seedlings compete poorly with well-established vegetation. Seeds require a dormancy period of up to 127 days before germination. Primarily expands from rhizomes and tillering. Harding grass will resprout after grazing if meristematic tissue and rhizomes are undamaged. Vegetative parts remain green well past the flowering period making it desirable forage for later season grazing. May be toxic to livestock in large quantities and produces alkaloids that are particularly poisonous to sheep (Bourke et al. 1990, DiTomaso and Healy 2003.).
Forage considerations—Quality, palatability, quantity	High-quality forage palatable to all kinds and classes of livestock except sheep. Most preferred by cows and horses.
Grazing effects—General and on MTW Lands	**General:** Introduced as forage for livestock, this species is palatable and nutritious and high-intensity grazing later into the growing season may reduce its vigor and fecundity. However, grazing alone, especially at low intensity is not expected to control this species due to abundant tillering, and may exacerbate infestations due to seeds distributed by the livestock (Peterson 1988).
Grazing management considerations and recommendations (exclusion, timing, intensity, repetition, trade-offs)	**Timing.** Early season cattle grazing during the flowering period is the most effective method for Harding grass control as defoliation during this period reduces tillering (Peterson 1988). It is very unlikely Harding grass will be eradicated by grazing alone.

4. Suitable Potential Grazing Areas/Potential Grazing Scenarios

4.1 Area Selection

The study team identified 16 potential grazing areas through discussions with A. Williams and her GIS site analysis. Ms. Williams then prepared maps of the grazing areas (Appendix 2). Suitable grazing areas are those that provide adequate livestock forage to sustain animal health; are physically accessible to graziers, for delivering livestock with their vehicles and for their staging and grazing equipment; are reasonably close to water sources that could be adapted for livestock watering; and do not include very steep canyons and cliffs or dense forest. These areas either include target plants that may benefit from grazing (rare plants) or that may be negatively affected by grazing (weeds) or that are priority fuelbreak areas.

Should MMWD determine that grazing is an appropriate vegetation management tool for their MTW Lands, final grazing area selection should be based on additional site review, including evaluation by contract graziers to determine if unknown site constraints exist and if proposed areas can be grazed/browsed without damaging non-target vegetation or causing other undesired effects.

4.1.1 Potential Grazing Areas and Management Objectives

1. Sky Oaks. This 282-acre potential grazing area includes significant infestations of French broom with low-density and pioneer occurrences west of Bon Tempe Road, and denser more substantial populations to the east ranging from 11 to 90% cover. This area includes numerous other smaller weedy infestations of broom species, common velvet grass, Harding grass, yellow starthistle, tall fescue, barbed goat grass, and eggleaf spurge. One extant occurrence of harlequin lotus is situated in the Sky Oaks meadow immediately north of Old Bull Frog Road. Fewer than 100 plants were observed in 2012 although the population is spread over approximately 10 acres with most individuals immediately adjacent to trails.

Primary objectives are to control and reduce infestations of French broom with particular emphasis on sparse/pioneer occurrences. Grazing management in Sky Oaks meadow should place emphasis on timing and intensity of grazing to control existing weeds and exotic annual grasses without significant impacts to harlequin lotus and other native plants. Appropriate grazing management should benefit harlequin lotus and native species richness/cover by reducing competition from invasive weeds and exotic annual grasses.

2. Porteous-Ross Reservoir-Worn Spring Middle. This 115-acre potential grazing area includes significant infestations of broom with many areas occupied by more than 50% cover, particularly in the south near Phoenix Lake. One small patch of leafy spurge occurs in open grassland near terminus of Worn Spring Road. No priority rare plant populations occur in this grazing area. Grassland and oak woodlands suitable for grazing livestock dominate this area.

Primary objectives are to control and reduce infestations of French broom and eggleaf spurge while managing grasslands and oak woodland understory to reduce the abundance of weeds and exotic annual grasses and increase native species richness and cover. This would likely be achieved by targeted goat browsing in areas with significant broom infestations and moderate intensity, continuous late winter-spring cattle grazing in grasslands and oak woodlands. If hand removal is infeasible, targeted late spring to summer goat browsing using a temporary enclosure should be used to control eggleaf spurge. Goats should be restricted from native chaparral to the maximum extent feasible.

3. Pilot Knob. This 59-acre potential grazing area is densely forested with native perennial grassland in the southern portion along Pilot Knob Road and Lakeview Road. No rare plants or invasive weeds are currently mapped in this area.

Management objectives include preventing future incursions of invasive plants and exotic annual grasses and enhancing the native species composition in existing grasslands. French broom is limited to two small patches along the northern border of the grazing area. These infestations are best managed using manual removal techniques. Moderate intensity spring grazing prior to seed production by native perennial grasses may enhance existing native grasslands. However, grazing should be carefully monitored in this area to ensure native perennial bunchgrasses are not adversely affected.

4. Ridgecrest-Rock Spring-Potrero. This 191-acre potential grazing area is mostly forested with chaparral in the center of the area and non-native annual grassland along the western border. Harding grass and tall fescue are present with several small populations of yellow starthistle occurring just beyond the area boundary. Mt. Tamalpais thistle, harlequin lotus, and marsh zigadenus co-occur in several wet meadows and in serpentine seeps in the northeast portion of the area. Small patches of serpentine grassland are isolated and grazing in these areas is likely infeasible.

Grazing management in contiguous non-native annual grassland and oak woodland in should occur from late winter to spring to reduce the abundance of exotic annual grasses while promoting increased native species richness and cover. Grazing should also be considered in contiguous grassland west of this area to improve habitat and prevent establishment and/or spread of invasive species, including yellow starthistle. If possible, hand removal of tall fescue should occur prior to introduction of grazing livestock to prevent expansion of the existing infestation due to selective avoidance. Broom is not problematic in this area.

5. Pumpkin-Pine-Fish-Lag Meadows. This 179-acre potential grazing area has moderate to dense infestations of broom, particularly along the northeast and southern boundaries. Common velvet grass and Harding grass also prevalent in mesic grassland and oak savannah immediately bordering Sky Oaks Road. This meadow complex also supports extant, patchy occurrences of harlequin lotus and marsh zigadenus.

Grazing should be timed to reduce the cover and abundance of exotic annual grasses and invasive weeds while carefully minimizing impacts to harlequin lotus. Grazing should not occur in areas supporting marsh zigadenus to avoid poisoning livestock. French broom should be managed with targeted summer goat browsing where feasible, particularly while broom is in flower prior to seed set. Goat browsing will likely require temporary exclusion fencing to avoid impacts to adjacent native woody plant communities (e.g., chaparral, woodland).

6. Deer Park-Worn Spring North. The majority of this 138-acre potential grazing area is invaded by broom species, with the densest infestations along the west and east perimeters. No other targeted invasive weeds or rare plants are currently identified in this area, although there is the potential for future Harding grass, common velvet grass, and yellow starthistle invasions in grassland and oak savannah based on proximity to nearby occurrences of these species.

Grazing management should target invasive broom where possible using targeted spring goat grazing to prevent existing plants from flowering and producing seed. Goat grazing will likely require temporary exclusion fencing to avoid impacts to adjacent native woody plant communities (e.g., chaparral,

woodland). Continuous late-winter to mid-spring cattle grazing in open grassland and oak savannah (or oak woodland with well-developed herbaceous understory) may reduce cover of exotic annual grasses and increase native species diversity. However, cattle grazing may also promote the establishment and spread of invasive thistle species, especially in oak woodlands, and should be carefully monitored.

7. Bill Williams-Indian Crown. This is a narrow and steep 18-acre potential grazing area directly abutting an urban interface to the east has low to medium broom cover throughout the majority of area. At least one population of eggleaf spurge is also identified in grassland in the central portion of the area immediately west of Indian Road. No other targeted invasive weeds or rare plants are identified in this area.

Very limited grazable (herbaceous) acreage is available and therefore cattle and sheep grazing is likely infeasible in this area. Targeted spring goat browsing should be implemented to control significant infestations of dense French broom occurring mostly along the eastern half of this area at the urban interface. Goat grazing will likely require temporary exclusion fencing to avoid impacts to adjacent native woody plant communities and to avoid conflicts with neighboring residents.

8. Fawn Ridge-Deer Park. The entirety of this 57-acre potential grazing area is invaded by broom species, with medium- to high-density cover in the north central portion of the area north of Deer Park Road. Harding grass is mapped in disturbed grassland in the northwest portion of the potential grazing area along Concrete Pipe Road. Eggleaf spurge is also present adjacent to Deer Park Elementary School. No other targeted invasive weeds or rare plants are present in this area. This area is heavily forested with limited herbaceous acreage available for cattle and sheep grazing. Grassland patches are largely disjunct and adjacent woodland has nearly entire canopy cover and offers limited available forage.

Targeted spring goat browsing could be used to control invasive broom while late spring and summer grazing could be effective for controlling eggleaf spurge. Due to the widespread distribution of broom, management is best achieved in small, temporary enclosures to focus browsing behavior on broom while avoiding impacts to woody communities and native plants.

9. Azalea Hill. Low-density French broom covers the north and east portions of this 231-acre potential grazing area. This area consists of a mixed mosaic of grassland, chaparral, and woodland with a significant area of serpentine soil. A northwest to southeast trending ridgeline supports an extant population of Marin western flax in serpentine grassland and chaparral. Barbed goatgrass has begun to establish in this area and may threaten Marin western flax if allowed to persist and expand at this location. Several serpentine seeps in the southwest portion of the area north of Alpine Road and east of Fairfax-Bolinas Road contain Mt. Tamalpais thistle. Common velvet grass is also present in mesic grasslands throughout the center of the area and may be spreading at these locations.

Several factors, including the localized occurrences of rare plants and invasive weeds and varying RDM[8] requirements for serpentine and annual grassland communities, complicate grazing management in this area. In general, late-winter to spring moderate-intensity cattle grazing should be implemented to reduce abundance of exotic annual grasses while promoting increased native species richness and cover. The area supporting Marin western flax should be grazed prior to flowering when taller exotic grasses are the dominant available forage. This area should be carefully monitored to ensure impacts to this population are minimized. Areas supporting barbed goatgrass should only be grazed for a two- to three-week period after plants have bolted but prior to production of unpalatable flower heads (Brownsey et al. 2016). Serpentine seeps should be excluded from grazing using temporary fencing or other suitable

management techniques. Targeted spring goat browsing should be implemented to control significant infestations of dense French broom occurring mostly along the eastern half of this area at the urban interface. Goat browsing will likely require temporary exclusion fencing to avoid impacts to adjacent native plant communities and to avoid conflicts with Meadow Club golf course immediately west of these occurrences.

10. Pine Mountain South Gate. This 58-acre potential grazing area includes a northwest to southeast trending ridgeline dominated by serpentine grassland and chaparral that contains an extant occurrence of Marin western flax. These occurrences are generally in decline with no individuals seen in the northernmost occurrence for the past several years. Barbed goatgrass is currently invading most of these locations and can be considered a direct threat to Marin western flax and other native vegetation. Low-density broom is also present along the western perimeter of this area adjacent to Fairfax-Bolinas Road.

If feasible, moderate-intensity spring cattle grazing could be used in serpentine grassland to control exotic annual grasses and promote increased richness and cover of native species. Marin western flax occurrences should be grazed prior to flowering when taller exotic grasses are the dominant available forage. These areas should be carefully monitored to ensure impacts to these populations are minimized. Areas supporting barbed goatgrass should only be grazed for a two- to three-week period after plants have bolted but prior to production of unpalatable flower heads (Brownsey et al. 2016). Broom is not problematic in this area although there is potential for occurrences immediately to the west to spread into this area if uncontrolled.

11. Bathtub Gap-Carson Ridge. This 207-acre potential grazing area includes a north to south trending ridgeline dominated by serpentine grassland and chaparral that supports several seeps containing marsh zigadenus and Mt. Tamalpais thistle. These species co-occur in one seep complex in the central portion of this area. In the northern portions of MTW Lands, serpentine chaparral supports an occurrence of Marin western flax and an adjacent serpentine seep is occupied by a small population of marsh zigadenus. The serpentine seep containing marsh zigadenus and Mt. Tamalpais thistle should be excluded from grazing using temporary fencing or by actively managing animal behavior using appropriately located watering facilities or other shepherding techniques. Significant grazable acreage occurs in this area although grasslands are a mosaic of native serpentine and non-native annual grassland types.

In general, mid-winter to spring cattle grazing should be used to reduce the cover and abundance of exotic annual grasses while promoting native species richness, particularly native forbs in areas with serpentine soils. RDM[8] levels should be carefully monitored to avoid excessive grazing, particularly in serpentine grassland, where it may promote the establishment of invasive weeds including barbed goatgrass. Goatgrass is not currently mapped in this area but several prominent populations occur immediately north in the Pine Mountain South Gate grazing area.

12. Poison Spring Grasslands. This 121-acre potential grazing area is situated immediately northeast of Alpine Lake and is composed of dense oak woodland, chaparral, and open grassland with loamy soils. There are no mapped invasive weeds or rare plant occurrences in this potential grazing area. Grazing would be limited to contiguous grassland in the eastern portion of the area.

Moderate intensity, late-winter to spring cattle grazing in contiguous grasslands should focus on reducing the abundance of exotic annual grasses while increasing native species richness and cover.

Currently invasive weeds, including broom, are not problematic in this area and ongoing monitoring should ensure new infestations are carefully managed. Several areas of existing native perennial (coastal prairie) grassland should also be monitored to ensure management is benefiting existing native species, including perennial bunchgrasses. In general, oak woodlands in this area are dense and likely have relatively low herbaceous forage and may not be suitable for grazing.

13. Kent Pump Beginning. Located northwest of Alpine Lake, this 53-acre potential grazing area is primarily dominated by dense mixed hardwood forest interspersed with patches of chaparral. Open grassland and oak savannah occur immediately north of Alpine Lake Dam. Several areas supporting French broom are identified along the eastern perimeter of this area adjacent to Kent Pump Road. However, these areas are isolated and consist of few pioneer individuals and are not suitable for grazing management. No other occurrences of targeted invasive weeds or rare plants are known to occur in this area. Two non-contiguous grassland patches (21 and 28 acres, respectively) could support cattle grazing but their relatively small size, isolation, and infrastructure costs make grazing in these areas potentially infeasible. However, these areas would likely benefit from moderate intensity late-winter to spring grazing to reduce the abundance of exotic annual grasses while increasing native species richness and cover.

14. Grassy Knoll. The majority of this four-acre potential grazing area is dominated by dense Douglas-fir/mixed hardwood forest with several small grassland openings in the northern and southern portions. Medium-density broom occurs throughout much of the northwest portion of the area along Grassy Slope Road in grasslands or oak woodlands with reduced canopy cover. No other targeted invasive weeds or rare plants are known to occur in this area.

Cattle grazing is infeasible here due the small size of grazable land (4 acres). Targeted summer goat browsing should be implemented to control significant infestations of dense French broom occurring mostly along the eastern half of this area along the urban interface. Goat browsing will likely require temporary exclusion fencing to avoid impacts to adjacent native woody plant communities (e.g., hardwood forest, coastal scrub).

15. Cascade Creek. This 101-acre potential grazing area is composed of a mosaic of oak woodland and forest, chaparral, and grassland. Serpentine soils are not present in this area and one small occurrence of French broom is mapped in the south along Cascade Canyon Road. No other targeted invasive weeds or rare plants are known to occur in this area.

Primary grazing management objectives are to reduce the abundance of exotic annual grasses while increasing native species richness and cover. This area is well suited for cattle grazing as grassland and oak woodland are largely contiguous making it is more cost effective and logistically feasible than smaller, disjunct patches. If possible, grazing should be expanded into adjacent grassland to the east just beyond the area boundary.

16. Midpoint Meadows. One yellow starthistle occurrence is located in the center of this 38-acre potential grazing area immediately north of Fairfax Bolinas Road. Mt. Tamalpais thistle co-occurs with marsh zigadenus in a serpentine seep in the north-central portion of the area. Declining populations of both species were last observed in 1994, but are presumed extant. These populations are threatened by the succession of woody forest species into the meadows. There are additional extant occurrences of marsh zigadenus in the southern portion of the area in a drainage immediately north of Alpine Lake.

Grazing should be excluded from serpentine seeps and drainages supporting Mt. Tamalpais thistle and marsh zigadenus. Targeted periodic short duration, high-intensity late spring to summer goat grazing may control yellow starthistle. Cattle grazing must be carefully managed, as late-season or high-intensity grazing will likely exacerbate yellow starthistle infestations.

4.2 Water Quality Concerns

Livestock grazing has the potential to degrade water quality, but appropriate management practices can avoid or ameliorate these risks. Potential contaminants include sediment, temperature, nutrients, and pathogens. The latter two can present a health risk when downstream water is used for human consumption. It is important to note that the risks, benefits, and appropriate management practices vary by site, depending on topography, soil, species present, and other site-specific factors. Monitoring and adaptive management are key.

In general, riparian habitat and water quality benefit when riparian grazing is limited to mid- to late-spring in California. Grazing livestock will generally focus on annual herbaceous vegetation (including the adjacent uplands) during this timeframe. Grazing pressure on riparian vegetation increases in summer to mid-winter when green annual forage is scarce. Grazing during hot summer weather can also lead to increased loitering by livestock seeking shade or cool water. Minimizing rainy season grazing (when soils are saturated) protects riparian habitat and bank stability (Bush 2006; George et al. 2011). Grazing in spring and early summer has potential benefits relative to complete exclusion. Controlling annual vegetation can be important in promoting oak regeneration (McCreary 2001), controlling invasive weeds, and reducing fire risk (which itself negatively affects water quality).

Livestock are known to carry and shed several pathogens, including *Cryptosporidium, Escherichia coli*, *Giardia*, and *Salmonella*. Recent improvements in pathogen identification technology have revealed that fewer livestock-shed pathogens are human-infective than previously believed (Atwill 2015). A study of cow-calf operations in fourteen California counties found 0%–0.5% infection rates of human-infective strains of *Salmonella, Cryptosporidium* and *Giardia* (although 3% of the latter pathogen's samples were of undetermined strains) and a low (5%) rate of potentially human-infective *E. coli*. Most positive results were from a small percent of individual animals, or from two specific outbreaks. Calves were significantly more likely to shed *Cryptosporidium* and *Giardia* than older livestock. Other research indicates that for sheep, lambs up to five months old are more likely than older sheep to shed *Cryptosporidium*.

Maintaining sufficient RDM[8] in the uplands surrounding water bodies is an important and effective means of protecting water quality. RDM minimum standards for California annual grasslands are designed to minimize erosion, and therefore help to minimize the amount of sediment contributed by uplands (Bartolome et al. 2006). RDM minimum targets are also appropriate in leaving sufficient cover to slow or stop the transport of nutrients and pathogens, preventing them from entering water bodies and (for several nutrients and pathogens) facilitating the breakdown of the contaminant by sunlight (Li et al. 2005, Mander et al. 2000; Parkyn 2004; Hefting et al. 2005; Räty et al. 2010, Tate 2010). As little as a one-meter buffer of natural grassland can retain 95–99% of pathogens (Atwill et al. 2006; Tate et al. 2004). These measures lose effectiveness in the rainy season, especially during the first few rainfall events of the year, and during major storms (Tate et al. 2000). Grazing in or near drainages in the dry season, and to a lesser extent late in the rainy season or in dry periods between storms, improves buffer effectiveness and the opportunity for solar inactivation. Grazing of spring-fed wetlands can be beneficial in removing some nutrients from spring waters (Allen-Diaz et al. 2004).

The risk of impacts to water quality increases in areas where livestock congregate in or adjacent to a drainage or other water body, for instance if a loafing area, service area, bedding area, feeding/supplementing station, or water trough, is within 30 feet of a drainage (Tate et al. 2004; CLGPHMA 2012). Areas particularly susceptible to erosion include steep slopes with highly erodible soils (as classified by the Natural Resources Conservation Service Soil Survey), overhanging banks, and gullies. Steep banks, thickets of dense vegetation and other physical obstacles can restrict or minimize livestock access, especially if easier access or crossing points are nearby (Bush 2006; George et al. 2011). Fencing (e.g., large riparian pastures or small exclosures) and off-stream attractants (such as troughs and shade) can be important tools in controlling the timing and intensity of riparian grazing (Bush 2006, Hahn 1999, Willms et al. 2002).

5. Grazing and Browsing Habits of Domestic Livestock and Tule Elk (and Operational Requirements of Kind and Class of Animal)

5.1 Foraging Differences

Livestock are divided into groups based on their preferences for different types of vegetation and primary foraging methods. These groups include grazers (cattle and horses) which have a diet dominated by grasses and grasslike plants, browsers (goats), which consume primarily shrubs and forbs, and intermediate feeders (sheep), which have no particular preference for grasses, forbs, or shrubs (Holechek et al. 1998). Browsers generally consume large amounts of green grass in spring, but avoid dry, mature grass and often experience digestive upsets if forced to consume too much mature grass (Vallentine 1990).

Body size, anatomical differences in teeth, lips, and mouth structure, grazing ability, and differences in digestive systems account for some of the differences in foraging behavior. Mouth size directly affects the degree of selectivity that is physically possible. For example, livestock with small mouth-parts such as goats and sheep can more effectively utilize shrubs while selecting against woody plants.

In addition to physiological influences on diet selection, animal behavior can strongly affect what they choose to eat. Young animals learn foraging behaviors from their mothers and peers and can be taught to eat or avoid certain plants. In fact, researchers have taught livestock in experimental settings to consume some weed species, although this practice is extremely time consuming and impractical on an operational level. Additionally, consumption of weed species does not necessarily result in reduced populations of target plants. Depending on timing and frequency of weed consumption, grazing or browsing can actually increase some weed populations. Grazing of yellow starthistle (described above in Section 3.1.3) is a good example where removal or wrong timing can lead to increased flowering and reproduction.

Generalized livestock preferences for diet and topographic position and the associated suitability for MMWD vegetation management are summarized in Table 1 below.

5.1.1 Production Agriculture vs. Fees for Service Grazing

Meat and dairy animals. Ranchers raise a vast majority of the livestock in Marin County for production of saleable products including meat, fluid milk, and processed dairy products such as cheese. Ranchers rely on high-quality forage and supplemental feeds to ensure that their animals are in good health, reproduce successfully, and produce a high yield of milk or meat. With meat animals, weight gain is important since the animals or their meat are sold based on weight. Dairy animals, are valued based on their milk production, which is strongly influenced by their feed. Additionally, dairy animals are kept close to the milking parlor to facilitate ease of milking and to avoid burning unnecessary calories by walking long distances. The only type of production agriculture operation that would be likely to utilize its animals for vegetation management on MTW Lands would be beef ranchers who may be interested in grazing cattle on grasslands. However, this could lead to incidental browsing of shrubs and tree seedlings within those grasslands.

Vegetation management animals. Unlike meat and dairy animals, a more limited number of businesses keep animals for managing vegetation rather than producing a saleable product, although some do also produce meat animals as a byproduct. These operations earn income by charging a fee for vegetation

management service. Although animal and herd health are important to this type of operation, it is not as essential in terms of profitability. However, consumption of unsuitable feed, especially for prolonged periods, can weaken of sicken animals and require costly animal replacement.

5.1.2 Tule elk

Tule elk, which are native grazers/intermediate feeders, roamed California until the late 1880s. Tule elk are classified by the CDFW as game animals and can only be managed by this agency.

CDFW oversees several areas where tule elk have been reintroduced, all of which are extensive in size, providing adequate acreage to support planned populations. CDFW only establishes elk herds on lands that fall within the species' historic range, and that roughly include a minimum of 10,000 acres or high-quality appropriate habitat composed primarily of grasslands and open-canopied oak woodlands. Additionally, elk herd introductions have to be acceptable to neighbors. CDFW is not interested in having fenced herds, as this leads to the need to remove and relocate excess animals, a practice that they do not engage in. Furthermore, CDFW requires population control in managed elk herds, which is done through hunting programs in most areas of California. Birth control treatments for females have been used in some herds but have been abandoned due to high costs (Joe Hobbs, personal communication 2017).

Table 1. Generalized livestock preferences for diet and topographic position and suitability for MMWD vegetation management

Species	Class/ Type	Diet Preferences/Needs	Topographic Position Preferences	Suitability for MMWD Vegetation Management
Sheep	Meat	Intermediate feeder: high use of forbs, but also eat high volumes of grass and browse[14]	Well adapted to steep hills and rough terrain	Yes, where rare forbs are not present or during periods that they would not be damaged by grazing
	Dairy	Same but additional of supplemental feed in barn to ensure good milk production	Adapted to steep hills and rough terrain	No, must stay close to milking parlor
Goats	Meat	Browser to intermediate feeder: high forb use, but can utilize large amounts of browse and grass; highly versatile	Adapted to a wide variety of terrain	Yes, where rare forbs are not present or during periods that they would not be damaged by grazing
	Dairy	Same but additional of supplemental feed in barn to ensure good milk production	Adapted to steep hills and rough terrain	No, must stay close to milking parlor
Cattle	Dairy	Primarily dry forages in barn, with some grass, especially for organic production	Level to gently rolling ground	No, must stay close to milking parlor
	Dairy heifers	Grazer: mostly grasses, some seasonal use of forbs and browse	Prefer level to gently rolling terrain but will climb steep hills	Yes, in grasslands
	Beef, cow-calf	Grazer: mostly grasses, some seasonal use of forbs and browse	Prefer level to gently rolling terrain but will climb steep hills	Yes, in grasslands
	Beef, stockers	Grazer: mostly grasses, some seasonal use of forbs and browse	Prefer level to gently rolling terrain but will climb steep hills	Perhaps, in grasslands; stockers can be wild and difficult to manage
Horses	NA	Grazer: mostly grasses, minor amount of forbs and browse	Prefer level to gently rolling terrain	No, other species are better suited to MTW Lands
Tule elk	NA	Grazer and intermediate feeder	Widely adapted native ungulate	No, introduced herds must be managed by CDFW and require tall, sturdy fences for containment

[14] Browse refers to woody plant material ingested by animals.

5.2 Timing of Grazing, Duration, Intensity and Repeated Treatments

Grazing effects on target plants can vary dramatically based on timing of grazing. Seasonal conditions, age, or phenological stages of plant development may make plants more or less vulnerable to damage due to herbivory, which can be positive or negative, depending on grazing objectives. For example, if enhancement of seed production is desired, grazing should be deferred until after flowering and seed set. Where the opposite is desired—reduction of seed output by weed species—grazing or browsing would theoretically be desirable during flowering and before seed drop.

Despite this obvious potential effect of herbivory on flowering and seed set, numerous examples (some which can seem counterintuitive) exist where populations of flowering plants thrive despite, or because of, continuous grazing pressure. Timing of grazing/browsing should be keyed to specific site objectives but determining appropriate timing can be difficult where competing objectives that might best be served by different or even conflicting times of grazing occur. Carefully identifying and prioritizing objectives should take place before grazing/browsing timing is determined.

The duration of grazing episodes and stocking intensity[15] also greatly affect plant enhancement or control outcomes. Duration can last from only hours in extremely intensive grazing regimes, to year-round, which is common in California on dry Mediterranean grasslands. Some ranchers and consultants have popularized short-term, high-intensity grazing in recent decades. Proponents believe that such systems are inherently superior to more traditional, less intensive grazing. However, duration and intensity of grazing episodes should be tailored to meet grazing/browsing objectives, whether they are focused on animal weight gain or resource enhancement and no one particular regime has been shown to be generally superior to another.

Frequency of grazing episodes is another important variable that strongly influences outcomes of most grazing programs. With year-round continuous grazing, frequency does not come in to play, but frequency must be considered in any grazing regime that employs grazing for only a portion of each year. For example, grazing that is aimed at reducing barbed goatgrass populations may require only one, carefully timed grazing episode in spring to reduce seed development of this annual plant, while two grazing episodes may be required to reduce yellow starthistle due to its staggered germination and development.

Repeated grazing treatments may also be necessary in proposed grazing areas where objectives can best be met by targeting different plants at different times of year.

5.3 Targeted Grazing Versus Grazing to Meet Broader Objectives

The term targeted grazing is used in reference to livestock grazing that is managed to accomplish very specific outcomes. Usually used for conservation purposes, it can be focused on specific plant species or vegetation types, either to their detriment or benefit at specified places (Campbell-Craven 2017). This is in contrast to grazing that is conducted for broader purposes such as forage utilization or mimicking an ecosystem process (e.g., prehistoric ungulate effects). Traditionally, grazing in the region around MTW Lands has been conducted primarily for the economic production of animal products, including meat, dairy, and fiber, and for maintaining larger landscapes in particular conditions. For example, grazing has effectively been used to maintain grasslands and prevent type-conversion to

[15] Stocking intensity refers to the number of animals (or animal units) on a given area of land at any one time.

woody vegetation without this being specifically identified as a desired outcome. The study team focused on livestock grazing to target priority rare native plant habitat, weeds, vegetation types, and fire fuels for the conservation purposes described by MMWD (Section 2). Grazing contractors would be paid for their services and be under MMWD direction and monitoring to achieve specified priority resource conservation objectives.

5.4 Supplementary Alternative/Additional Treatments

Interviews with ranchers and contract graziers indicate that any grazing on MTW Lands will probably be conducted by outfits that own animals specifically for targeted contract work. Due to expected high costs and questionable effectiveness at achieving some of MMWD's vegetation management objectives, at least some of MMWD's vegetation management will continue to be achieved with non-grazing methods, including hand crews, heavy equipment, chainsaws, and weed-eaters. Mechanical and hand treatments are compared with grazing/browsing vegetation management methods in Table 2 below.

6. Survey of Potential Availability and Costs of Livestock Grazing Contractors

6.1 Background

L. Bush conducted telephone interviews with 13 ranchers and contract graziers to determine their interest and the availability of livestock for a potential grazing/browsing program on MTW Lands. For the most part, ranchers and contract graziers make up two very distinct groups with very different business models, though a few ranchers do some contract vegetation management work with their livestock. Generally, ranchers earn a living by producing and selling a product, including live animals, meat, fiber, milk, or processed dairy products. Labor is costly, so only essential labor is engaged. Cattle, sheep, and goat ranches (excluding dairies) typically operate with meager cash flow and low profit margins and so do not normally have many, if any, employees, although this depends on the size of the operation. Most ranchers are so busy with their livestock production operations that they are not interested in taking on contract vegetation management projects, which would involve hiring employees and possibly being away from the ranch during crucial periods in their animals' life cycles.

On the other hand, contract graziers earn income by providing labor-intensive vegetation management and ecological services for a fee. They may also produce meat and fiber as by-products of their business, but for the most part their financial goals are met through direct payment for services rather than by selling products.

6.2 Methodology

L. Bush compiled a list of potential contract graziers by searching the internet, communicating with other rangeland management professionals, and through referrals made by initial interviewees. She also interviewed several ranchers whom she knows from working in the field of rangeland management in Marin and Sonoma Counties for over 30 years.

Persons contacted included two Marin County beef ranchers, two Sonoma-Marin sheep ranchers, and one Sonoma-Marin goat and beef rancher; and eight contract graziers from the greater Bay Area and Merced County. L. Bush conducted telephone interviews that lasted form several minutes to an hour. Ranchers who were not interested in contract grazing quickly stated their lack of interest while contract graziers all answered a series of questions after L. Bush provided the following background information to those who indicated an interest in providing vegetation management services to MMWD:

> MMWD has lands totaling several thousand acres where they are exploring the potential to use limited livestock grazing to:
>
> - Manage herbaceous and woody weed species
> - Manage grassland areas (totals about 1,100 acres over 16 areas)
> - Manage fuelbreak areas to reduce shrub and tree growth

MTW Lands include 16 potential grazing/browsing areas with more than two dozen potential staging areas (parking lots). Constraints and conditions include:

- Lack of fencing
- Lack of established watering locations and facilities, although some hydrants and springs could be tapped to provide water for distribution to grazing treatment areas
- Grazing/browsing may be very seasonal/short-term/intensive
- Some areas are on very rugged, remote terrain

- Some areas will require trailing the livestock to treatment sites
- None of the areas have been grazed since the 1940s, so forage quality may be low (due to thatch build up and succession adding woody and less palatable herbaceous species)
- Some areas/species may require goats and/or sheep, and some may be better for cattle

6.2.1 Survey Questions

Questions asked of all graziers included:

1. Do you have cattle, goats, and/or sheep (and supporting personnel) available for this kind of service?
2. Do you have transport, temporary fencing, and watering equipment to bring to, install, maintain, and use on-site?
3. Potential treatment areas range from several acres to several hundred acres; are the sizes of the targeted patches big enough to be worthwhile?
4. When would you be available?
5. What are your constraints (access, shelter, predation, compensation, etc.) and logistical needs?
6. What shelters, staging, guard dogs, and non-lethal predator controls would be required?
7. How far can you walk animals from staging areas?
8. Would your livestock eat this material:
    - grasses (general grassland vegetation plus tall fescue, barbed goatgrass, Harding grass, and common velvet grass)
    - yellow starthistle, fennel, and blackberry[16]
    - French broom
    - shrubs (possibly chaparral) and tree growth, including tan oak
9. Are there seasons when this would work best/worst?
10. What additional treatments or services would be necessary for MMWD to perform to prepare/condition this forage/browse?
11. If not feasible or attractive, what would make it so?
12. What would be your per-acre costs?
13. What would be your staging costs?

6.3 Survey Results

Of the contract graziers contacted, one operates with cattle, one with goats, one with sheep, and the remaining five use a mixture of sheep and goats depending on project requirements. The cattle grazier uses dairy heifers that belong to local dairies to manage vegetation on large estate properties. This cattle grazier serves landowners who are interested in the ecological benefits of grazing or need fire fuels reduced, but do not have their own livestock. At least one of the sheep graziers rents or borrows many of the sheep he uses on larger projects from ranchers or other sheep graziers.

Several of the livestock graziers have gotten into this business within the last few years, with the most well-established operating for 24 years and the newest operating for about two years. Several local companies that were listed on the Livestock for Landscapes website (Voth 2017) have gone out of business or did not respond to phone calls and emails. Livestock graziers contacted are headquartered

[16] Fennel and blackberry were included in the survey, and eggleaf spurge was excluded because the survey took place while the final list of weed species to be addressed was still in draft form.

in Marin, Sonoma, Lake, Contra Costa, Santa Clara, and Merced Counties. They are all able to travel to Marin County and most of them are used to travelling significant distances to work sites.

Only one of the beef ranchers indicated a possible interest in contract grazing, although he has not conducted this type of work in the past, while all eight of the contract graziers indicated an interest in working on MTW Lands and said they would be available to perform vegetation management for MMWD.

Herd Transportation and Portable Infrastructure. All of the contract graziers said they have the necessary equipment to transport animals to the site and manage them. Portable infrastructure includes electric mesh fencing and portable watering equipment. Several mentioned they are used to obtaining livestock water from hydrants.

Minimum Project Size. One grazier said he will do small, backyard-sized to one-acre projects, but most indicated that about five acres is their minimum project size. One specified a minimum project cost of $10,000. Several said that larger scale projects cost less per acre, as transportation costs can be spread over a larger number of acres. One grazier set five acres as a minimum overall project size, but stated that having large and small treatment areas within an overall project is acceptable.

Seasonal Availability. Most graziers said they can work year-round, but several with goats and sheep do not like to work in winter due to inclement weather and the fact that sheep generally lamb in winter. The one cattle grazier said that he manages animals year-round but that services would be less expensive between December and April when providing water to animals is not as critical. One sheep and goat grazier has developed a herd of wethers (castrated males) that work up until October and start again in February, before her other animals are working. One sheep and goat grazier mentioned that he works May through August but later than that ewes need to be fed to prepare for lambing in winter.

Constraints. None of the graziers expressed concern about the site constraints.

Requirements from MMWD. The things needed by graziers from MMWD are site access for trucks and gooseneck trailers or 18-wheelers (less expensive for large herds, but access usually prevents their use), site maps, staging areas for livestock and herders, space for herder trailers, permission to use all-terrain vehicles (“4-wheelers”) off-road on MTW Lands, and an adequate water supply. All are used to distributing water from water supply points.

Trailing/Walking Distance from Staging Areas. Most graziers indicated that they could trail livestock over fairly long distances from staging areas or between treatment sites. One mentioned that the ability to trail animals between treatment sites is easier thus cheaper than trucking between sites. The distance that animals can be trailed depends on terrain, but most graziers said animals and herders can walk one to five miles per day, with a total distance of between 10 and 30 miles.

Herd Protection**.** All but two of the livestock graziers use professional herders to guard and manage animals. All of the sheep and goat graziers also use guardian dogs, which they would not use on sites with significant public recreational use or near residences. Most of the sheep and goat graziers indicated that they could manage their herds without the dogs, but that herders or employees are always with the animals. One grazier uses guardian dogs to protect goats from theft.

Livestock Consumption of Target Species. Some graziers are familiar with specific plant species, some said they are not, and some seemed to have questionable knowledge of browsing/grazing effects on particular species. Two interviewees stated that animals will consume some species only as a percentage of their overall diet and that they need a large enough area around the patches of target species to select other more nutritious or less toxic plants. This was mentioned in relation to consumption of French broom. Most interviewees indicated whether or not their livestock will consume the plants they were asked about, but some specifically mentioned actual population decreases of the targeted weeds over time. However, this information is anecdotal and consumption and long-term effectiveness of browsing/grazing effects of these plants may vary greatly depending on site characteristics, grazing/browsing intensity and frequency, and timing of treatments. Consumption of plant material by livestock does not necessarily equal control of the targeted plants. Some targeted grazing research (Kyser et al. 2014) has demonstrated weed species control with livestock only under carefully prescribed experimental conditions, which could be difficult to impossible to reproduce in other settings. Additionally, research-driven grazing prescriptions can be very time consuming, thus expensive to replicate. Also, repeated treatments within the year and across multiple years (even perpetually) might be required, thus indicating higher long-term costs than a single treatment.

The following species were included in the survey:

> ***Tall fescue.*** Responses regarding livestock species' ability to consume and manage this species varied. Generally, responses indicate that multiple grazing treatments are needed with heavy stocking rates. Using intensive grazing, apparently all three livestock species will consume this plant.
>
> ***Barbed goatgrass*****.** The cattle grazier is familiar with this plant and said that cattle will eat barbed goatgrass, depending on phenology (i.e., it is palatable when very young). None of the other graziers seemed familiar with it.
>
> ***Harding grass*****.** Goats apparently consume Harding grass much more readily than do sheep. One grazier said that his goat and sheep herd will eat Harding grass, but consume the inflorescences first, often leaving a large round mass of basal stems and leaves. Cattle will also consume Harding grass, depending on phenology and the availability of other forage plants.
>
> ***Common velvet grass*****.** This is a coarse-textured plant with low palatability. Of the four graziers who are familiar with this species, two said that goats will eat it, one said that sheep will eat it, but that the animals' condition deteriorates on it over time, and one said that neither animal will eat common velvet grass but that they could be bedded down on it to try and damage it.
>
> ***Yellow starthistle*****.** This plant is familiar to most of the graziers. The one cattle grazier indicated a low success rate managing this plant with cattle. Most of the goat and sheep graziers have had some success managing yellow starthistle, with goats possibly eating it more readily than sheep. One interviewee mentioned that yellow starthistle should be grazed at least twice in May and June to knock it back, and most said that over a period of years, grazing with sheep and/or goats will deplete populations.
>
> ***French broom*****.** Many of those interviewed are familiar with French broom, although they may or may not know the difference between broom genera and species. Two graziers reported toxicity/nutritional issues with broom. One said that goats can only eat broom early in the year,

before bloom-time, because if consumed too late in the season it can interrupt estrus. Another said that broom contains toxic compounds that goats can tolerate more easily than sheep, although this person referred to browsing during flowering. A third person that has a large sheep and goat operation has never had toxicity issues with her animals when they eat broom. Two graziers stated that goats and sheep will consume French broom, but will not eat stalks over ¼" to ½" in diameter. One sheep grazier said that sheep will consume broom in quantities up to 25% of their diet, so they need access to a large enough area so that other plants can provide adequate nutrition.

***Tanoak*.** Interviewees' familiarity with this plant are questionable. Several seemed unable to differentiate it from the genus *Quercus*, despite attempted clarification. Two said that goats will eat tanoak early in the year and one said that sheep will not eat it.

***Poison hemlock*.** The survey did not include a question about this species, but the one cattle grazier mentioned observing a decrease in poison hemlock with cattle grazing, which is consistent with L. Bush's (co-author) observations over many years.

***Eggleaf spurge*.** The survey did not include a question about this species.

Himalayan blackberry (*Rubus armeniacus*). All interviewees who has experience with this plant said that goats and sheep will consume this plant. One cattle grazier described cattle consumption of Himalayan blackberry as "so-so." One sheep and goat grazier stated that sheep are not as effective on blackberry as goats are. One goat and sheep grazier stated that goats will target blackberry.

Fennel (*Foeniculum vulgare*). All sheep and goat graziers who were interviewed who were familiar with fennel said that both species readily eat this plant.

Best Season for Treatment. Answers to the question about the best season for grazing/browsing treatment of the species discussed above varied from "it depends on the species," to "early to late spring'" to "April through June", and "June and July, but earlier for broom." One goat grazier said that his animals can lose weight browsing in late summer, and thus he needs to provide supplemental alfalfa at that time of year.

Costs. L. Bush described MTW Lands to each grazier and requested rough per-acre costs.[17] Rough costs ranged from $250/acre to $1,200/acre per treatment, with several citing $400 to $500/acre for projects and areas with few complications, easy access, and where temporary fencing is simple to install. Two others quoted rough prices of $700 to $800/acre.

Logistical issues such as difficult access and steep terrain were cited as factors that can greatly increase the actual price. Project scale also affects price. Ease of setting up fencing was cited as affecting price, because areas with dense woody vegetation require extra labor for vegetation clearing before fencing can be installed.

[17] Graziers cannot be expected to provide accurate or precise costs or bids for specified projects without knowing the project size, number and location of treatment sites, desired timing of treatments, repetitions of treatments per year and between years, distance from staging areas to water, and more information on terrain at treatment sites.

One grazier said that yearlong access to MTW Lands would bring his costs down, and thus the price he would offer. One charges $800/acre plus transportation, which is charged every time a truck is loaded and moved (versus trailing animals between treatment areas). One said that his prices are lowest between August 15th and April 15th, which is his low season. One mentioned lowering costs if several neighboring agencies utilize his services. Another said that transportation in an 18-wheeler (semi-truck) is the most efficient and cheapest, so this would reduce costs, but is rarely practical (and is unlikely to be practical at any of the access and staging areas at MMWD). Trucks and gooseneck trailers are more commonly used but increase costs. Feasibility for MMWD to accommodate yearlong access and support for the grazing animals and associated personnel would likely involve designation of non-target sites near the targeted sites within MTW Lands or on neighboring properties. A long-term arrangement that allowed the contract grazier to use such areas for off-season keeping of their animals between jobs might work. This would also require supplemental feeding of the animals. The study team understands that the latter practice would be unacceptable to MMWD (A. Williams, MMWD, personal communication) due to the impossibility to obtain weed-free and GMO-free supplemental feed.

6.4 Other Comments

Planning Ahead. Two graziers spoke about taking reservations well in advance of the planned grazing/browsing treatment time. One takes deposits a year in advance to secure a time slot, and one prefers to have spring contracts secured the previous fall. If bids are requested by agencies in fall, graziers need to know bid results as soon as possible to allow adequate planning. Multi-year projects are more attractive, and allow contractors to plan for livestock demand, and obtain necessary animals in time for projects.

Some of the larger graziers have up to four or five herds working at one time, while smaller operators have only one herd, meaning that obtaining their services when demand is high would be difficult. Herds typically include from about 350 to 500 animals.

Chaparral Browsing. One grazier mentioned that sheep will not eat chaparral plants and one said that goats will defoliate Manzanita, but will not consume its woody parts.

Effectiveness. One grazier stated that browsing/grazing for weed management will not achieve the level of selectivity that mechanical treatments do. Another stated that grazing effectiveness and feasibility is always dependent on the livestock species and that he prefers using sheep near residences because they are easier to control than goats.

Nutrition and Animal Health. Several interviewees mentioned possible livestock health problems associated with intake of too much of a particular plant species or consumption of low-quality forage or browse, especially in late summer. Some mentioned the need to supplement with alfalfa under certain conditions, but said that it is not essential. One mentioned use of protein supplement tubs instead of dry feed. Two interviewees indicated a need to keep animals on their home ranches during birthing seasons (winter for sheep), and for several months leading up to that time so that pregnant animals receive optimal nutrition. One of the larger operations has a dedicated veterinarian and cares for retired animals their entire natural life, rather than slaughtering them.

6.5 Survey Conclusions

Considering the number of contract graziers who have businesses in the greater Bay Area and beyond, MMWD should be able to enter into a contractual agreement with one or more of these companies if staff and board members decide that vegetation management with livestock is something they wish to pursue. Given the rough terrain, other site constraints and very specific objectives of MMWD's vegetation management program, leasing these lands to production ranchers would be impractical since the amount of labor required to meet MMWD's specific objectives is considerable and beyond what most ranchers are equipped to provide. Additionally, much of the vegetation on MTW Lands would not provide high-quality forage for most livestock on an ongoing basis. Ideally, lands in Marin County would be used for local ranchers to help support their operations and Marin's agricultural economy, but given the constraints mentioned above, this is not practical on MTW Lands.

If targeted grazing/browsing is added to MMWD's vegetation management program, very clear communication between MMWD staff and contractors will be essential to help avoid ecological and other problems. Contractors should be knowledgeable about targeted plant species, sensitive plant species, and other environmental concerns and should be well prepared to deal with the public's concerns and questions about livestock and their effects on the landscape. If recreational access occurs at the same time and general locations as the grazing treatment, the contractors are likely to be asked such questions. Contractors must also be extremely attentive and responsive to any conflicts that arise with their animals so that problems do not escalate resulting in ecological damage, livestock illness, or conflicts with the public.

Cost Effectiveness. Due to the number of factors that affect costs for provision of grazing/browsing services, accurate costs for this work can only be obtained once a specific grazing/browsing program is designed and described in writing and with a map, then reviewed with potential contractors in the field. Project scale, exact locations of treatment sites, season of work, length of project (single treatments versus multiple treatments), distance from staging areas to exact treatment sites etc. are all considered by grazing browsing contractors when setting a price.

Grazing and browsing by livestock will not remove woody vegetation with stems beyond about ¼" to ½" in diameter, so it cannot be used to replace initial brush cutting or use of heavy equipment for fire fuel clearing. However, it can be used for on-going maintenance of cleared sites, although livestock may avoid some woody species meaning that grazing/browsing alone may not be completely effective.

The MMWD *Draft Biodiversity, Fire, and Fuels Integrated Plan* (Panorama Environmental, Inc. 2016: Table 7-2) provides a Summary of Costs for Vegetation Management Actions/Performance Criteria. It includes costs for performing various vegetation management tasks using mechanical methods and hand weed control. Additionally, MMWD identified other vegetation management needs not addressed there. Table 2 below summarizes projected per-acre costs for pertinent vegetation management tasks using mechanical and manual methods, potential effectiveness of grazing/browsing, and probable cost effectiveness of grazing and browsing methods compared to the mechanical and manual methods given the rough costs provided by interviewees.

Table 2. Comparison of mechanical/manual to grazing/browsing vegetation management methods

Mechanical/Manual Methods		**Grazing/Browsing Methods**	
Actions/Performance Criteria*	**Projected Per Acre Cost***	**Probable Effectiveness to Achieve Comparable Performance Criteria**	**Expected Cost Effectiveness**
1. Retreatment of fuels in existing fuelbreaks [MA-20.1]	$1,700	May be effective for many species, but not all targeted species or vegetation types Only if woody plant parts are ¼" to ½" or less	Yes, where species are palatable and wood is small diameter
2. Cyclical mowing of fine fuels [MA-20.2]	$360	Yes	No
3. Cyclical [hand] removal of broom in Optimized and Transitional Zones [MA-20.3]	$360	Not as effective as hand pulling, but may be effective for small plants	No
4. Roadside mowing [MA-20.4]	$2,000	Yes, for herbaceous vegetation, maybe for woody vegetation May be effective for many species, but not all targeted species or vegetation types Only if woody plant parts are ¼" to ½" or less	Yes
5. Dam maintenance [MA-20.5]	$2,000	Likely	Yes
6. New fuelbreak construction [MA-21]	$10,000	No. Animals will not remove large, woody material	N/A
7. Reduce accumulated fuels and brush in forests [MA-23.1]	$12,300	May be effective for many species, but not all targeted species or vegetation types Only if woody plant parts are ¼" to ½" or less	Yes
8. Douglas-fir thinning in oak woodlands and grasslands [MA-24.1]	$480	Sheep and goats will remove Douglas-fir seedlings, but may damage other forest species	No
9. Broom, initial removal in oak woodlands and grasslands [MA-24.3]	$6,000	No, will not remove mature plants – will defoliate and eat small stems	NA
10. Yellow starthistle [MA-24.5]	$1,200	Probably effective over several years	Possibly, if project is big enough to keep costs down. Required size is not known
11. Goat grass [MA-24.6]	$360	Probably effective over several years, but requires very carefully timed, intensive treatment	No
12. General grassland and thatch management for selected special-status plants [MA-24.2]	NA	Very effective with proper timing	Possibly if comparable to prescribed burn, $18,000/project or between $300-$600/acre depending on unit size and complexity

* Actions/Performance Criteria and Projected Costs #1-12 from Panorama Environmental, Inc. 2016, Table 7-2. p. 7-5; comparable action numbers in brackets.

7. Summary of Feasible Grazing Scenarios

Feasible grazing scenarios are described below for each of the high priority potential grazing areas identified by A. Williams (Appendix 2). Each area supports species that may be effectively enhanced (rare plants) or managed (weeds and fuelbreaks) with livestock grazing based on scientific literature and feedback from livestock operator surveys. In all cases, contract graziers would provide livestock management infrastructure to keep their animals contained in the defined treatment (targeted) areas, so presence or availability of grazing management infrastructure is not a factor in determining grazing feasibility, unless site-specific evaluations by contract graziers identify unknown limitations.

7.1 Prospective Grazing Scenarios for the Potential Grazing Areas

This section summarizes the conditions that contribute to feasibility and expected success of grazing and browsing in each of the 16 potential grazing areas.

1. Sky Oaks, 282 acres

Targets. French broom, common velvet grass, Harding grass, yellow starthistle, tall fescue, barbed grass, eggleaf spurge, and harlequin lotus.

Primary Objectives. Decrease of broom seed production and young plants with particular emphasis on sparse/pioneer occurrences; reduction/management of non-native perennial grasses including common velvet grass, Harding grass, and tall fescue; reduction/management of yellow starthistle, eggleaf spurge, and barbed goatgrass, all without negatively affecting harlequin lotus and other native plants and ideally enhancing harlequin lotus habitat.

Feasibility of Grazing/Browsing. Grazing appears to be physically feasible in this area as terrain and vegetation are generally appropriate.

Expected Success of Grazing/Browsing Treatments. Some reduction of French broom seedlings and defoliation of larger plants would likely be achieved with browsing by sheep and/or goats, although grazier interviews indicate that toxicity may be an issue for these animals. Reduction of common velvet grass and Harding grass by grazing may require cattle and is questionable due to the fact that intensive grazing, which may damage harlequin lotus, would be required. Reduction of yellow starthistle may be possible with short-duration, high-intensity goat grazing. If hand removal of eggleaf spurge is infeasible, targeted late-spring to summer goat grazing may reduce eggleaf spurge, but is not expected to eliminate this plant. Intensive and carefully timed grazing of barbed goatgrass for only a two- to three-week period after plants have bolted but prior to production of unpalatable flower heads may help control this plant (Brownsey et al. 2016). Moderate cattle and possibly goat grazing could enhance harlequin lotus habitat, although grazing by sheep may damage harlequin lotus plants due to sheep preference for forbs.

2. Porteous-Ross Reservoir-Worn Spring Middle, 115 acres

Targets. Broom with many areas occupied by more than 50% cover, particularly in the south near Phoenix Lake; one small patch of leafy spurge in open grassland near terminus of Worn Spring Road. No target rare plant populations in this grazing area.

Primary Objectives. Decrease of broom seed production and young plants; reduction/management of eggleaf spurge; management of grasslands and oak woodland understory to reduce the abundance of weeds and exotic annual grasses while increasing native species richness and cover.

Feasibility of Grazing/Browsing. Grazing appears to be physically feasible in this area as terrain and vegetation are generally appropriate. Grassland and oak woodlands suitable for grazing livestock dominate this area, providing appropriate forage for livestock.

Expected Success of Grazing/Browsing Treatments. Some reduction of French broom seedlings and defoliation of larger plants would likely be achieved with browsing by sheep and/or goats, although grazier interviews indicate that toxicity may be an issue for these animals. Moderate intensity, continuous late winter-spring cattle grazing in grasslands and oak woodlands may reduce the abundance of weeds and exotic annual grasses while increasing native species richness, but is unlikely to effectively manage broom. If hand removal of eggleaf spurge is infeasible, targeted late spring to summer goat grazing may reduce eggleaf spurge, but is not expected to eliminate this plant.

3. Pilot Knob, 59 acres
Targets. Two small patches of French broom along northern border and native perennial grasses.

Primary Objectives. Decrease of broom seed production and young plants, prevent future incursions of invasive plants and exotic annual grasses and enhance the native species composition in existing grasslands.

Feasibility of Grazing/Browsing. Grazing appears to be physically feasible in this area, although dense forest cover keeps it from being ideal grazing land.

Expected Success of Grazing/Browsing Treatments. Small patches of broom would be best managed by manual removal. Moderate intensity spring grazing prior to native perennial grass seed production may enhance these grass populations. However, grazing would need to be carefully monitored in this area to ensure native perennial bunchgrasses are not adversely affected.

4. Ridgecrest-Rock Spring-Potrero, 191 acres
Targets. Harding grass, tall fescue, Mt. Tamalpais thistle, harlequin lotus, marsh zigadenus, isolated and small patches of serpentine grassland.

Primary Objectives. Enhance wet meadow habitat for Mt. Tamalpais thistle, harlequin lotus, and marsh zigadenus by reducing or eliminating Harding grass and tall fescue; enhance serpentine grassland.

Feasibility of Grazing/Browsing. Grazing appears to be physically feasible although vegetation in this area is mostly forested with chaparral in the center of the area. Chaparral and forest are inappropriate vegetation types for grazing/browsing due to poor forage quality of plants and potential for damage to non-target plants. Non-native annual grassland, which occurs along the western border is suitable for grazing. Wet meadows that support Mt. Tamalpais thistle and harlequin lotus could be grazed individually or in conjunction with larger areas. Grazing should not take place where marsh zigadenus occurs due to the potential of poisoning livestock. Small patches of serpentine grassland are isolated and grazing in these areas is likely infeasible.

Cattle grazing in contiguous non-native annual grassland and oak woodland could occur from late winter to spring to reduce the abundance of exotic annual grasses while promoting increased native species richness and cover. Grazing could also be considered in contiguous grassland west of this area to improve habitat and prevent establishment and/or spread of invasive species, including yellow starthistle. Grazing infrastructure would need to be provided by contract graziers to keep animals off main roads and contained in treatment areas.

Expected Success of Grazing/Browsing Treatments. Due to the number of target species with competing needs, establishing a grazing program that could effectively meet all relevant objectives would be difficult. Wet meadows that support Mt. Tamalpais thistle and harlequin lotus could be grazed, but the level of grazing needed to damage Harding grass and tall fescue would likely also damage the rare plants. Hand removal would likely be more effective at reducing or eliminating tall fescue and Harding grass without damaging rare plants.

5. Pumpkin Pine-Fish-Lag Meadows, 179 acres.
Targets. French broom, common velvet grass, Harding grass, harlequin lotus and marsh zigadenus.

Primary Objectives. Decrease broom seed production and young plants; and enhance habitat for harlequin lotus and marsh zigadenus by reducing common velvet grass, Harding grass, and exotic annual grasses.

Feasibility of Grazing/Browsing. Grazing appears to be physically feasible in this area as terrain is generally appropriate. Suitable forage is available in grassland areas where common velvet grass, Harding grass, and harlequin lotus occur. Grazing should not take place where marsh zigadenus occurs due to the potential of poisoning livestock.

Expected Success of Grazing/Browsing Treatments. Some reduction of French broom seedlings and defoliation of larger plants would likely be achieved with browsing by sheep and/or goats, although grazier interviews indicate that toxicity may be an issue for these animals. Reduction of common velvet grass and Harding grass by grazing may require cattle and is questionable due to the fact that intensive grazing would be required, which may damage harlequin lotus. Additionally, due to overlap of marsh zigadenus and common velvetgrass , it would be difficult to treat all of the common velvetgrass, since areas containing marsh zigadenus should not be grazed.

6. Deer Park-Worn Spring North, 138 acres
Targets. Fuelbreak management, broom species, potential future Harding grass, common velvet grass, and yellow starthistle in grassland and oak savannah based on proximity of nearby occurrences of these species.

Primary Objectives. Decrease broom seed production and young plants; fuelbreak management; and prevention of Harding grass, common velvet grass, and yellow starthistle invasion from nearby occurrences.

Feasibility of Grazing/Browsing. Terrain does not pose an obstacle to grazing, although adequate forage is not provided by broom alone where infestations are dense, so any grazed/browsed areas would have to include adequate additional vegetation to sustain livestock without damaging non-target vegetation (e.g., chaparral, woodland).

Expected Success of Grazing/Browsing Treatments. Some reduction of French broom seedlings and defoliation of larger plants would likely be achieved with browsing by sheep and/or goats, although grazier interviews indicate that toxicity may be an issue for these animals. Fuelbreak management may be successful with browsing/grazing livestock depending on vegetation species composition and maturity of woody plants.

7. Bill Williams-Indian Crown, 18 acres
Targets. Broom, fuelbreak, eggleaf spurge.

Primary Objectives. Decrease of broom seed production and young plants (low-to medium-density broom); reduction/management of a population of eggleaf spurge in the central portion of the area immediately west of Indian Road; and fuelbreak management.

Feasibility of Grazing/Browsing. This is a small, narrow, steep site, directly abutting an urban interface to the east. Sheep and/or goats could traverse the steep terrain.

Expected Success of Grazing/Browsing Treatments. Some reduction of seedlings and defoliation of larger plants in the dense French broom patches that occur mostly along the eastern half of this area at the urban interface would likely be achieved with browsing by sheep and/or goats, although grazier interviews indicate that toxicity may be an issue for these animals. If hand removal of eggleaf spurge is infeasible, targeted late spring to summer goat grazing may reduce eggleaf spurge, but is not expected to eliminate this plant. Fuelbreak management may be successful with browsing/grazing livestock depending on vegetation species composition and maturity of woody plants.

8. Fawn Ridge-Deer Park, 57 acres
Targets. Broom, Harding grass, eggleaf spurge

Primary Objectives. Decrease broom seed production and young plants; reduction/management of Harding grass, reduction/management of eggleaf spurge; and fuelbreak management.

Feasibility of Grazing/Browsing. Grazing appears to be physically feasible in this area since terrain is appropriate, but grassland patches are largely disjunct and adjacent woodland has a nearly closed canopy, offering limited suitable forage. Due to the widespread distribution of broom, management would be best achieved in small, temporary enclosures areas to allow for better management of browsing behavior focusing on broom while avoiding impacts to woody communities and native plants.

Expected Success of Grazing/Browsing Treatments. Some reduction of French broom seedlings and defoliation of larger plants would likely be achieved with browsing by sheep and/or goats, although grazier interviews indicate that toxicity may be an issue for these animals. If hand removal of eggleaf spurge is infeasible, targeted late spring to summer goat grazing may reduce eggleaf spurge, but is not expected to eliminate this plant. Harding grass could be reduced by targeted, intensive grazing focused on this plant, but would not be eliminated by grazing. Fuelbreak management may be successful with browsing/grazing livestock depending on vegetation species composition and maturity of woody plants.

9. Azalea Hill, 231 acres
Targets. Marin western flax (in serpentine grassland and chaparral), barbed goatgrass, Mt. Tamalpais thistle (in serpentine seeps), and common velvet grass in non-serpentine grasslands.

Primary Objectives. Manage/reduce barbed goatgrass and other annual grasses that threaten Marin western flax; enhance Mt. Tamalpais thistle habitat; decrease of broom seed production and young plants; and reduce/manage common velvet grass.

Feasibility of Grazing/Browsing. Grazing is feasible in this area although numerous factors, including the localized occurrences of rare plants and invasive weeds and varying RDM[8] requirements for serpentine and annual grassland communities, complicate grazing management. In general, late winter to spring moderate intensity cattle grazing may reduce abundance of exotic annual grasses while promoting increased native species richness and cover.

Grazing for only a two- to three-week period after plants have bolted but prior to production of unpalatable flower heads may help control barbed goatgrass (Brownsey et al. 2016).

The area supporting Marin western flax and Mt. Tamalpais thistle could be grazed to reduce exotic annual grasses and thatch. Cattle grazing would be preferred over goat and/or sheep grazing, due to the increased ability for sheep and goats to selectively graze forbs and the possible damage to Mt. Tamalpais thistle by goats. If grazing occurs in areas supporting Marin western flax and Mt. Tamalpais thistle, plants should be carefully monitored to ensure impacts to this population are minimized. Grazing could be excluded during Marin western flax flowering, which can occur from April through July, though year-round cattle grazing appears to be compatible with Marin western flax on cattle-grazed sites within GGNRA.

Expected Success of Grazing/Browsing Treatments. Common velvet grass could be reduced, but not eliminated, by targeted, intensive grazing focused on this plant. Habitat for Mt. Tamalpais thistle and Marin dwarf flax may be enhanced through reduction of exotic annual grasses, including barbed goatgrass, with cattle grazing.

Some reduction of French broom seedlings and defoliation of larger plants in dense patches occurring mostly along the eastern half of this area at the urban interface may occur with sheep and/or goat browsing, although grazier interviews indicate that toxicity may be an issue for these animals.

10. Pine Mountain South Gate, 58 acres
Targets. Marin western flax, barbed goatgrass, and broom.

Primary Objectives. Manage/reduce barbed goatgrass and other annual grasses that threaten Marin western flax; and decrease broom seed production and young plants in low-density patches along the western perimeter adjacent to Fairfax-Bolinas Road.

Feasibility of Grazing/Browsing. Grazing is feasible in this relatively small area but numerous factors, including the localized occurrences of rare plants and invasive weeds and varying RDM[8] requirements for serpentine and annual grassland communities, complicate grazing management. The area supporting Marin western flax could be grazed to reduce exotic annual grasses and thatch. Cattle grazing would be preferred over goat and/or sheep grazing in areas that support Marin western flax, due to the increased ability for sheep and goats to selectively graze forbs, which could damage Marin western flax plants. If grazing occurs in areas supporting Marin western flax, plants should be carefully monitored to ensure impacts to this population are minimized. Grazing could be excluded during Marin western flax flowering, which can occur from April through July, though year-round cattle grazing appears to be compatible with Marin western flax on cattle-grazed sites within GGNRA.

Expected Success of Grazing/Browsing Treatments. Habitat for Mt. Tamalpais thistle and Marin dwarf flax may be enhanced through reduction of exotic annual grasses, including barbed goatgrass, with cattle grazing.

Some reduction of French broom seedlings and defoliation of larger plants in dense patches occurring mostly along the eastern half of this area at the urban interface may occur with sheep and/or goat browsing, although grazier interviews indicate that toxicity may be an issue for these animals.

11. Bathtub Gap-Carson Ridge, 207 acres
Targets. Marsh zigadenus, Mt. Tamalpais thistle, Marin western flax.

Primary Objectives. Enhance wet meadow habitat for Mt. Tamalpais thistle and marsh zigadenus; and manage annual grasses to reduce thatch where Marin western flax occurs.

Feasibility of Grazing/Browsing. Generally, grazing is feasible within this area, but should not take place where marsh zigadenus occurs due to the potential of poisoning livestock. Significant grazable acreage occurs in this area although grasslands are a mosaic of native serpentine and non-native annual grassland types.

The area supporting Marin western flax could be grazed to reduce exotic annual grasses and thatch. Cattle grazing would be preferred over goat and/or sheep grazing in areas that support Marin western flax, due to the increased ability for sheep and goats to selectively graze forbs, which could damage Marin western flax plants. If grazing occurs in areas supporting Marin western flax, plants should be carefully monitored to ensure impacts to this population are minimized. Grazing could be excluded during Marin western flax flowering, which can occur from April through July, though year-round cattle grazing appears to be compatible with Marin western flax on cattle-grazed sites within GGNRA.

Expected Success of Grazing/Browsing Treatments. Cattle grazing may enhance habitat for Mt. Tamalpais thistle and Marin dwarf flax through reduction of exotic annual grasses, including barbed goatgrass.

12. Poison Spring Grasslands, 121 acres
Targets. Native grassland species.

Primary Objectives. Enhancement of native grassland species by reducing grassland canopy density and thatch.

Feasibility of Grazing/Browsing. The chaparral and dense oak woodland within this area, which have little herbaceous forage, are unsuitable for grazing, but contiguous open grassland in the eastern portion of the area is suitable forage for livestock grazing.

Expected Success of Grazing/Browsing Treatments. Moderate intensity, late-winter to spring cattle grazing in grasslands is expected to reduce exotic annual grasses while increasing native species richness and cover.

13. Kent Pump Beginning, 53 acres
Targets. French broom.

Primary Objectives. Decrease broom seed production and young plants.

Feasibility of Grazing/Browsing. The dominance of dense mixed hardwood forest interspersed with patchy areas of chaparral mean that relatively little suitable livestock forage is available in this area. Several areas supporting French broom are identified along the eastern perimeter of this area adjacent to Kent Pump Road. However, these areas are isolated, consist of few pioneer individuals, and are not suitable for grazing management. Two non-contiguous grassland patches (21 and 28 acres, respectively) could support cattle grazing but their relatively small size, isolation, and infrastructure costs make grazing in these areas potentially infeasible.

Expected Success of Grazing/Browsing Treatments. Low success expected for reduction of broom by grazing/browsing.

14. Grassy Knoll, 4 acres
Targets. Native grassland species, medium-density broom in the northwest portion of the area along Grassy Slope Road in grasslands or oak woodlands with reduced canopy cover.

Primary Objectives. Enhancement of native grassland species by reduction of grassland canopy density and thatch; and reduction/management of broom.

Feasibility of Grazing/Browsing. The majority of this four-acre area is dominated by dense Douglas-fir/mixed hardwood forest with several small grassland openings in the north and south portions. Cattle grazing, which could benefit native grassland species, is infeasible in this area due the small grazable area (four acres). Sheep/goat browsing could be used to reduce seed production and small broom plants.

Expected Success of Grazing/Browsing Treatments. Grazing not feasible.

15. Cascade Creek, 101 acres
Targets. French broom and native grassland species.

Primary Objectives. Enhancement of native grassland species by reduction of grassland canopy density and thatch; and reduction/management of one small occurrence of French broom.

Feasibility of Grazing/Browsing. Grazing is feasible in this area within oak woodland and grassland, which would provide adequate forage for animals.

Expected Success of Grazing/Browsing Treatments. Grazing is expected to enhance native grassland species and some reduction of French broom seedlings and defoliation of larger plants would likely be achieved with browsing by sheep and/or goats, although grazier interviews indicate that toxicity may be an issue for these animals.

16. Midpoint Meadows, 38 acres
Targets. Mt. Tamalpais thistle, marsh zigadenus, and yellow starthistle.

Primary Objectives. Enhance habitat for Mt. Tamalpais thistle and marsh zigadenus by reduction of woody forest species; and reduce the one occurrence of yellow starthistle.

Feasibility of Grazing/Browsing. Grazing is feasible within this small area but would be complicated by the fact that marsh zigadenus, which should not be grazed due to its toxicity, co-occurs with Mt. Tamalpais thistle in one location. If marsh zigadenus is excluded from grazing, the area supporting Mt. Tamalpais thistle where marsh zigadenus does not occur could be grazed to reduce exotic annual grasses and thatch. Cattle or sheep grazing would be preferred over goat grazing, due to the potential for goats to damage Mt. Tamalpais thistle. Plants should be carefully monitored to ensure impacts to this population are minimized.

Expected Success of Grazing/Browsing Treatments. Sheep grazing would likely help slow woody plant invasion, although sheep will probably not kill woody plants larger than seedlings or small saplings. Reduction of yellow starthistle may be possible with short-duration, high-intensity goat grazing, although hand removal is probably more cost effective especially where occurrences are small or isolated.

7.2 Summary of Grazing/Browsing Effectiveness

Only one of the 16 grazing areas described in Section 7.1 above appears to have no feasibility for grazing: Grassy Knoll. Only one has high feasibility (both high expected effectiveness to meet management objectives and high cost-effectiveness): Poison Spring Grasslands. Seven others have low feasibility (combined effectiveness). However, 15 grazing areas have some degree of feasibility and would likely be grazed by a contract grazier if paid appropriately for the service.

Table 3 summarizes the study team's judgments about effectiveness of grazing at each of the potential grazing areas. Ranks are shown to indicate the priority that MMWD might give to each grazing area if they decide to proceed with further investigations, grazing plans, and eventual grazing contracts. It also indicates where to focus MMWD's initial testing of targeted grazing as a vegetation management method.

Table 3. Summary ranking of grazing and browsing effectiveness at potential grazing areas (high, medium, or low)

Potential Grazing Area	**Rank for Expected Effectiveness in Meeting Management Objectives**	**Rank for MMWD Cost Effectiveness**	**Combined Rank**
1. Sky Oaks	Medium	Medium	Medium
2. Porteous-Ross Reservoir-Worn Spring Middle	Medium	Low	Low+
3. Pilot Knob	Low	Low	Low
4. Ridgecrest-Rock Spring-Potrero	Low	Medium	Low+
5. Pumpkin Pine-Fish-Lag Meadows	Medium	Medium	Medium
6. Deer Park-Worn Spring North	Medium	Low	Low+
7. Bill Williams-Indian Crown	Medium	Low	Low+
8. Fawn Ridge-Deer Park	Medium	Low	Low+
9. Azalea Hill	Medium	Medium	Medium
10. Pine Mountain South Gate	Medium	Medium	Medium
11. Bathtub Gap-Carson Ridge	High	Medium	Medium+
12. Poison Spring Grasslands	High	High	High
13. Kent Pump Beginning	Low	Low	Low
14. Grassy Knoll	N/A	Low	N/A
15. Cascade Creek	Medium	Medium	Medium
16. Midpoint Meadows	High	Medium	Medium+

8. Potential Environmental Impacts of Grazing

The following outline identifies categories of potential environmental impacts, including impacts to public recreation, that could occur if the feasible grazing scenarios are implemented at suitable treatment sites on MTW Lands:

1. Rangeland Livestock and Livestock Operations
    a) Livestock Physical Mechanisms
        - Behavior—preference for forages, trailing
        - Traffic—hoof impact, presence in waters
    b) Grazier Operation Mechanisms
        - Associated facilities and vehicle parking
        - Vehicle traffic on internal and external roads and internal off-road
        - Service areas (sites of potentially excessive impact associated with supplementary feeding, watering, gathering, and travel along fences and through gates)
        - Installation and maintenance of grazing infrastructure

2. General Rangeland Ecosystem Health (Ford and Huntsinger 2007; BLM 1999)
    a) Forage Productivity and Quality
        - Poor forage condition requiring supplementation
    b) Soil Integrity and Cover (Bartolome, Frost, and McDougald 2006)
        - Erosion
        - Compaction, pitted, or muddy conditions
        - Too little or too much RDM[8] and cover in grasslands
    c) Water Quality and Watershed Health (Ward, Tate, and Atwill 2003)
        - Pathogens
        - Nutrients
        - Sediments
        - Hydrology—reduced infiltration, ground water retention, and water supply
    d) Pest Plants (Cal-IPC)
        - Increase of current infestations
        - New infestations
        - Spread of pest plants to adjacent properties
    e) Absence of Comprehensive Plans for Grazing Management, Monitoring, and Adaptation
        - Lack of compliance by grazier and lack of feedback by managers
        - Lack of accurate and tested grazing management objectives and performance standards
        - Lack of monitoring program with interpretation and sharing of results, reports, and recording system
        - Lack of adaptation of plans based on monitoring results and feedback according to triggering and response system

3. Ecological Integrity (USEPA 1999)
    a) Fragmentation of Habitat and Corridors between Habitat Patches
    b) Lack of Appropriate Disturbance Regimes
    c) Insufficient Structural Complexity
    d) Lack of Integration of Grazing with Other and Adjacent Land Uses

4. Desired Characteristics of Special-Status Species and Natural Communities (CDFW https://www.wildlife.ca.gov/Data/VegCAMP/Natural-Communities)
    a) Open grassland character
    b) Native grasses
    c) Oak woodland regeneration
    d) High-quality riparian woodlands and wetlands

5. Cultural Resource Integrity

6. Fire Fuels and Wildfire Risks (Stechman 1983)
    a) Excess fuels in High Risk Zones

7. Recreation and Aesthetics (Wolf, Baldwin, and Barry 2015; CCRC workshops http://www.elkhornsloughctp.org/training/show_train_detail.php?TRAIN_ID=Op891WS; http://www.elkhornsloughctp.org/training/show_train_detail.php?TRAIN_ID=KeK6VVR)
    a) Lack of Recreational Compatibility
        - Conflicts on internal MMWD roads and trails—perceived damage and threats; encounters with livestock, hoof imprints, and livestock waste; and encounters associated with off-leash dogs
        - Damage associated with a combination of recreational, maintenance, and livestock uses, including damage to cultural and aesthetic resources, littering, and disturbances to wildlife that alter their behavior
        - Mechanisms of potential impact (conflicts)—poor drainage on trails and roads, unhardened trail treads through vulnerable soils, and forced encounters due to merging or proximity of trails and grazing infrastructure
    b) Landscape Views—perceived damage associated with service areas and lack of appreciation of viewing livestock or pastoral settings
    c) Lack of Perception of Wilderness
    d) Potential Mitigations—novel approaches to public education and collaborative land management and better design and placement of trails and infrastructure

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Personal Communication:
Hobbs, Joe. 2017. Telephone conversation with Lisa Bush on July 19, 2017. Mr. Hobbs is Senior Environmental Scientist for CDFW's elk and pronghorn antelope program.

APPENDIX 1. Memo from Andrea Williams, MMWD (14 August 2017) – Plant Species to Potentially Target with Grazing

MARIN MUNICIPAL WATER DISTRICT

220 Nellen Avenue Corte Madera CA 94925-1169
www.marinwater.org

August 14, 2017
MA 5535

To: Lawrence Ford, LD Ford Rangeland Conservation Science
From: Andrea Williams, Marin Municipal Water District
Cc: Lisa Bush, Pete Van Hoorn, Justin Davilla
Re: Marin Municipal Water District Species Selection Background

The Marin Municipal Water District (MMWD) stewards over 20,000 acres of watershed lands, supporting over 1,000 plant species, water for 190,000 residents, and recreation for millions of visitors. More than 50 of these plants are considered rare by the state or federal government or the California Native Plant Society; over 100 are listed as invasive by the California Invasive Plant Council. In order to limit the scope of the contract, a maximum of 12 plant species are to be considered in potential grazing scenarios.

I made selections of priority species based on how prevalent the species was on watershed lands potentially subject to grazing; whether the species may serve as a representative for other similar species; and whether the population may be influenced by grazing. MMWD staff also decided to remove Nicasio and Soulajule lands from consideration, which further reduced potential species selection. These lands—Nicasio in particular—may be evaluated for grazing at a future date. Additionally, if grazing is shown to be feasible and beneficial on watershed lands, grazing plans will provide an additional opportunity to examine potential effects on species not currently included in this study.

Rare Plants Selected (Table 1):
Mt. Tamalpais thistle is a biennial plant that grows in wet, serpentine-influenced sites. Approximately 12 sites are extant in the county, nine of which are on watershed lands. This species is declining for several reasons: changes in hydrology, shading at forest edge sites, and lack of bare ground in wet meadow sites. Well-meaning but ignorant individuals may be killing plants, but other than a planted site we have no direct evidence of this. Mt. Tam thistle was chosen as a broadly distributed but rare and declining species, endemic and emblematic of the watershed, that may benefit from well-managed grazing.

Marin western flax is our only extant federally listed species within the area of focus. It can be found in three sites on watershed lands in serpentine grassland and edges of chaparral. Thought to be on the decline due to competition from other plants, it may also benefit from well-managed grazing.

Harlequin lotus grows in wet meadows on seven sites across the watershed. A low-growing, short-lived perennial, this species overlaps at one site with Mt. Tam thistle but otherwise is found in non-serpentine wet meadows on the watershed. It may be declining from a combination of hydrologic changes and competition from invasive plants (particularly perennial grasses).

Marsh zigadenus is another wet-meadow species, but it can be found in chaparral as well, and has an affinity to serpentine soils. So far it has been mapped at 18 locations across the watershed. A geophyte, and poisonous, it is unknown how the species will respond to grazing.

Rare Plants Not Selected (Table 2):
Most of the rare taxa were excluded from consideration because they were too uncommon, or grew in habitats unlikely to be grazed.

Weed Species Selected (Table 3):
Weedy plants were difficult to narrow down, but species chosen were those on which we currently spend the most time and/or money on, and those which are affecting the most high-quality habitat.

Weed Species Not Selected (Tables 4 and 5):
With over 100 weeds included on the Cal-IPC of Invasive Plant Inventory, giving a rationale for each would be time-consuming. Species that were uncommon or rare (Table 5) were not selected based on their low abundance; Table 4 contains rationales for more common species. Several of these were excluded simply due to lack of space on the priority list.

Native Species:
Not included are native woody species tanoak (*Notholithocarpus densiflorus*), coyote brush (*Baccharis pilularis*), and chaparral pea (*Pickeringia montana*), which also make up a large portion of our fuel reduction work. If there is time, some or all of these may be added to the list of species considered.

Table 1. Rare plant species selected for consideration

Scientific Name	Common Name	Lifeform	CRPR	CESA	FESA	Blooming Period	Habitat	MMWD Status*
Cirsium hydrophilum var. vaseyi	Mt. Tamalpais thistle	perennial herb	1B.2	None	None	May-Aug (Sep)	Meadows and seeps, serpentinite	C
Hesperolinon congestum	Marin western flax	annual herb	1B.1	CT	FT	Apr-Jul	Chaparral, grassland, serpentinite	R
Hosackia gracilis	harlequin lotus	perennial rhizomatous herb	4.2	None	None	Mar-Jul	Meadows and seeps	C
Toxicoscordion fontanum	marsh zigadenus	perennial bulbiferous herb	4.2	None	None	Apr-Jul (Aug)	Chaparral, meadows and seeps, serpentinite	C

Table 2. Rare plant species not selected

Scientific Name	Common Name	Lifeform	CRPR	CESA	FESA	Blooming Period	Habitat	MMWD Status*	Reason Excluded
Amorpha californica var. *napensis*	Napa false indigo	perennial deciduous shrub	1B.2	None	None	Apr-Jul	Broadleafed upland forest (openings)	C	Forest dweller
Amsinckia lunaris	bent-flowered fiddleneck	annual herb	1B.2	None	None	Mar-Jun	Coastal bluff scrub	WP	Unconfirmed/outside area of focus
Arabis blepharophylla	coast rockcress	perennial herb	4.3	None	None	Feb-May	Broadleafed upland forest, rocky	R	Single population in ungrazeable area
Arctostaphylos montana ssp. *montana*	Mt. Tamalpais manzanita	perennial evergreen shrub	1B.3	None	None	Feb-Apr	Chaparral, serpentinite	A	Abundant; unlikely to be affected by grazing
Arctostaphylos virgata	Marin manzanita	perennial evergreen shrub	1B.2	None	None	Jan-Mar	Forest openings, chaparral	R	Habitat succession /lack of fire reason for loss; unlikely to be affected by grazing
Aspidotis carlotta-halliae	Carlotta Hall's lace fern	perennial rhizomatous herb	4.2	None	None	Jan-Dec	Chaparral, woodland, rock outcrops; usually serpentinite	I	Incomplete knowledge of distribution
Astragalus breweri	Brewer's milk-vetch	annual herb	4.2	None	None	Apr-Jun	Meadows and seeps, grassland (often gravelly/ serpentinite)	R	Single population
Calamagrostis ophitidis	serpentine reed grass	perennial herb	4.3	None	None	Apr-Jul	Chaparral, meadows and seeps, grassland; serpentinite	A	Abundant; unlikely to be affected by grazing

Scientific Name	Common Name	Lifeform	CRPR	CESA	FESA	Blooming Period	Habitat	MMWD Status*	Reason Excluded
Calandrinia breweri	Brewer's calandrinia	annual herb	4.2	None	None	(Jan)Mar-Jun	Chaparral, Coastal scrub	R	Small annual in rocky, open areas unsuitable for grazing
Calochortus umbellatus	Oakland star-tulip	perennial bulbiferous herb	4.2	None	None	Mar-May	Chaparral, grassland; often serpentinite	A	Abundant; considered, but likely avoidance measures known
Calochortus uniflorus	pink star-tulip	perennial bulbiferous herb	4.2	None	None	Apr-Jun	Meadows and seeps	R	Only two populations
Calystegia collina ssp. *oxyphylla*	Mt. Saint Helena morning-glory	perennial rhizomatous herb	4.2	None	None	Apr-Jun	Chaparral, grassland; serpentinite	I	Ambiguous subspecies; in rocky, open areas unsuitable for grazing
Castilleja ambigua var. *ambigua*	johnny-nip	annual herb (hemiparasitic)	4.2	None	None	Mar-Aug	Marshes, grassland, vernal pools margins	R	Single population
Ceanothus decornutus	Nicasio ceanothus	perennial shrub	1B.2	None	None	Mar-May	Chaparral (maritime)	WR	Outside area of focus
Ceanothus gloriosus var. *exaltatus*	glory brush	perennial evergreen shrub	4.3	None	None	Mar-Jun(Aug)	Chaparral (maritime)	R	Single population in ungrazeable area
Ceanothus masonii	Mason's ceanothus	perennial evergreen shrub	1B.2	CR	None	Mar-Apr	Chaparral (maritime)	R	Single population in ungrazeable area
Cypripedium californicum	California lady's-slipper	perennial rhizomatous herb	4.2	None	None	Apr-Aug(Sep)	Bogs and fens, seeps and streambanks, usually serpentinite	X	Extirpated
Delphinium bakeri	Baker's larkspur	perennial herb	1B.1	CE	FE	Mar-May	Broadleafed upland forest, coastal scrub	WR	Outside area of focus
Dirca occidentalis	western leatherwood	perennial deciduous shrub	1B.2	None	None	Jan-Mar(Apr)	Riparian forest or woodland; greenstone	R	Populations in ungrazeable areas
Elymus californicus	California bottle-brush grass	perennial herb	4.3	None	None	May-Aug(Nov)	Forest openings, riparian woodland	C	Forest dweller
Eriogonum luteolum var. *caninum*	Tiburon buckwheat	annual herb	1B.2	None	None	May-Sep	Chaparral, grassland; serpentinite	A	Small annual in rocky, open areas unsuitable for grazing

Scientific Name	Common Name	Lifeform	CRPR	CESA	FESA	Blooming Period	Habitat	MMWD Status*	Reason Excluded
Fritillaria lanceolata var. *tristulis*	Marin checker lily	perennial bulbiferous herb	1B.1	None	None	Feb-May	Coastal scrub or prairie	WR	Outside area of focus
Fritillaria liliacea	fragrant fritillary	perennial bulbiferous herb	1B.2	None	None	Feb-Apr	Coastal prairie or scrub, often serpentinite	WR	Outside area of focus
Gilia capitata ssp. *tomentosa*	woolly-headed gilia	annual herb	1B.1	None	None	May-Jul	Coastal bluff scrub, grassland	WP	Unconfirmed/outside area of focus
Grindelia hirsutula var. *maritima*	San Francisco gumplant	perennial herb	3.2	None	None	Jun-Sep	Coastal scrub, grassland	P	Unconfirmed
Helianthella castanea	Diablo helianthella	perennial herb	1B.2	None	None	Mar-Jun	Forest, Chaparral, woodland, Coastal scrub, grassland	X	Extirpated
Hemizonia congesta ssp. *congesta*	congested-headed hayfield tarplant	annual herb	1B.2	None	None	Apr-Nov	Coastal grassland	WP	Unconfirmed/outside area of focus
Holocarpha macradenia	Santa Cruz tarplant	annual herb	1B.1	CE	FT	Jun-Oct	Coastal prairie, scrub, grassland	X	Extirpated
Horkelia tenuiloba	thin-lobed horkelia	perennial herb	1B.2	None	None	May-Jul(Aug)	Forest, Chaparral, grassland; wet or sandy spots	R	Few populations, largely in chaparral
Iris longipetala	coast iris	perennial rhizomatous herb	4.2	None	None	Mar-May	Coastal prairie, Meadows and seeps	WR	Outside area of focus
Kopsiopsis hookeri	small groundcone	perennial rhizomatous herb (parasitic)	2B.3	None	None	Apr-Aug	North Coast coniferous forest	R	Forest dweller
Leptosiphon acicularis	bristly leptosiphon	annual herb	4.2	None	None	Apr-Jul	Chaparral, grassland	R	Two small populations; may react to changes similar to Hesperolinon
Lessingia hololeuca	woolly-headed lessingia	annual herb	3	None	None	Jun-Oct	Coastal scrub, grassland	I	Unconfirmed
Lessingia micradenia var. *micradenia*	Tamalpais lessingia	annual herb	1B.2	None	None	(Jun)Jul-Oct	Chaparral, grassland; serpentinite	C	Small annual in rocky, open areas unsuitable for grazing

Scientific Name	Common Name	Lifeform	CRPR	CESA	FESA	Blooming Period	Habitat	MMWD Status*	Reason Excluded
Micropus amphibolus	Mt. Diablo cottonweed	annual herb	3.2	None	None	Mar-May	Broadleafed upland forest, Chaparral, woodland, grassland; rocky sites	I	Unconfirmed
Microseris paludosa	marsh microseris	perennial herb	1B.2	None	None	Apr-Jun(Jul)	Forest, woodland, coastal scrub, grassland	X	Extirpated (1940s specimen from Summit Ave Ridge)
Navarretia rosulata	Marin County navarretia	annual herb	1B.2	None	None	May-Jul	Forest, chaparral; rocky serpentinite	C	Small annual in rocky, open areas unsuitable for grazing
Pentachaeta bellidiflora	white-rayed pentachaeta	annual herb	1B.1	CE	FE	Mar-May	Woodland, grassland (often serpentinite)	X	Extirpated
Perideridia gairdneri ssp. *gairdneri*	Gairdner's yampah	perennial herb	4.2	None	None	Jun-Oct	Grassland, vernal pools	R	Single population
Pityopus californicus	California pinefoot	perennial herb (achlorophyllous)	4.2	None	None	(Mar-Apr)May-Aug	Forests, often wet	RI	Forest dweller
Pleuropogon hooverianus	North Coast semaphore grass	perennial rhizomatous herb	1B.1	CT	None	Apr-Jun	Forest openings, meadows and seeps	X	Extirpated
Pleuropogon refractus	nodding semaphore grass	perennial rhizomatous herb	4.2	None	None	(Mar)Apr-Aug	Forests, meadows and seeps	X	Extirpated
Quercus parvula var. *tamalpaisensis*	Tamalpais oak	perennial evergreen shrub	1B.3	None	None	Mar-Apr	Forests	I	Forest dweller
Ranunculus lobbii	Lobb's aquatic buttercup	annual herb (aquatic)	4.2	None	None	Feb-May	Woodland, coniferous forest, grassland, vernal pools; wet sites	X	Extirpated
Ribes victoris	Victor's gooseberry	perennial deciduous shrub	4.3	None	None	Mar-Apr	Broadleafed upland forest, chaparral; wet, shady openings	X	Extirpated

Scientific Name	Common Name	Lifeform	CRPR	CESA	FESA	Blooming Period	Habitat	MMWD Status*	Reason Excluded
Sidalcea hickmanii ssp. *viridis*	Marin checkerbloom	perennial herb	1B.1	None	None	May-Jun	Chaparral (serpentinite)	X	Extirpated
Stebbinsoseris decipiens	Santa Cruz microseris	annual herb	1B.2	None	None	Apr-May	Coastal scrub, grassland; open, sometimes serpentinite	R	Unconfirmed; at most one population in ungrazeable area
Streptanthus batrachopus	Tamalpais jewelflower	annual herb	1B.3	None	None	Apr-Jul	Closed-cone coniferous forest, chaparral; serpentinite	R	Small annual in rocky, open areas unsuitable for grazing
Streptanthus glandulosus ssp. *pulchellus*	Mt. Tamalpais bristly jewelflower	annual herb	1B.2	None	None	May-Jul(Aug)	Chaparral, grassland; serpentinite	C	Small annual in rocky, open areas unsuitable for grazing
Trifolium amoenum	two-fork clover	annual herb	1B.1	None	FE	Apr-Jun	Coastal bluff scrub, grassland (sometimes serpentinite)	X	Extirpated

MMWD Status*

A=Abundant (>30 pops or >100 ac)
C=Common (>3 pops)
R=Rare (3 or fewer pops)
I=Incomplete information
W=Nicasio or Soulajule (West Marin)
P=Possible (presence unconfirmed)
X=Extirpated

Table 3. Weed species selected for consideration.

Scientific Name	Common Name	Lifeform	Habitat on watershed	Comments
Aegilops triuncialis	Goatgrass	Annual	Grassland, often serpentine	Populations large, accessible; currently hand-pull populations annually
Centaurea solstitialis	Yellow starthistle	Annual	Grassland, occasionally serpentine	Populations large, accessible; currently hand-pull populations annually
Conium maculatum	Poison hemlock	Perennial	Wet meadows and scrub, often disturbed areas	Poisonous to people; not currently managed; don't want to increase populations by disturbing wet meadows
Euphorbia oblongata	Eggleaf spurge	Perennial	Grasslands, woodlands, forest edges	Spreading quickly; some sites managed
Festuca arundinacea	Reed fescue	Perennial	Wet meadows and grasslands	Populations large, accessible; currently hand-dig outlier populations in high-value habitat
Genista monspessulana	French broom	Shrub	Woodlands, grasslands, scrub, riparian corridors	Over 1400 acres infested; at max effort can hand-pull approximately 700
Holcus lanatus	Common velvetgrass	Perennial	Wet meadows and grasslands	Spreading in wet areas and high-value habitat
Phalaris aquatica	Harding grass	Perennial	Wet meadows and grasslands	Populations large; currently hand-dig outlier populations in high-value habitat

Table 4. Common weed species not selected

Scientific Name	Common Name	Lifeform	MMWD Status*	Habitat on watershed	Reason Excluded
Aira caryophyllea	Silvery hairgrass	Annual	A	Grasslands on thin/poor soil	Not impactful
Allium triquetrum	White flowered onion	Perennial	C	Forest edges, often moist areas	Not impactful or in grazeable areas
Anthoxanthum odoratum	Sweet vernal grass	Annual	C	Grasslands	Considered; second-tier species
Avena barbata	Slim oat	Annual	A	Grasslands	Impacts grassland composition but not fuels, recreation, or rare species management
Brachypodium distachyon	Purple false brome	Annual	A	Grasslands on thin or poor soil, sometimes serpentine	Considered; possibly unpalatable due to high silica content
Briza maxima	Rattlesnake grass	Annual	A	Grasslands	Impacts grassland composition but not fuels, recreation, or rare species management
Bromus diandrus	Ripgut brome	Annual	A	Grasslands	Impacts grassland composition but not fuels, or rare species management
Bromus hordeaceus	Soft chess	Annual	A	Grasslands	Impacts grassland composition but not fuels, recreation, or rare species management

Scientific Name	Common Name	Lifeform	MMWD Status*	Habitat on watershed	Reason Excluded
Bromus madritensis ssp. rubens	Foxtail brome	Annual	C	Grasslands	Impacts grassland composition but not fuels or rare species
Carduus pycnocephalus	Italian thistle	Annual	A	Grasslands and scrub, generally disturbed sites	Does not impact fuels or rare species managementl often in disturbed sites
Centaurea melitensis	Tocalote	Annual	C	Grasslands, generally disturbed sites	Usually in already disturbed sites, not a habitat converter
Cirsium vulgare	Bullthistle	Perennial	C	Grasslands and scrub	Usually in already disturbed sites, not a habitat converter
Cotoneaster pannosus	Woolly cotoneaster	Shrub	C	Forests, scrub	Considered; palatable to deer
Crataegus monogyna	Hawthorn	Shrub	C	Forests, scrub, grasslands	Considered; palatable to deer once cut to below browse line
Crocosmia Xcrocosmiiflora	Monbretia	Perennial	C	Wetland-riparian	In ungrazeable areas
Cynodon dactylon	Bermuda grass	Perennial	C	Wet grasslands	Impacts grassland composition but not fuels, recreation, or rare species management
Cynosurus echinatus	Dogtail grass	Annual	A	Grasslands	Impacts grassland composition but not fuels, recreation, or rare species management
Cytisus scoparius	Scotch broom	Shrub	C	Grasslands and scrub	Possibly covered under French broom
Dactylis glomerata	Orchardgrass	Perennial	A	Grasslands	Impacts grassland composition but not fuels, recreation, or rare species management
Ehrharta erecta	Upright veldt grass	Perennial	C	Forests, scrub	Mostly in forests
Erodium cicutarium	Coastal heron's bill	Annual	C	Grasslands and scrub	Impacts grassland composition but not fuels, recreation, or rare species management
Festuca myuros	Rattail sixweeks grass	Annual	C	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Geranium dissectum	Wild geranium	Annual	C	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Geranium molle	Crane's bill geranium	Annual	C	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Helminthotheca echioides	Bristly ox-tongue	Annual	C	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Hypochaeris glabra	Smooth cats ear	Annual	C	Grasslands on thin/poor soil	Impacts grassland composition but not fuels, recreation, or rare species management
Hypochaeris radicata	Hairy cats ear	Perennial	A	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Medicago polymorpha	California burclover	Annual	C	Moist grasslands, disturbed sites	Usually in already disturbed sites, not a habitat converter

Scientific Name	Common Name	Lifeform	MMWD Status*	Habitat on watershed	Reason Excluded
Mentha pulegium	Pennyroyal	Perennial	A	Wetlands	Unlikely to be grazed
Myosotis latifolia	Wide leaved forget me not	Perennial	A	Forest edges	Most sites along disturbed roadsides, forest edges
Myriophyllum spicatum	Water milfoil	Perennial	C	Aquatic	Submerged aquatic
Oxalis pes-caprae	Bermuda buttercup	Perennial	C	Grasslands, scrub, disturbed sites	Most sites along disturbed roadsides, forest edges
Plantago lanceolata	Ribwort	Perennial	A	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Poa pratensis	Kentucky blue grass	Perennial	A	Moist grasslands	Impacts grassland composition but not fuels, recreation, or rare species management
Polypogon monspeliensis	Annual beard grass	Annual	C	Wet, disturbed areas	Most sites along reservoir shores or in already disturbed zones
Rumex acetosella	Sheep sorrel	Perennial	A	Grasslands, scrub, disturbed sites	Impacts grassland composition but not fuels, recreation, or rare species management
Rumex crispus	Curly dock	Perennial	C	Wet sites	At the edge of common/uncommon; not apparently impactful where found
Rytidosperma penicillatum	Purple awned wallaby grass	Perennial	C	Grasslands, scrub, chaparral	Considered
Sonchus asper	Spiny sowthistle	Annual	C	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Spartium junceum	Spanish broom	Shrub	C	Grassland, rocky areas, scrub, riparian, disturbed sites	Possibly covered under French broom
Taraxacum officinale	Red seeded dandelion	Perennial	C	Grasslands, forest edge, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Torilis arvensis	Field hedge parsley	Annual	A	Grasslands, scrub, disturbed sites	Usually in already disturbed sites, not a habitat converter
Trifolium hirtum	Rose clover	Annual	A	Grasslands and scrub	Impacts grassland composition but not fuels, recreation, or rare species management
Vicia villosa	Hairy vetch	Annual	C	Grasslands	Impacts grassland composition but not fuels, recreation, or rare species management

Table 5. Weed species not selected due to rarity on watershed lands

Scientific Name	Common Name	Lifeform	MMWD Status*	Comment
Acacia dealbata	Silver wattle	Tree	R	
Acacia melanoxylon	Blackwood acacia	Tree	U	
Ageratina adenophora	Thoroughwort	Perennial	R	Population under manual control

Scientific Name	Common Name	Lifeform	MMWD Status*	Comment
Agrostis avenacea	Pacific bentgrass	Perennial	R	
Agrostis stolonifera	Redtop	Perennial	R	
Anthemis cotula	Dog fennel	Annual	P	
Arundo donax	Giant reed	Perennial	R	
Asparagus asparagoides	African asparagus fern	Vine	R	
Avena fatua	Wildoats	Annual	R	
Bellardia trixago	Mediterranean lineseed	Annual	W	
Bellis perennis	English lawn daisy	Perennial	R	Lawn weed
Bromus tectorum	Downy chess	Annual	U	Considered
Buddleja davidii	Butterfly bush	Tree	P	
Carthamus lanatus	Woolly distaff thistle	Annual	W	
Centaurea calcitrapa	Purple star thistle	Annual	U	Populations scattered, often roadside; able to hand-pull annually
Convolvulus arvensis	Field bindweed	Perennial	U	
Cordyline australis	Cabbage tree	Tree	R	
Cortaderia jubata	Andean pampas grass	Perennial	U	
Cotoneaster franchetii	Cotoneaster	Shrub	U	
Cotoneaster lacteus	Milkflower cotoneaster	Shrub	R	
Cotula coronopifolia	Brass buttons	Perennial	R	
Cytisus striatus	Portuguese broom	Shrub	R	Possibly covered under French broom
Delairea odorata	Cape ivy	Perennial	R	Populations under manual control
Digitalis purpurea	Foxglove	Perennial	R	Populations under manual control
Dipsacus fullonum	Wild teasel	Perennial	R	Populations under manual control
Dipsacus sativus	Indian teasel	Biennial	W	
Dittrichia graveolens	Stinkwort	Annual	R	Populations under manual control
Echium candicans	Pride of madeira	Shrub	R	
Egeria densa	Brazilian water weed	Perennial	U	Aquatic
Erigeron karvinskianus	Latin american fleabane	Perennial	R	
Erodium brachycarpum	White stemmed filaree	Annual	R	
Erodium moschatum	Whitestem filaree	Annual	R	
Eucalyptus globulus	Blue gum	Tree	R	

Scientific Name	Common Name	Lifeform	MMWD Status*	Comment
Ficus carica	Common fig	Tree	R	
Foeniculum vulgare	Fennel	Perennial	U	Populations controlled manually; sites small, dispersed
Hedera canariensis	Canary ivy	Vine	R	
Hedera helix	English ivy	Vine	U	
Helichrysum petiolare	Licorice plant	Shrub	P	
Hirschfeldia incana	Mustard	Perennial	U	
Hypericum perforatum	Klamathweed	Perennial	U	Biocontrol available
Ilex aquifolium	Holly	Tree	R	
Iris pseudacorus	Horticultural iris	Perennial	R	
Lactuca serriola	Prickly lettuce	Annual	U	Most of ours is L. saligna
Leucanthemum vulgare	Oxe eye daisy	Perennial	R	
Ligustrum lucidum	Glossy privet	Tree	R	
Lupinus arboreus	Coastal bush lupine	Shrub	W	
Marrubium vulgare	White horehound	Perennial	R	
Melilotus albus	White sweetclover	Annual	R	
Nerium oleander	Oleander	Tree	R	
Olea europaea	Olive	Tree	R	
Oxalis corniculata	Creeping wood sorrel	Perennial	U	
Pennisetum setaceum	Fountaingrass	Perennial	R	
Phoenix canariensis	Canary island date palm	Tree	R	
Plantago coronopus	Cut leaf plantain	Annual	R	
Prunus cerasifera	Cherry plum	Tree	U	
Pyracantha angustifolia	Firethorn	Shrub	U	Considered
Raphanus sativus	Jointed charlock	Annual	W	
Rubus armeniacus	Himalayan blackberry	Shrub	U	Considered
Senecio minimus	Coastal burnweed	Annual	U	
Silybum marianum	Milk thistle	Annual	U	
Ulex europaeus	Gorse	Shrub	R	Single small population
Vinca major	Vinca	Perennial	U	Populations under manual control
Watsonia meriana	Bulbil bugle lily	Perennial	P	
Zantedeschia aethiopica	Callalily	Perennial	R	

MMWD Status*
A=Abundant (>30 pops or >100 ac)
C=Common (>10 pops)
U=Uncommon (3-10 pops)
R=Rare (3 or fewer pops)
W=Nicasio or Soulajule (West Marin)
P=Possible (presence unconfirmed)

APPENDIX 2. Maps Prepared by Andrea Williams, MMWD (14 July 2017) – Potential Grazing Areas in Mt. Tamalpais Watershed

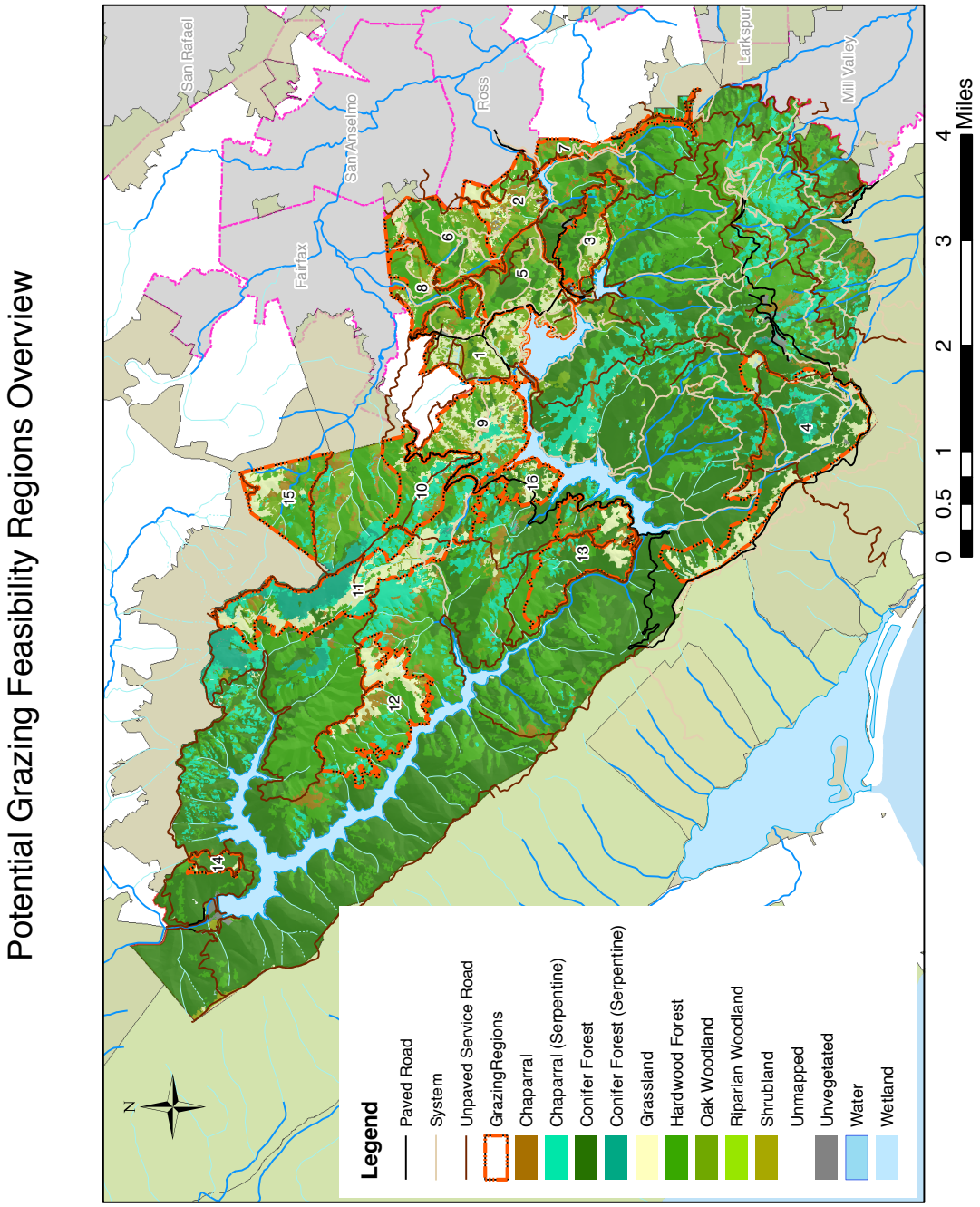
Notes on the Maps of Potential Grazing Areas with Major Vegetation Types and Infrastructure Prepared by A. Williams:

- These are preliminary maps for the potential grazing areas to be modified in a future Grazing Management Plan or other planning documents.
- Most areas are contiguous and boundaries are based on MMWD's existing vegetation management units rather than feasibility for grazing.
- The map numbers indicate the priority from most to least.
- Parking lots for recreational access as well as non-recreational access for graziers are shown as a magenta "P," and represent reasonable sites to stage grazing operations.
- Other existing infrastructure that could be used to support grazing are shown.
- No fencing exists around the grazing areas to contain the grazing livestock.
- In the spreadsheet (not maps), the vegetation layer is separate from the broom layer (i.e., broom is not its own veg type in the veg map) so the conditional formatting is as follows: deeper green means higher percentage of the region is a particular veg type (within-region comparison); deeper red means the region is more heavily broom-infested compared to other regions.
- *Brachypodium distachyon* occurs in most grasslands, although only points are shown.
- *Aegilops triuncialis* and *Centaurea solstitialis* occur as polygons, although only points are shown.

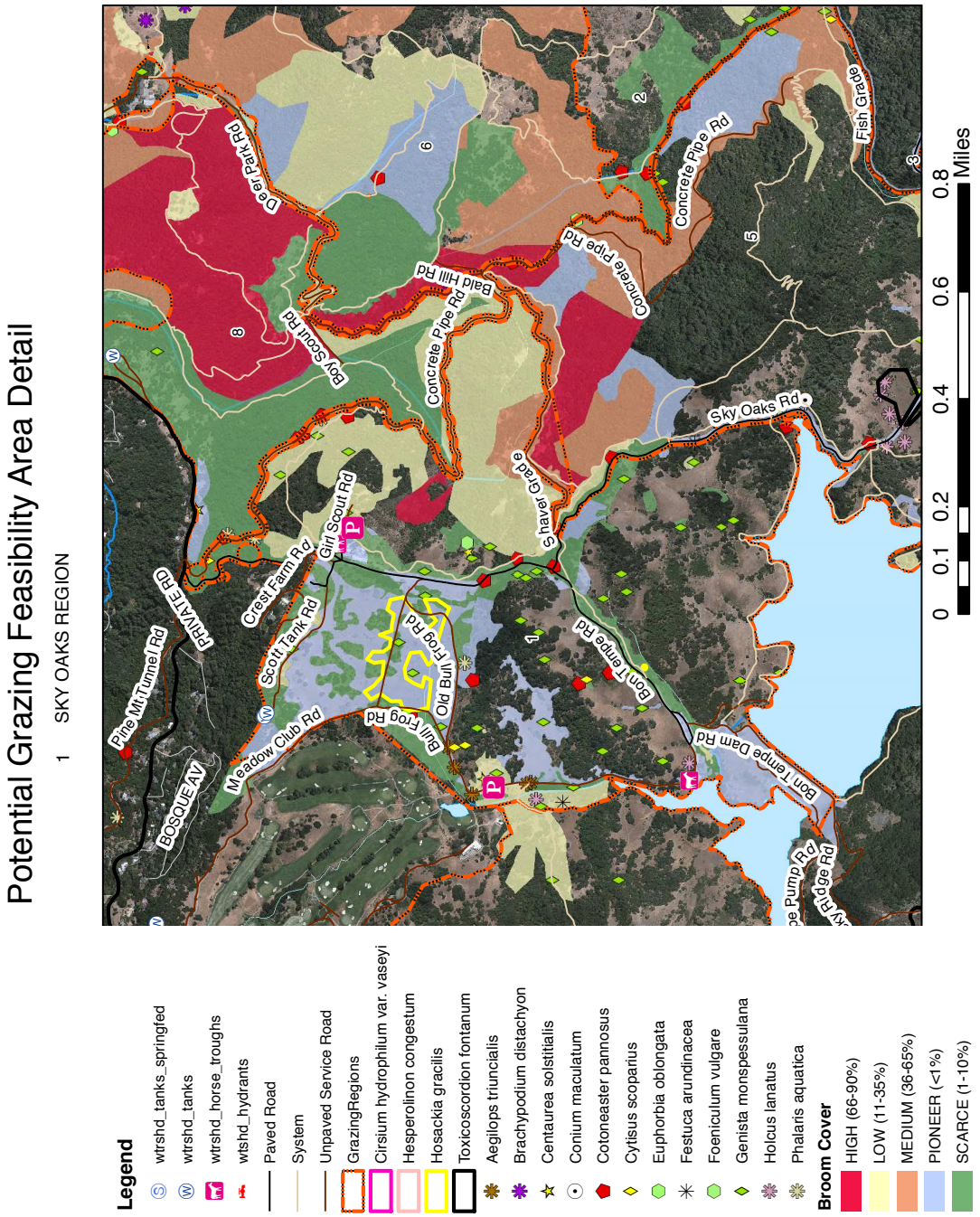
List of Maps of Potential Grazing Areas (prepared by Andrea Williams, MMWD)

- Overview Map of 16 Potential Grazing Areas within Mt. Tamalpais Watershed
- Map 1. Sky Oaks Potential Grazing Area
- Map 2. Porteous-Ross Reservoir-Worn Spring Middle Potential Grazing Area
- Map 3. Pilot Knob Potential Grazing Area
- Map 4. Ridgecrest-Rock Spring-Potrero Potential Grazing Area
- Map 5. Pumpkin-Pine-Fish-Lag Meadows Potential Grazing Area
- Map 6. Deer Park-Worn Spring North Potential Grazing Area
- Map 7. Bill Williams-Indian Crown Potential Grazing Area
- Map 8. Fawn Ridge-Deer Park Potential Grazing Area
- Map 9. Azalea Hill Potential Grazing Area
- Map 10. Pine Mountain South Gate Potential Grazing Area
- Map 11. Bathtub Gap-Carson Ridge Potential Grazing Area
- Map 12. Poison Spring Grasslands Potential Grazing Area
- Map 13. Kent Pump Beginning Potential Grazing Area
- Map 14. Grassy Knoll Potential Grazing Area
- Map 15. Cascade Creek Potential Grazing Area
- Map 16. Midpoint Meadows Potential Grazing Area

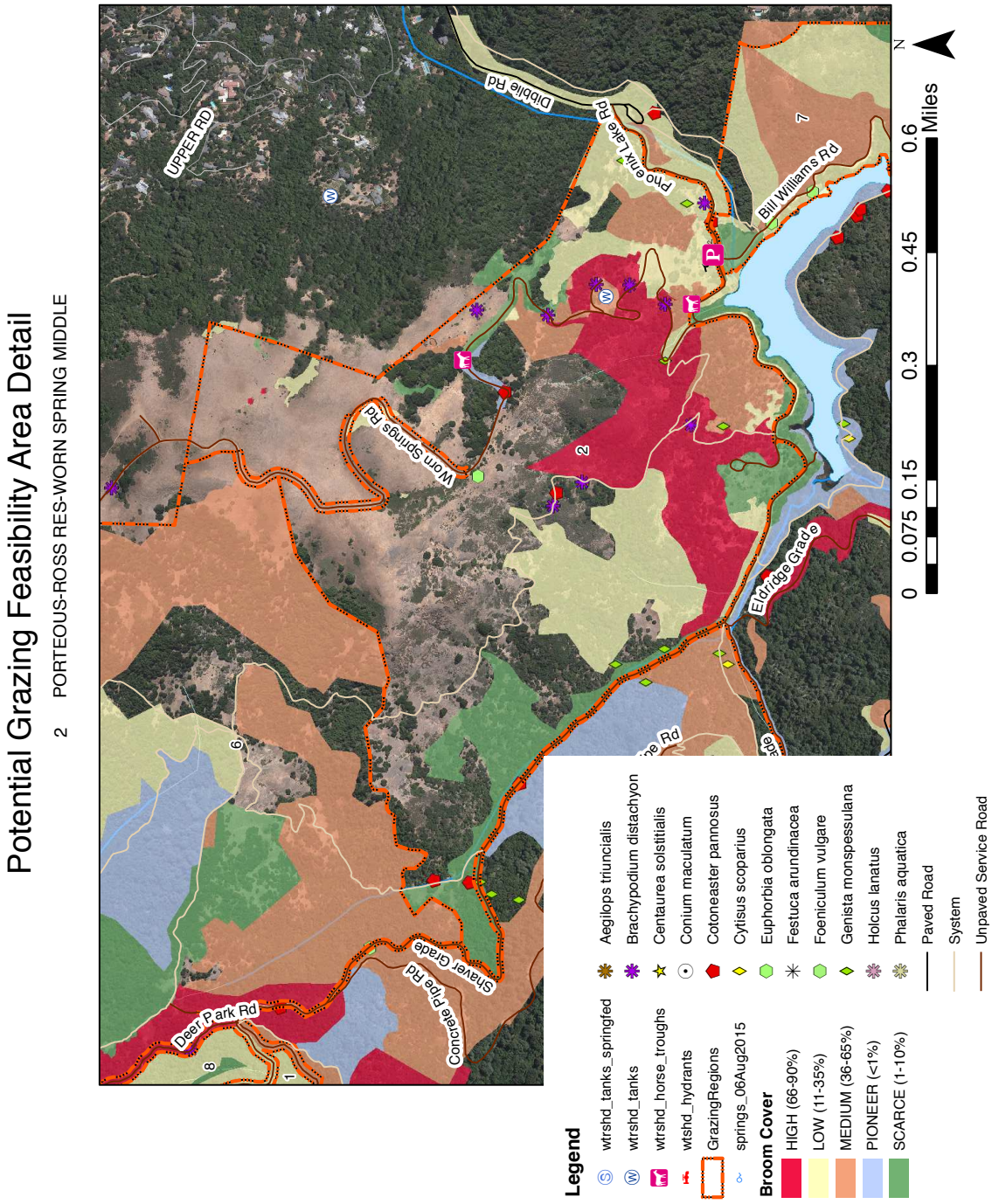
Overview Map of 16 Potential Grazing Areas within Mt. Tampalais Watershed (prepared by Andrea Williams, MMWD)



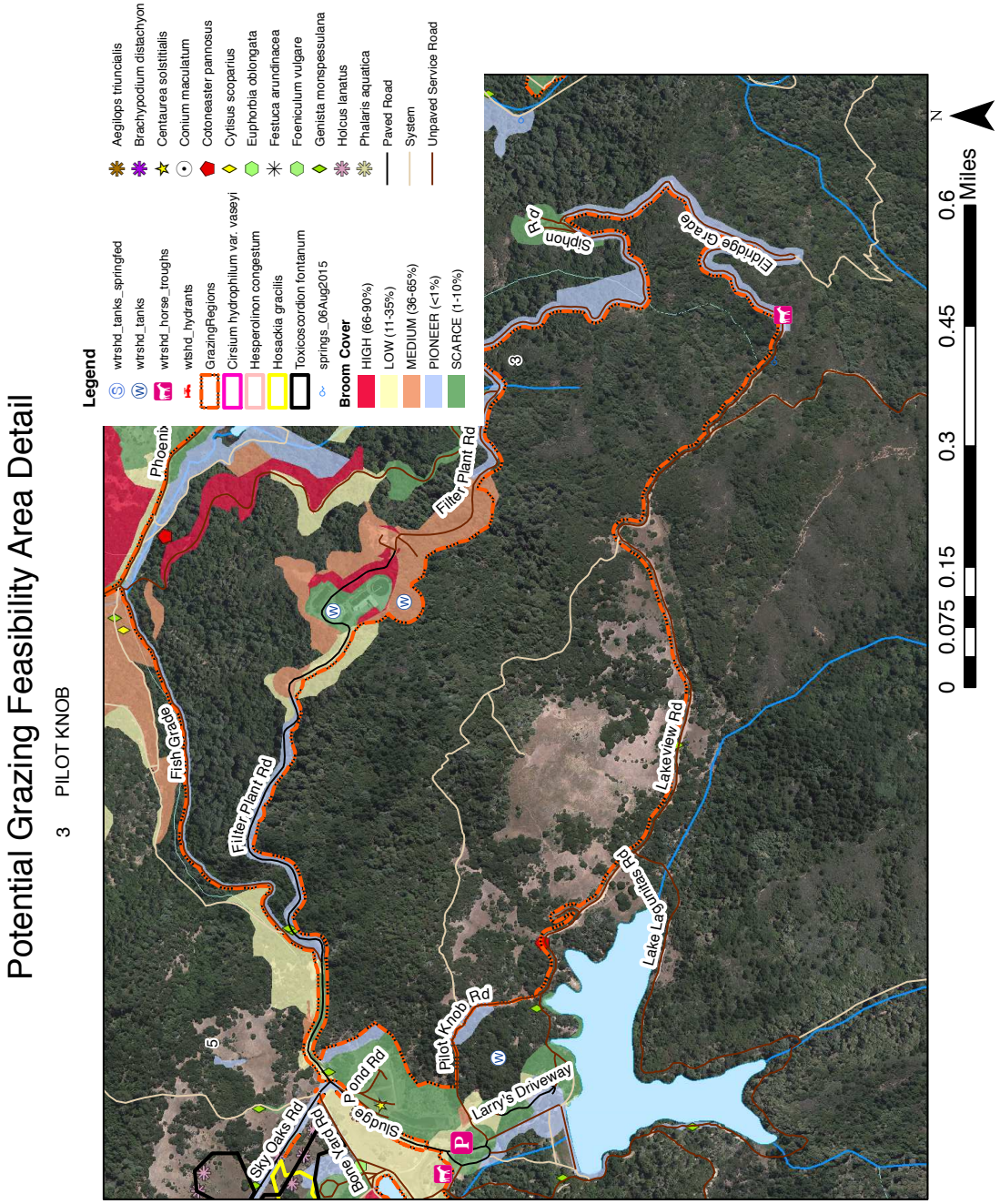
Map 1. Sky Oaks Potential Grazing Area (prepared by Andrea Williams, MMWD)



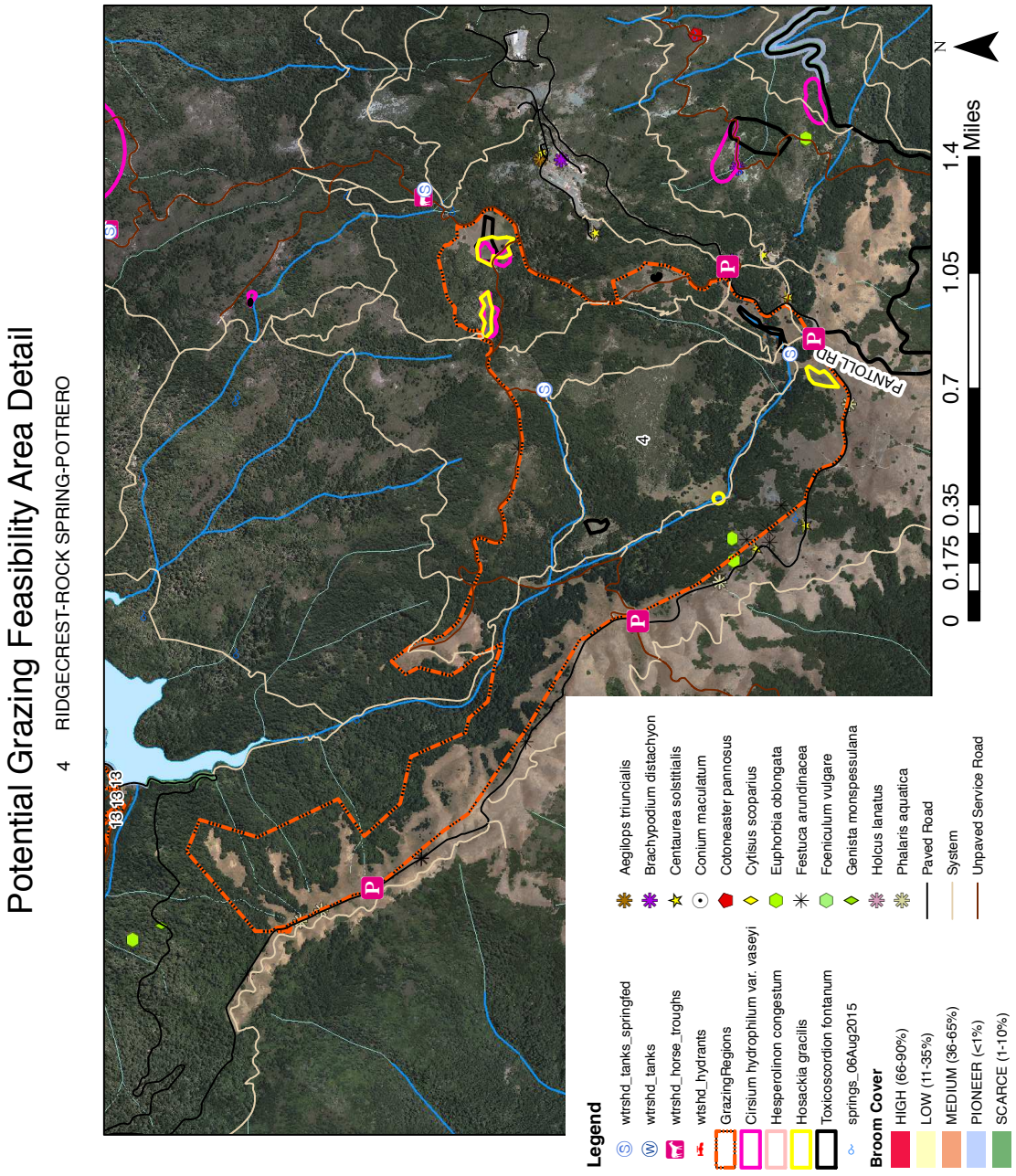
Map 2. Porteous-Ross Reservoir-Worn Spring Middle Potential Grazing Area (prepared by Andrea Williams, MMWD)



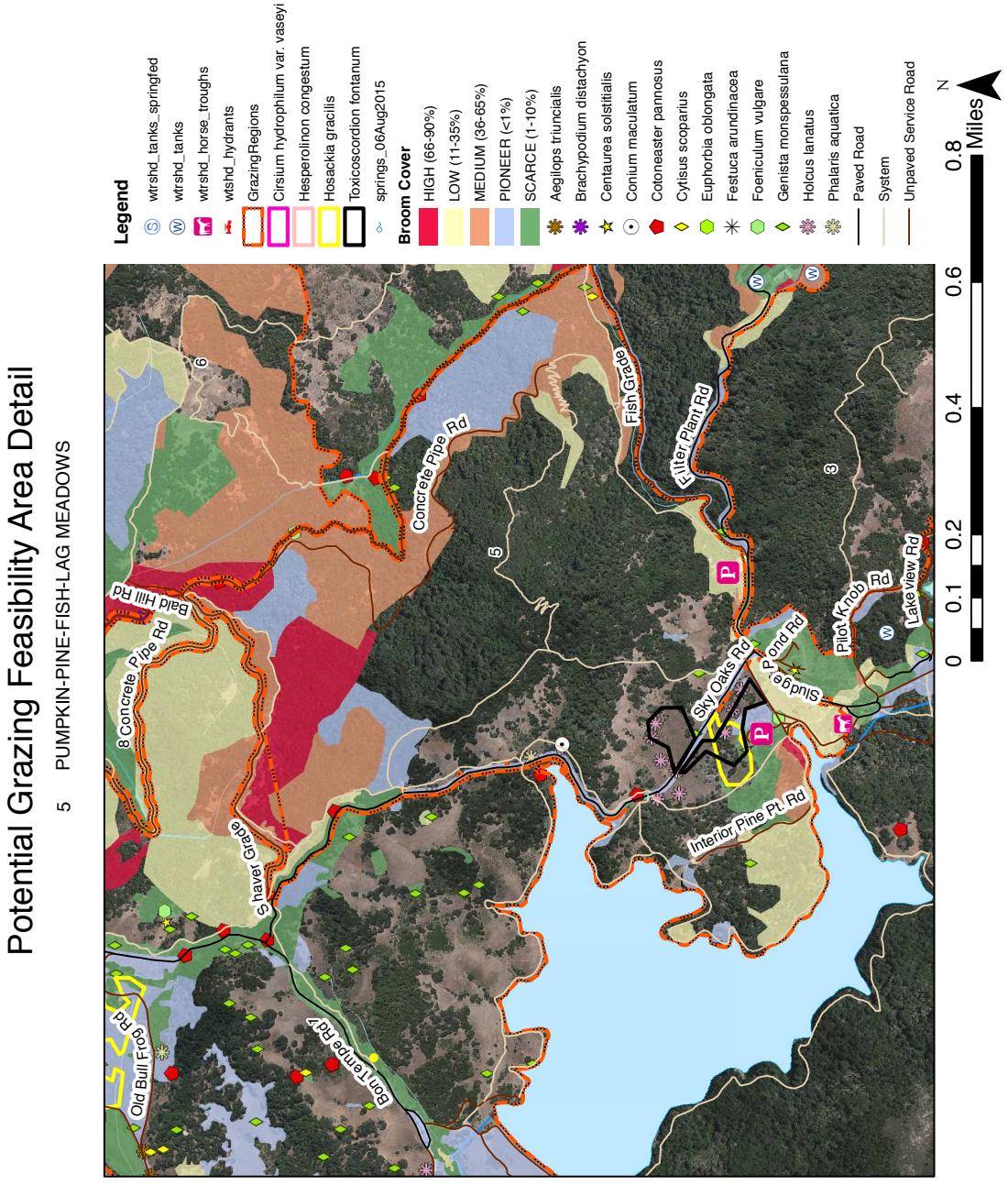
Map 3. Pilot Knob Potential Grazing Area (prepared by Andrea Williams, MMWD)



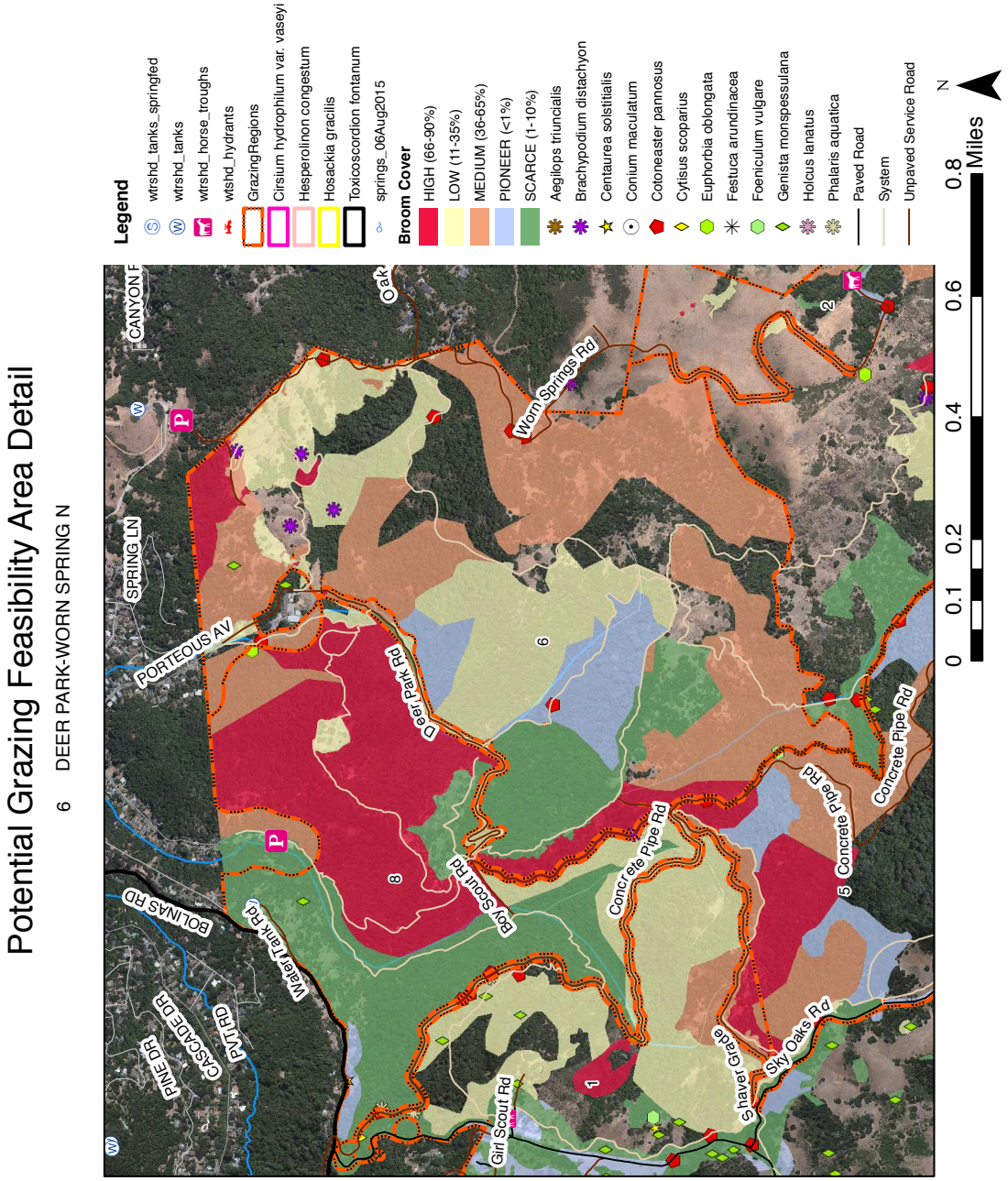
Map 4. Ridgecrest-Rock Spring-Potrero Potential Grazing Area (prepared by Andrea Williams, MMWD)



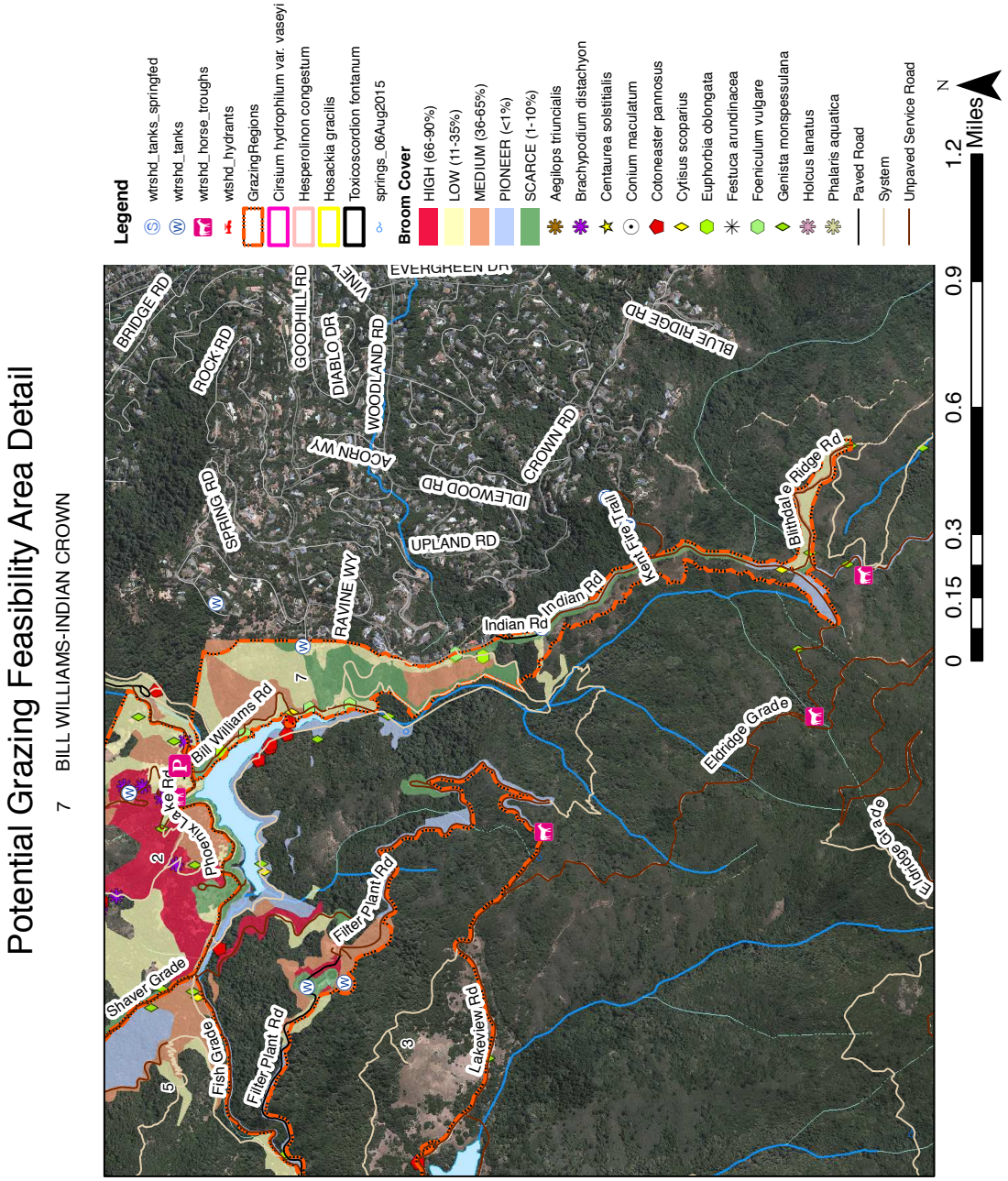
Map 5. Pumpkin Pine-Fish-Lag Meadows Potential Grazing Area (prepared by Andrea Williams, MMWD)



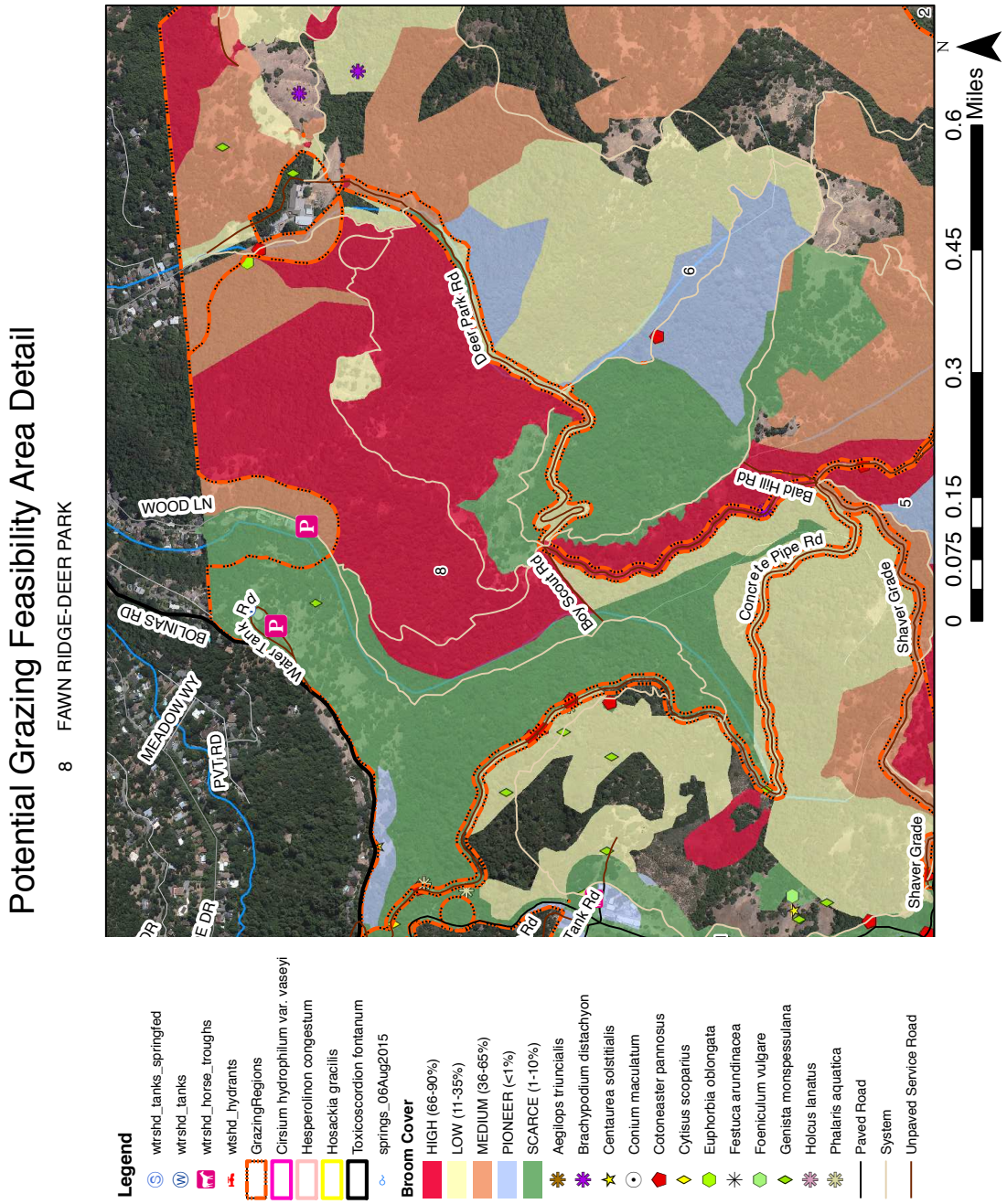
Map 6. Deer Park-Worn Spring North Potential Grazing Area (prepared by Andrea Williams, MMWD)



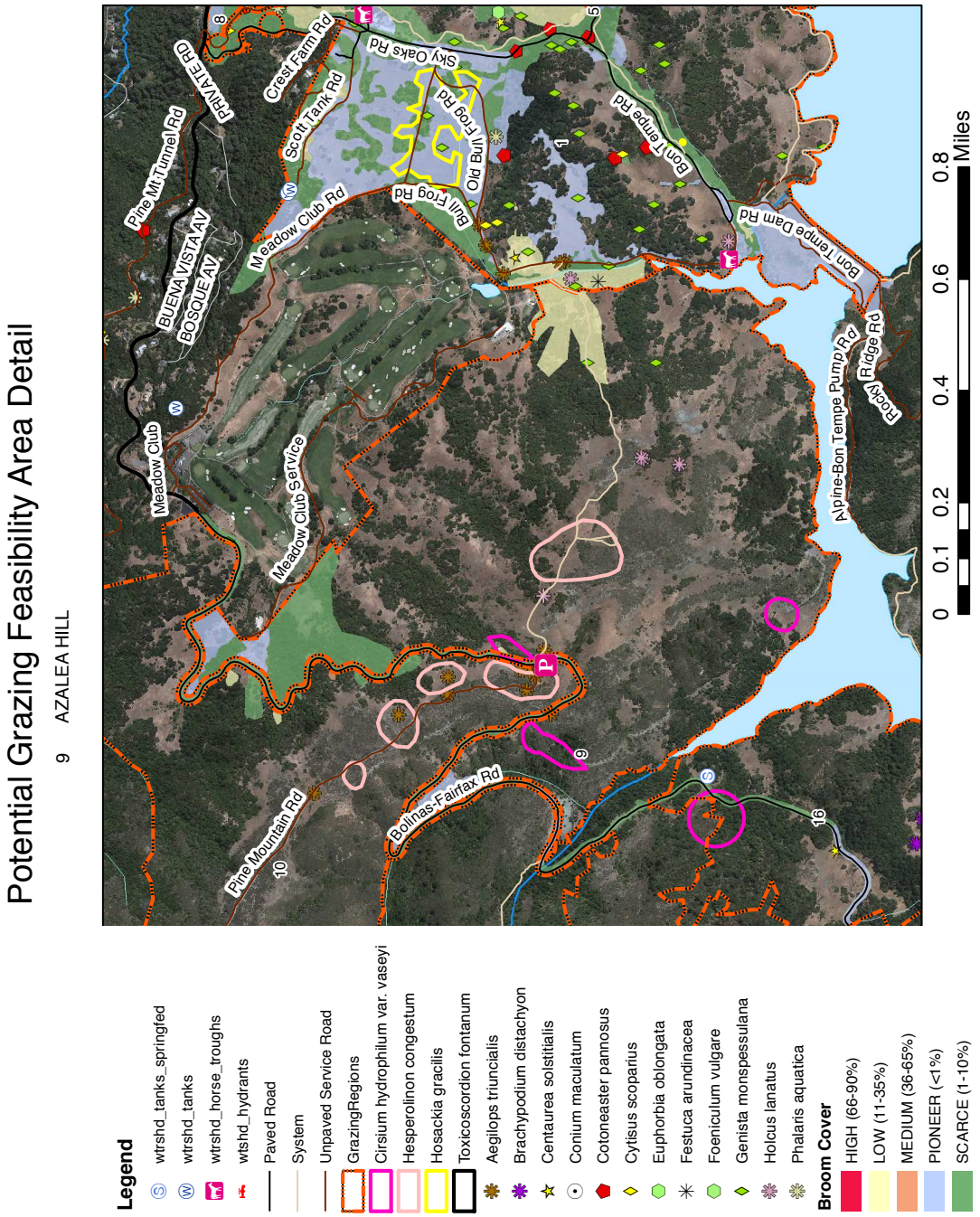
Map 7. Bill Williams-Indian Crown Potential Grazing Area (prepared by Andrea Williams, MMWD)



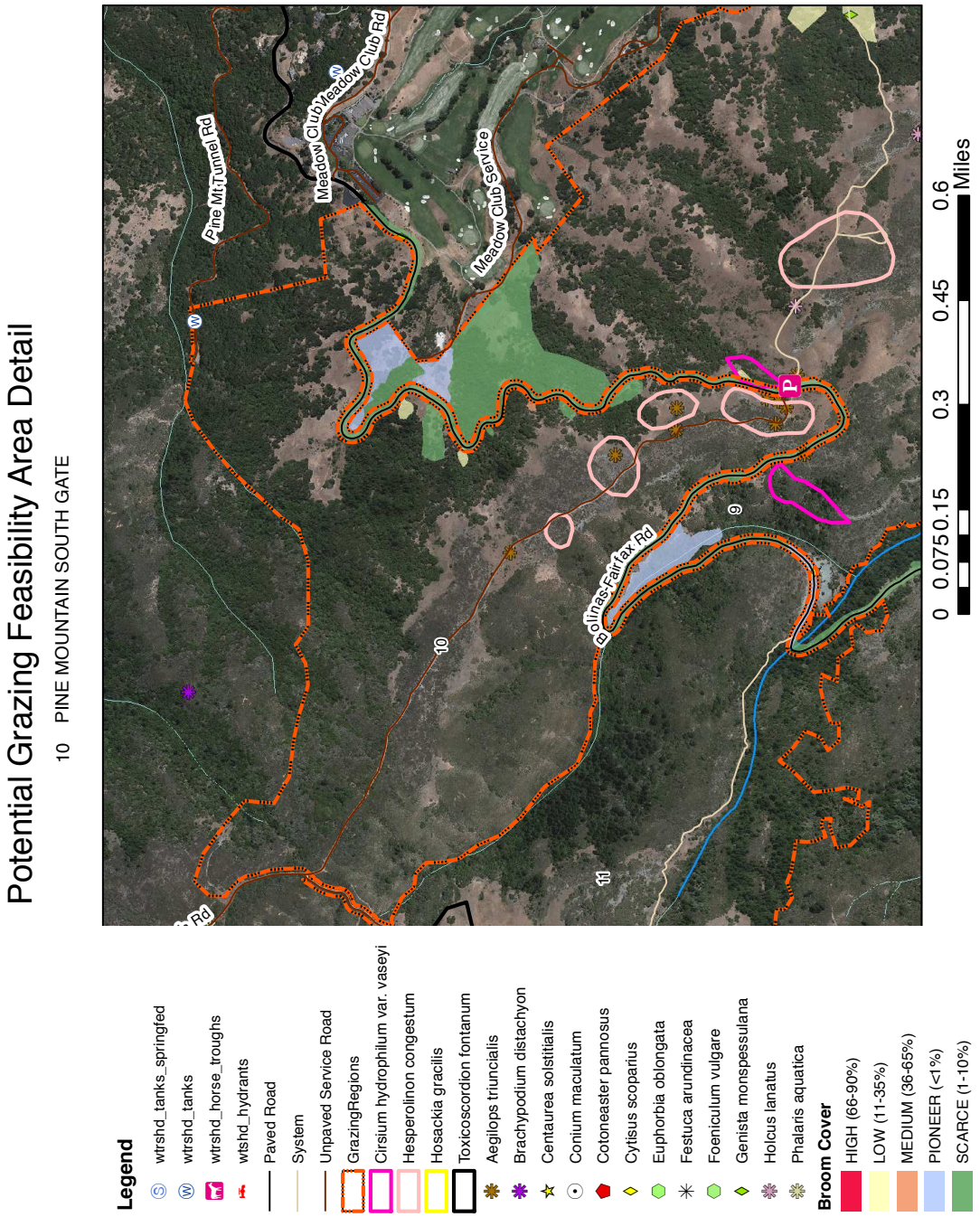
Map 8. Fawn Ridge-Deer Park Potential Grazing Area (prepared by Andrea Williams, MMWD)



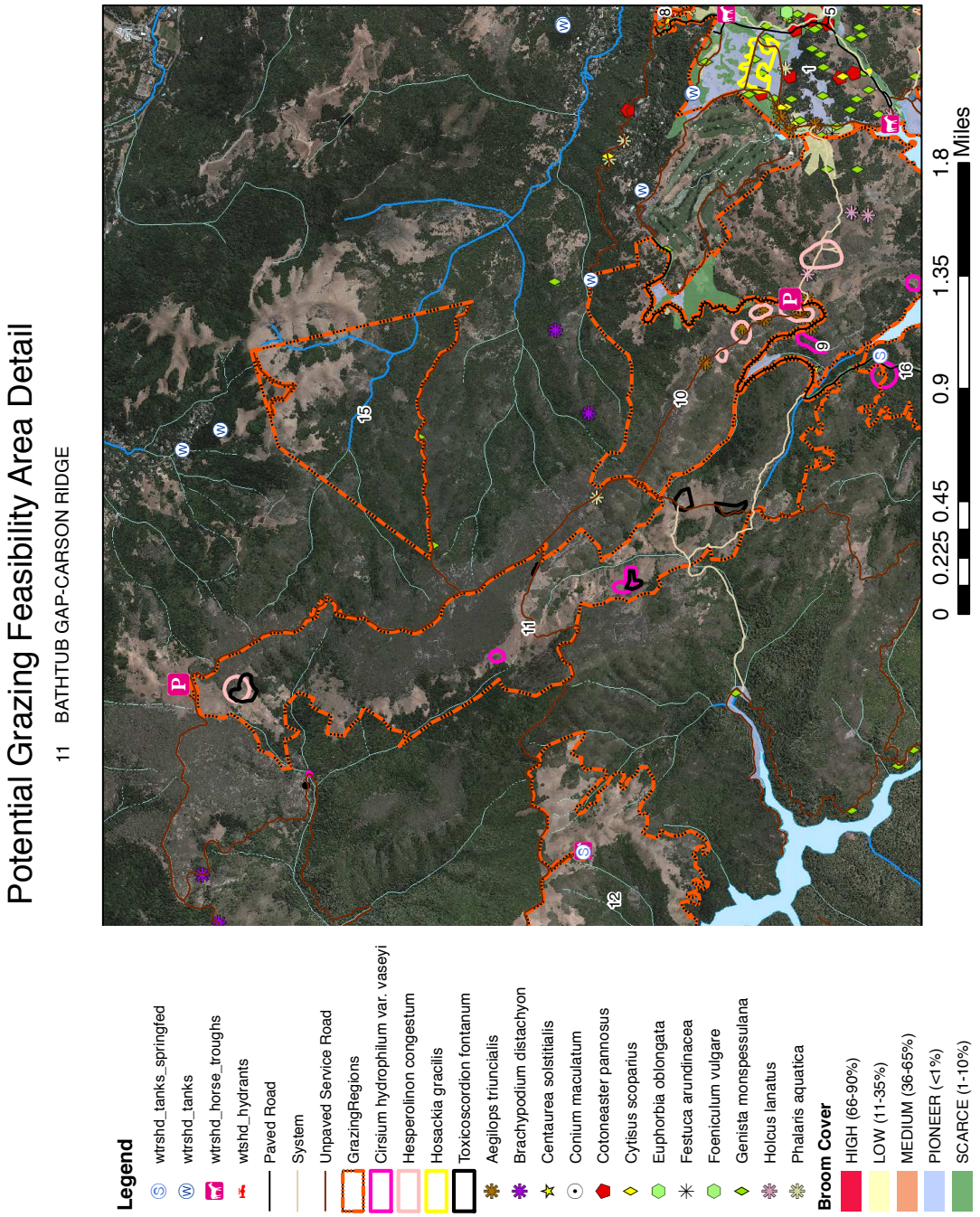
Map 9. Azalea Hill Potential Grazing Area (prepared by Andrea Williams, MMWD)



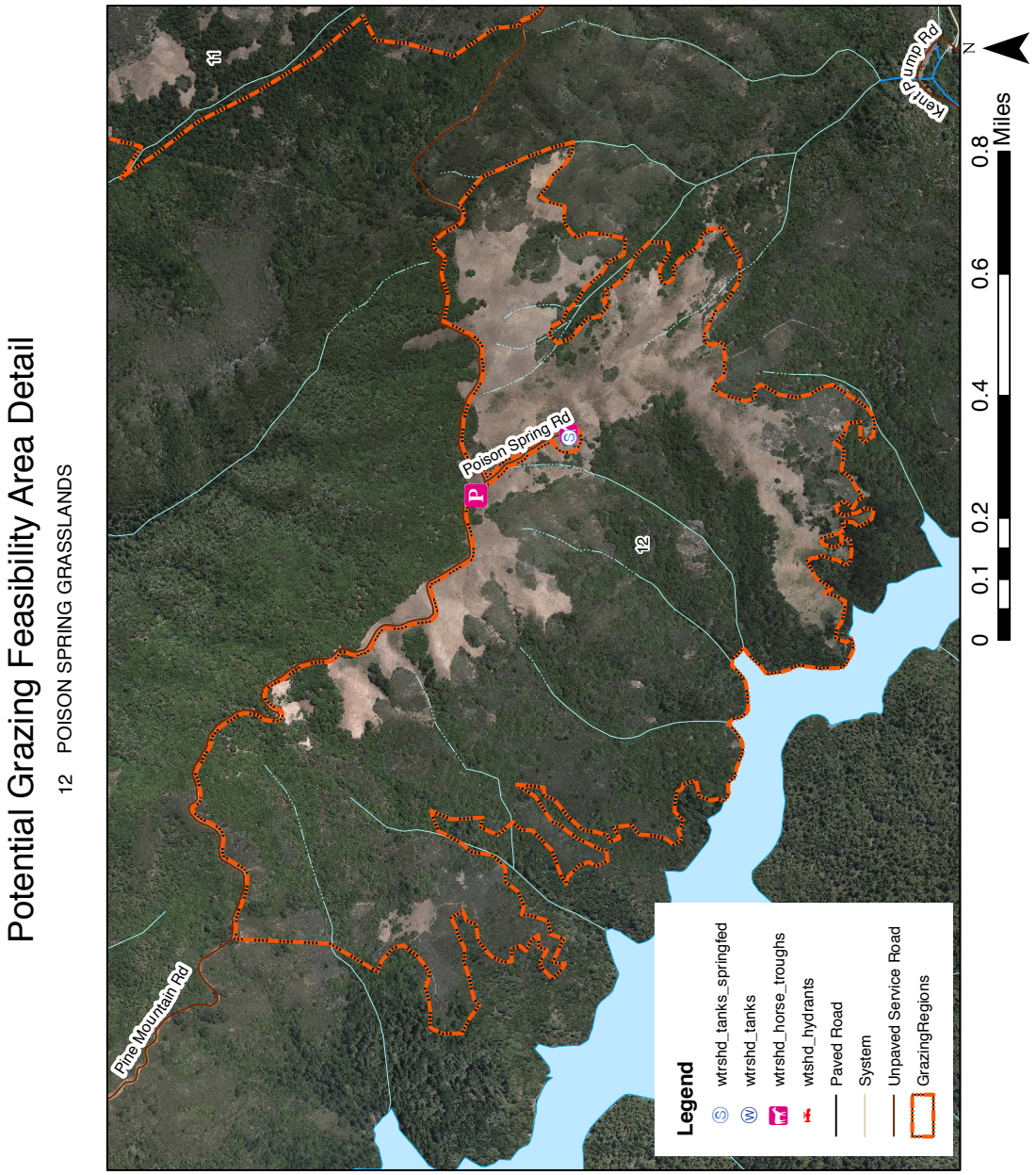
Map 10. Pine Mountain South Gate Potential Grazing Area (prepared by Andrea Williams, MMWD)



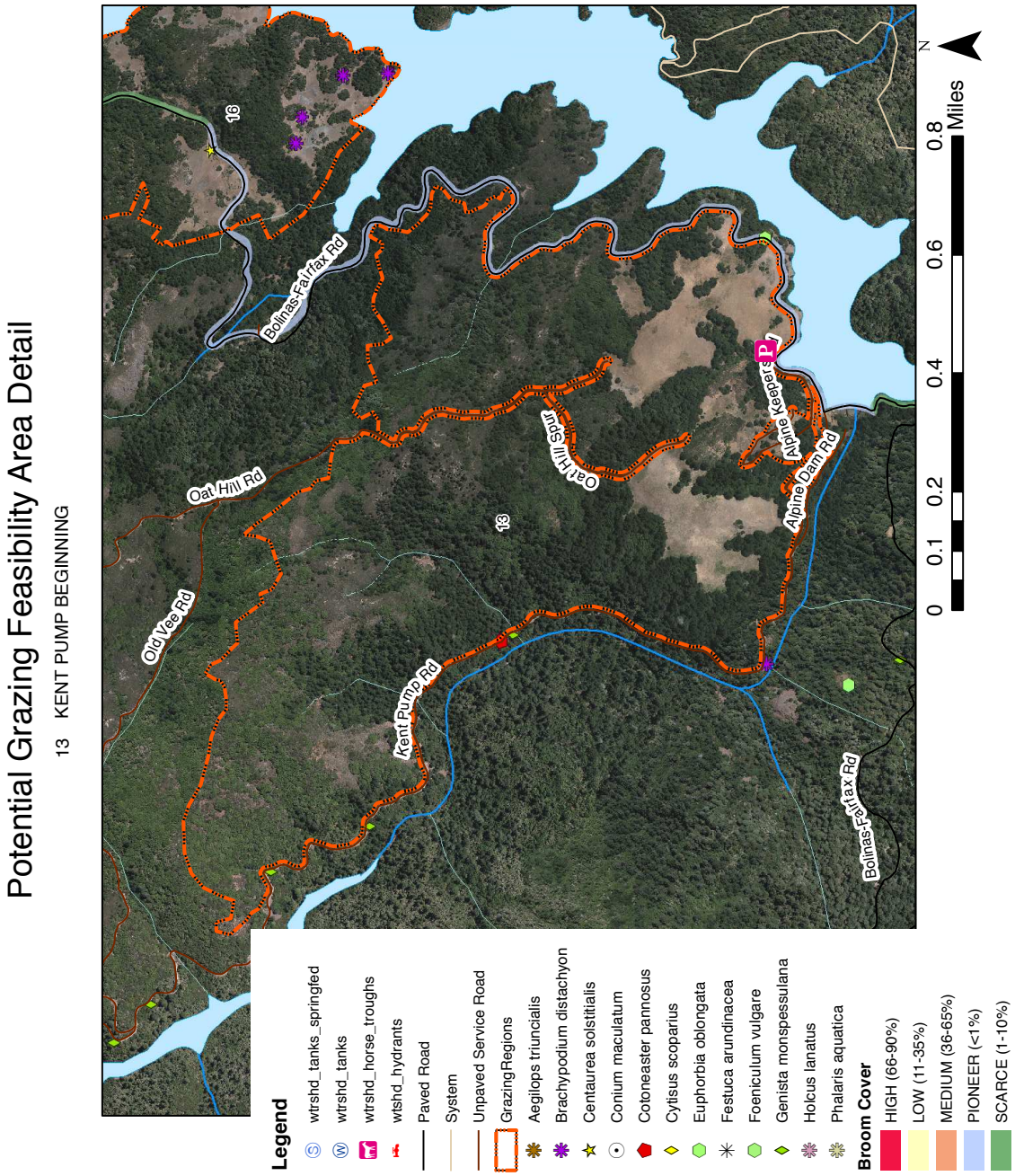
Map 11. Bathtub Gap-Carson Ridge Potential Grazing Area (prepared by Andrea Williams, MMWD)



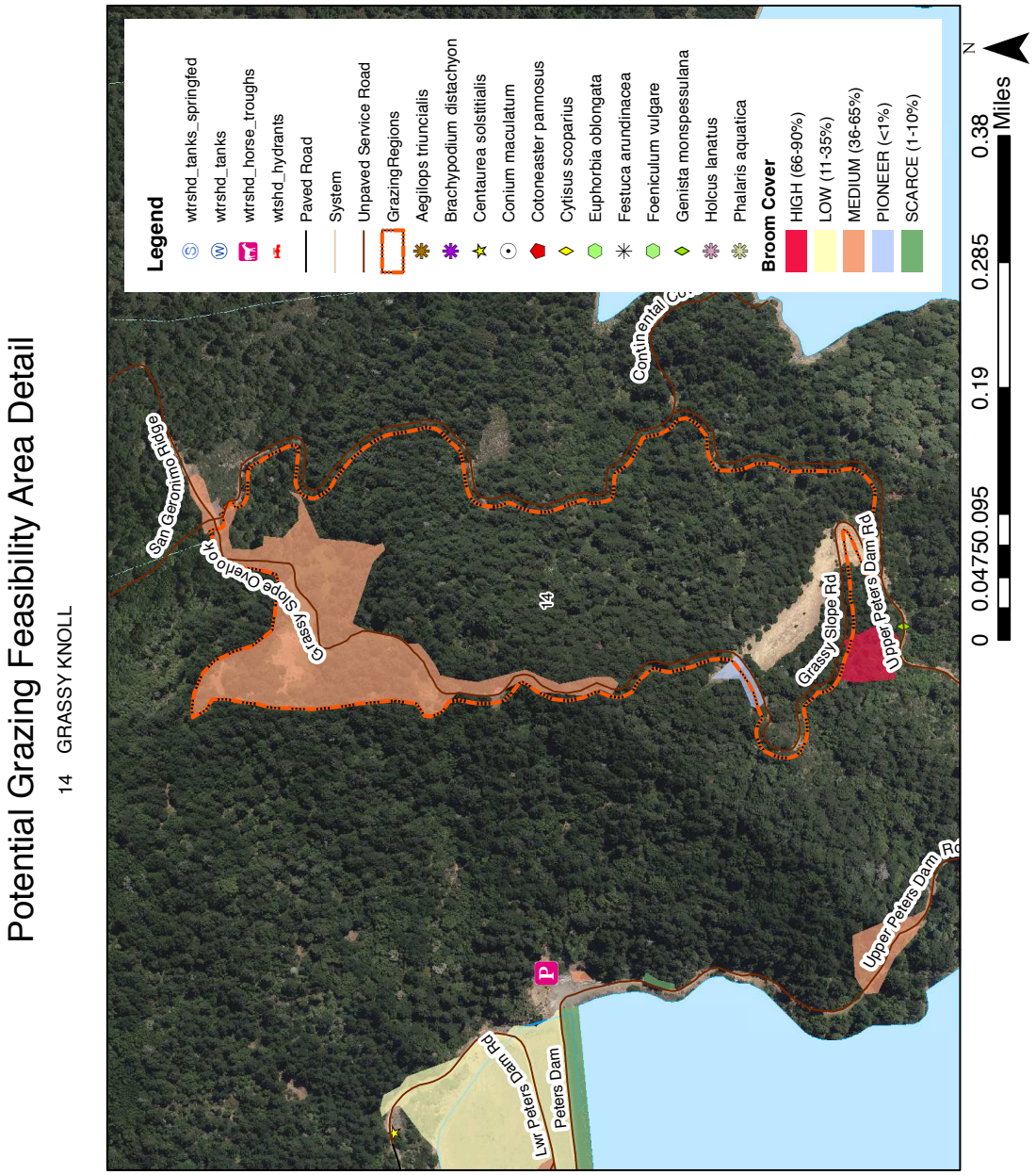
Map 12. Poison Spring Grasslands Potential Grazing Area (prepared by Andrea Williams, MMWD)



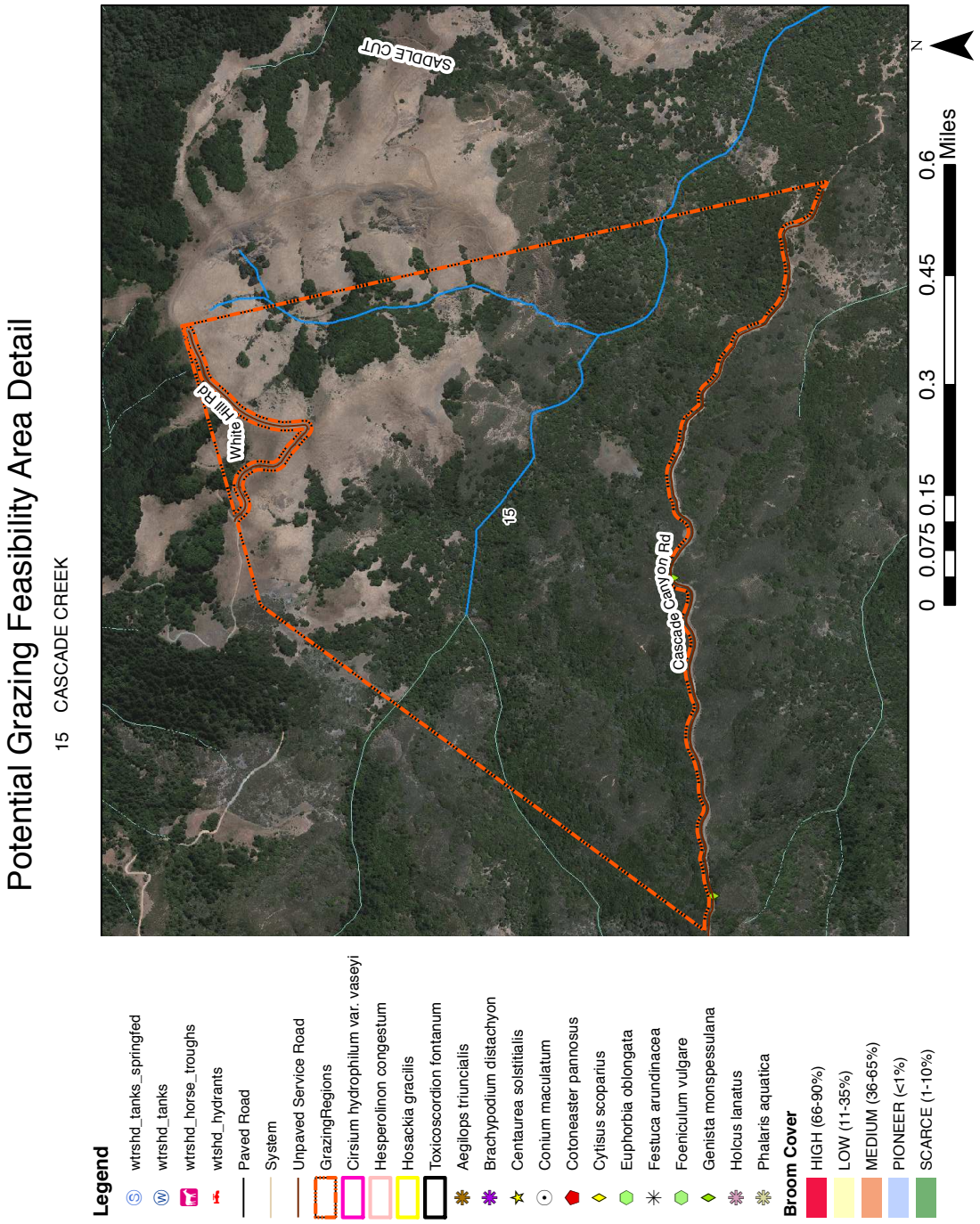
Map 13. Kent Pump Beginning Potential Grazing Area (prepared by Andrea Williams, MMWD)



Map 14. Grassy Knoll Potential Grazing Area (prepared by Andrea Williams, MMWD)



Map 15. Cascade Creek Potential Grazing Area (prepared by Andrea Williams, MMWD)



Map 16. Midpoint Meadows Potential Grazing Area (prepared by Andrea Williams, MMWD)