5-YEAR REVIEW

San Joaquin Valley Orcutt Grass (*Orcuttia inaequalis*)

GENERAL INFORMATION:

Species: San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*; also referred to as San Joaquin Orcutt grass)
Date listed: March 26, 1997
Federal Register (FR) citation: 62 FR 14338 (Service 1997)
Classification: Threatened

State Listing: San Joaquin Valley Orcutt grass was listed by the State of California as endangered in 1979.

BACKGROUND:

Species overview:

San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*) is a narrowly distributed annual of the grass family Poaceae, subfamily Chloridoideae, in the tribe Orcuttieae. The species was presumed to be the only member of the Orcuttieae tribe that was endemic to the San Joaquin Valley (Stone et al. 1988, p. 35) and is therefore commonly referred to as San Joaquin Valley Orcutt grass. Except for a single population in Solano County, the historical range of San Joaquin Valley Orcutt grass is believed to be in the Southern Sierra Foothills Vernal Pool Region, which includes parts of Stanislaus, Merced, Madera, Fresno, and Tulare Counties (Keeler-Wolf et al. 1998, p. 106).

San Joaquin Valley Orcutt grass is a highly specialized C_4 plant (an evolutionary adaptation that facilitates photosynthetic productivity in arid and semi-arid climates) that is dependent on deep vernal pools for survival. It requires inundated soils for at least part of the year for seed germination, seed bank storage, and its juvenile aquatic growth stage (Stone et al. 1988, p. 10). Consequently, San Joaquin Valley Orcutt grass seldom becomes established above the high-water mark where *Orcuttia* species are competitively excluded (Keeley 1998, p. 85) and forms distinct emergent ring-patterns below the high-water mark (Stebbins et al. 1996, p. 12). Seeds of this genus typically germinate underwater in the spring when the standing water begins to evaporate from the pool (Griggs 1980, p. 5; Griggs and Jain 1983, p. 176; Keeley 1988, p. 1086; Carol Witham 2022, *pers. comm.*) and after they are colonized by aquatic fungi (Griggs 1980, p. 74–75; Griggs 1981, p. 16). Other members of this genus, such as slender Orcutt grass (*Orcuttia tenuis*), may germinate in the fall or winter after standing water has remained present in the vernal pool for 2–4 weeks (Griggs 1980, p. 36). Plants emerge underwater, forming a basal rosette of juvenile leaves that are maintained for roughly three months (Keeley 1998, p. 87). As the water temperatures increase, floating leaves form and remain until the standing water has evaporated, at which point terrestrial leaves are formed. Flowering begins within a few days after the pool has dried and typically peaks in mid-June but may be extended into August or September depending on growth conditions (Figure 1; Griggs 1980, p. 5). Seed production in *Orcuttia* species can vary two- to three-fold among years (Griggs 1980, p. 22; Griggs and Jain

1983, p. 182–183). These growth phases, as well as C_4 photosynthetic anatomy, are adaptive features that promote the dominance of *Orcuttia* species in vernal pool environments for a month or more after the pools have dried (Keeley 1998, p. 85). There is anecdotal evidence of two different morphological variations of San Joaquin Valley Orcutt grass, with differences in plant stature and seed head appearance. These different types have been observed in multiple locations with both types present in the same pool, but an individual plant with both characteristics has not been observed in the field (Carol Witham, *pers comm.* 2022).

Figure 1: San Joaquin Valley Orcutt grass. Photo credit: E. Graves, USFWS

Most recent status review:

[Service] U.S. Fish and Wildlife Service. 2013. San Joaquin Valley Orcutt Grass (*Orcuttia inaequalis*). 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 28 pp.

We did not recommend a status change in the 2013 status review.

FR notice citation announcing this status review:

[Service] U.S. Fish and Wildlife Service. 2022. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 40 Species in California, Nevada. Federal Register 87:5832–5834.

We did not receive information from the public regarding San Joaquin Valley Orcutt grass in response to the notice.

ASSESSMENT:

Information acquired since the last status review:

This 5-year review was conducted by the U.S. Fish and Wildlife Service's (Service) Sacramento Field Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on February 2, 2022. We also contacted species experts, vernal pool experts, land managers, performed a literature search, reviewed information from our own files, including documents generated through Section 7 consultations and Section 10 permits, and obtained data from an occurrence search of the California Natural Diversity Database (Diversity Database) maintained by the California Department of Fish and Wildlife (Department).

Since the last 5-year status review, two additional occurrences of the species have been identified in the Diversity Database and three additional occurrences have been identified that are not yet entered in the Diversity Database. These locations are within the known current range of the species (addressed in **Distribution**). Thus, the species distribution remains the same as described in our previous 5-year review published in 2013 and this new information does not alter our understanding of the species' current distribution. We received additional survey and monitoring reports from the Department, independent researchers, and mitigation/conservation bank managers in response to our requests for current information on the status of San Joaquin Valley Orcutt grass (addressed in **Abundance**). This information was obtained for occurrences that are currently identified in the Diversity Database. Updates on threats and conservation since the last 5-year status review are addressed in the **Threats** and **Conservation** sections.

Distribution:

There have been several changes to the occurrences of San Joaquin Valley Orcutt grass as listed in the Diversity Database since the 2013 5-year review. Forty seven occurrences of the species were discussed in the 2013 5-year status review (Service 2013, p. 5). While there are still a total of 47 occurrences of the species in the Diversity Database as of 2022, the identity and status of some occurrences has changed since 2013. The 2013 5-year status review described 12 occurrences as extirpated, 4 as possibly extirpated, and 31 as presumed extant. Currently, the Diversity Database describes 16 occurrences as extirpated, 1 as possibly extirpated, and 30 as presumed extant (Figure 2; Diversity Database 2022). There are at least three additional occurrences of San Joaquin Valley Orcutt grass that are not yet listed in the Diversity Database, which brings the total number of presumed extant occurrences to 33. Details of all presumed extant occurrences are discussed in Appendix A.

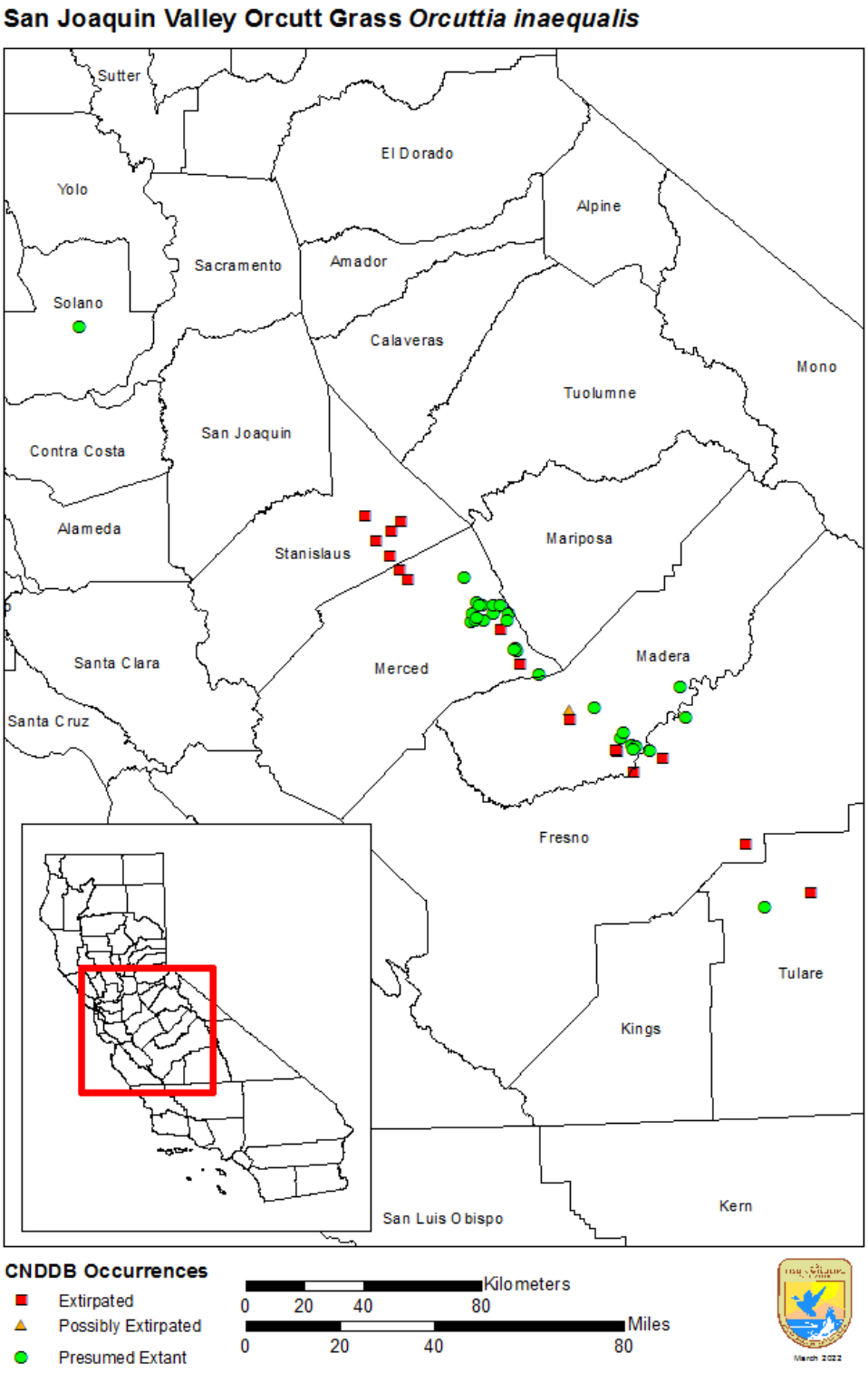

Figure 1: Known Diversity Database Occurrences of San Joaquin Valley Orcutt Grass (Diversity Database 2022).

There have been two new occurrences added to the Diversity Database since the 2013 5-year review (occurrences #66 and #68), and two occurrences have been combined into other existing occurrences (occurrence #46 is now combined with #35; occurrence #59 is now combined with #28). These new occurrences are within the known extent of the species' range and therefore do not alter our understanding of the species' current distribution. Since the 2013 5-year review, one occurrence that was previously listed as possibly extirpated in the Diversity Database is now listed as extirpated due to conversion to agriculture (occurrence #45; aerial imagery shows the area is now an orchard) and one occurrence (#44) that was presumed extant in the 2013 5-year review is now listed as possibly extirpated due to "intensive agriculture." Aerial imagery shows conversion to agriculture (orchard) and urban/housing development, so this occurrence is likely extirpated. Other "presumed extant" occurrences appear to still be potentially suitable habitat according to aerial imagery. The current status of many presumed extant populations has not been reassessed on the ground, and areas that may support the species remain to be surveyed. Thus, reliable estimates of the amount and distribution of suitable habitat is unknown.

Abundance:

Current standardized surveys are not known to occur for San Joaquin Valley Orcutt grass, and the Service is not aware of a range-wide survey taking place for San Joaquin Valley Orcutt grass since the publication of Carol Witham's 2013 report (Witham 2013, entire). Since development of the Recovery Plan (Service 2005c, entire) informal site visits confirming the presence of this species have been conducted at some of the known occurrences, but standardized survey protocols are still lacking so accurate estimates of current abundance are not available. According to the Diversity Database, only 9 out of the 30 presumed extant occurrences have been visited since the 2013 5-year review. The most recent visit to a known occurrence of San Joaquin Valley Orcutt grass documented in the Diversity Database was in 2017. However, San Joaquin Valley Orcutt grass has been confirmed at five occurrences since 2017: Muzzy Ranch Conservation Bank (#63), Kennedy Table Conservation Bank (#55), Fenston Ranch (#66, #41, and three occurrences not listed in the Diversity Database), Drayer Ranch Conservation Bank (#62), and Stone Corral Ecological Reserve (#56). These observations are detailed in Table 1.

Table 1. Confirmed presence-absence data of San Joaquin Valley Orcutt grass since the previous 5-year review for the species in August 2013.

Diversity Database Occurrence #	County	Ownership	# Plants Observed by Year	Data Source
6	Merced	unknown	0 in 2017	Diversity Database 2022
41	Madera	Fenston Ranch	500 in 2016;8 in 2017; 783 in 2019	Diversity Database 2022; Fenston Mitigation Bank (pending)
43	Madera	Caltrans advance permittee responsible mitigation site	100+ in 2017	Diversity Database 2022

Diversity Database Occurrence #	County	Ownership	# Plants Observed by Year	Data Source
49	Merced	UC Merced Grassland & Vernal Pool Reserve	1 in 2016; 35 in 2017	Diversity Database 2022
54	Madera	US Bureau of Reclamation	2 in 2017	Diversity Database 2022
56	Tulare	Stone Corral Ecological Reserve (California Department of Fish and Wildlife)	4 in 2017; ~50 in 2020	O'Leary 2022, *in litt*.
62	Merced	Drayer Conservation Bank	Present but uncounted in 2020	Drayer Conservation Bank
63	Solano	Muzzy Ranch Conservation Bank	Present but uncounted in 2017; present in 2018; 0 in 2019; 287 in 2020; 181 in 2021	Muzzy Ranch Mitigation Bank; Dr. Douglas Stone *in litt*.
66	Madera	Fenston Ranch	~500 in 2017; 2,460 in 2019	Dr. Douglas Stone 2022, *in litt*; Fenston Mitigation Bank (pending)
68	Madera	unknown	12 in 2017	Diversity Database 2022
Unlisted 1	Madera	Fenston Ranch	127,001 in 2019	Fenston Mitigation Bank (pending)
Unlisted 2	Madera	Fenston Ranch	49 in 2019	Fenston Mitigation Bank (pending)
Unlisted 3	Madera	Fenston Ranch	155 in 2019	Fenston Mitigation Bank (pending)

Muzzy Ranch Conservation Bank

The Muzzy Ranch Conservation Bank is a mitigation site located in Solano County, California and is the only occurrence of San Joaquin Valley Orcutt grass that is known to be surveyed on an annual basis. Survey results from the annual reports at Muzzy Ranch Conservation Bank are listed in Table 2. Numbers given are from two pools containing the species on the property. No plants were observed at Muzzy Ranch in 2019, but then increased to 287 plants detected in 2020. No more than 181 San Joaquin Valley Orcutt grass plants were observed at Muzzy Ranch in 2021 (Steve Foreman 2022, *in litt.*). However, the survey results from 2020 and 2021 show a significantly smaller population than the 262,251 plants that were observed in 2011. Population

fluctuations of this magnitude, likely related to environmental conditions (i.e., drought), make the determination of population trends difficult to interpret.

Table 2. Historic population trend data for Muzzy Ranch Conservation Bank in Solano County.

Year	# Plants observed	Data source
2003	1,600	Diversity Database
2011	262,251	Muzzy Ranch
2017	*Present but not surveyed*	Muzzy Ranch
2018	*Present but not surveyed*	Muzzy Ranch
2019	0	Muzzy Ranch
2020	287	Muzzy Ranch
2021	<181	Muzzy Ranch

Threats:

At the time of listing, threats to the San Joaquin Valley Orcutt grass were determined to be habitat loss and degradation due to urbanization, agricultural land conversion, livestock grazing, off-highway vehicle use, a flood control project, a highway project, mining projects, altered hydrology, landfill projects, and competition from weedy nonnative plants (Service 1997, p. 14338). These threats continued to act on the species at the time of our 2013 5-year review, with climate change and small population size included as additional threats to the species (Service 2013, pp. 11–12). The threats identified at the time of listing and our 2013 5-year review continue to act on the species, with pesticide use identified as a new potential threat. The following sections include new information about the ongoing threats of habitat loss and climate change, and the threat of pesticide use to San Joaquin Valley Orcutt grass.

Habitat loss: The 1997 listing rule described San Joaquin Valley Orcutt grass habitat as having been reduced and fragmented throughout its historical range (Service 1997, p. 14346–14347) and the Recovery Plan lists habitat loss and fragmentation (Factor A) as the largest threat to survival and recovery of this species (Service 2005c, p. I–16). Primary causes attributed to the reduction and fragmentation of habitat include agricultural land conversion, urbanization, hydrologic modifications, small population size, and improper grazing regimes (Service 2013, p. 7–8). All 5 historical populations that existed in Stanislaus County and 12 historical localities in Madera, Fresno, and Tulare Counties had been extirpated by 1986–1987 due to habitat modification (Stone et al. 1988). An additional locality in Madera County is presumed to be extirpated but has not been visited since 1987.

Between the listing of the species in 1997 and the development of the Recovery Plan in 2005, approximately 36,068 acres (7.7% of mapped extent) of vernal pool habitat within the current range of the species (Fresno, Madera, Merced, Solano, and Tulare Counties) were converted to urban or agricultural land uses (Holland 2009, p. 8). Across California, updated mapping of vernal pool habitat shows a net loss of 70,482 acres between 2005 and 2018, or approximately 5,848 acres per year of natural vernal pool habitat converted to other land uses (Witham 2021, p. 5). Most of this habitat loss is from conversion to agriculture, specifically the conversion to orchards, which total 56.6% of mapped acres lost. By contrast, habitat loss to urban or industrial development total 6.65% of mapped acres lost (Witham 2021, p. 1).

Climate change: California's Fourth Climate Change Assessment was published in 2018 (Thorne et al. 2018, entire) and has included subsequent regional reports on the different regions of California, including the San Joaquin Valley (Fernandez-Bou et al. 2021, entire). This region of California overlaps the core range of the San Joaquin Valley Orcutt grass and is expected to experience significant impacts from climate change. The average annual maximum temperature in the San Joaquin Valley has increased by 1° F (0.6° C) from 1950 to 2020. It is projected to increase 4–5° F (2.2–2.7° C) by mid-century and to increase 5–8° F (2.7–4.4° C) by the end of the century (Fernandez-Bou et al. 2021, p. 7). Models of projected future precipitation in the San Joaquin Valley show an increasing duration of the dry season with 20% less precipitation expected to occur overall on average (Fernandez-Bou et al. 2021, p. 8). Specifically, natural wetlands may experience extended periods of drought, floods, increased water temperatures, and higher evaporation rates (Fernandez-Bou et al. 2021, p. 10). While extended periods of drought are not expected to reduce seed bank viability, non-native plant species may invade vernal pool habitats during extreme drought conditions and competitively exclude San Joaquin Valley Orcutt grass and other sensitive vernal pool plant species (Witham *pers. comm.* 2022).

Wetlands (including vernal pools) are expected to be more sensitive to climate change because precipitation is often their main water source (Winter 2000, p. 307), so alterations to precipitation regimes are likely to disproportionally affect these ecosystems. Pyke (2004, pp. 3–4) reported that climate change and reduced frequency of suitable habitat might represent the greatest threat to vernal pool species. Modeling of vernal pool hydrology and plant community composition in northern California show that vernal pools will have shorter inundation times with little change in maximum depth under projections of altered climate change conditions (Montrone et al. 2019, p. 1010). Vernal pool specialists are highly sensitive to inundation time, so shortened inundation time due to climate change is expected to cause declines in the number of vernal pool specialist species. Variation in annual weather exacerbated by climate change also contributes to changes in vernal pool plant abundance and community composition, often allowing invasion by non-native exotic species (Javornik and Collinge 2016, p. 66). Specifically, threatened or endangered vernal pool obligate plant species, such as the San Joaquin Valley Orcutt Grass, may experience an increased risk from environmental and ecological changes from climate change (Bauder 2005, p. 2134).

Pesticides and Herbicides: Research over the last 20 years have shown that contaminants may threaten vernal pool ecosystems and pose a significant risk to threatened and endangered vernal pool species within the agricultural matrix of the Central Valley (Johnson 2006, p. 11). Pesticides from agricultural runoff, drift, precipitation, and/or aerial deposition can contaminate vernal pools. Due to the ephemeral nature of vernal pools, contaminants may concentrate in vernal pools during the dry-down phase, potentially exacerbating the ecological impacts of these contaminants (Cahill et al. 2001, p. 822). Modeling of pesticide concentrations in vernal pool habitats in Merced County within the San Joaquin Valley of California shows that vernal pools are under a high risk of pesticide inputs via agricultural runoff from the surrounding landscape (Sinnathamby et al. 2020, p. 9). The actual concentrations of pesticides in vernal pools are not well-known because of the difficulty of accurately sampling these highly seasonal habitats. However, higher concentrations are typically observed in pools directly adjacent to agricultural lands. A study of vernal pools and streams found that atrazine and glyphosate (both herbicides) are detected in concentrations above the freshwater aquatic life standard even when the vernal pools themselves were located on protected lands (Battaglin et al. 2009, p. 301). It is unknown

the extent to which pesticides (including insecticides, herbicides, and fungicides) may affect San Joaquin Valley Orcutt grass, but best management practices for weed control states that "if endangered grasses such as *Orcuttia viscida* (Sacramento Orcutt Grass) are also present, a grass-specific herbicide should never be used" and to avoid broadcast application of glyphosate to control invasive plants in vernal pools (DiTomaso and Kyser 2013, p. 2, Waxy Mannagrass section). There is also evidence that fungicides may inhibit germination of *Orcuttia* seeds, as demonstrated by Keeley (1988, p. 1088), which indicated that fungicide inhibited germination of *O. californica* seeds but did not affect Greene's Tuctoria (*Tuctoria greenei*) seeds. Detailed germination studies have not been conducted for the San Joaquin Valley Orcutt grass.

Conservation:

Conservation Banks: A mitigation bank or conservation bank (bank) is a property or suite of properties (i.e., umbrella bank, phased bank, etc.), providing habitat or other conservation values that are conserved and managed in perpetuity, and provides ecological functions and services for specified listed species or resources. Mitigation and conservation banks function to offset adverse impacts that occurred elsewhere; therefore, the Service approves a specified number of credits that the bank owner may sell to developers or other project proponents for use as compensation to offset adverse impacts their projects will likely have on listed species. The money from the initial investment and bank credit sales is then used to permanently protect and manage the land for those species and resources. The Service is aware of three banks with known populations of San Joaquin Valley Orcutt grass, with 2,245.4 acres under protection in total (Table 3). One bank is approved to sell credits for the species (Muzzy Ranch Conservation Bank). More information about conservation banks within the Sacramento Fish and Wildlife Office's Service area can be found at: https://www.fws.gov/media/conservation-bank-guide-sacramento-fish-and-wildlife-office.

Table 3. Summary of mitigation bank and conservation bank properties with known populations of San Joaquin Valley Orcutt grass.

Bank Name	**County**	**Status**	**Protected Acreage**	**Offers credits for San Joaquin Valley Orcutt grass?**
Drayer Conservation Bank	Merced	Active	254.4	No
Kennedy Table Mountain Mitigation Bank	Madera	Active	600.0	No
Muzzy Ranch Conservation Bank	Solano	Active	1391.0	Yes
Total Protected Acreage			2,245.4	

Permittee Responsible Mitigation: Permittee-responsible mitigation, also sometimes referred to as turn-key mitigation, includes activities or projects undertaken by a permittee (or authorized agent) to provide compensatory mitigation to offset impacts from a single project. The permittee retains full responsibility for this mitigation. Ideally, permittee-responsible mitigation projects are established in advance of the project-related impacts they are offsetting; however, this may not occur due to multiple factors. The Service is aware of two advance permittee-responsible mitigation properties with known populations of San Joaquin Valley Orcutt grass. The first area was proposed to be a mitigation bank in Madera County (Madera Pools Mitigation Bank), but the owner of the property (Caltrans) decided instead to use the property as advance permittee-responsible mitigation to offset future Caltrans projects (Marc Fugler 2022 in litt.). The current population status of San Joaquin Valley Orcutt grass on this 197-acre parcel is unknown since 2017 (see Table 1, Occurrence #43), but the habitat was described as being "present but degraded" with declining estimated vigor in 2011 (Witham 2013, p. 30). The second permittee-responsible mitigation area is Fenston Preserve (a separate parcel adjacent to the pending Fenston Mitigation Bank), which is part of the larger Fenston Ranch property owned by Vulcan Lands, Inc. This 765-acre parcel is used as compensatory mitigation for direct impacts from mining activities at the Vulcan Materials Company's Austin Quarry (WRA, Inc. 2019, p. 4). The current status of San Joaquin Valley Orcutt grass on this parcel is unknown since 2019. The status of this in 2019 is shown in Table 1.

Introductions: In 1993, the San Joaquin Valley Orcutt grass was introduced into created vernal pools as part of a vernal pool creation project (Stebbins et al. 1996, entire; Service 2013, pp. 14–15). The species continued to occur within these created pools, although only two "very dry" individual plants were observed in 2017, while adjacent pools have been heavily invaded by exotic grass species (Diversity Database 2022). This project suggests introductions into created vernal pools can provide increased species stability within habitats in the San Joaquin Valley, and augmentations can expand existing San Joaquin Valley Orcutt grass populations.

Recovery criteria:

General recovery criteria for San Joaquin Valley Orcutt grass and 19 other listed plants and animals are described in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (Service 2005c, entire). This recovery plan uses an ecosystem-level approach because many of the listed species and species of concern addressed in the plan co-occur in the same natural ecosystem and share the same threats. The five key elements that comprise this ecosystem-level recovery and conservation strategy are: 1) habitat protection, 2) adaptive habitat management and monitoring, 3) status surveys, 4) research, and 5) public participation and outreach. The recovery criteria for the San Joaquin Valley Orcutt grass have been partially met. The current status of each recovery criterion, and its status at the time of the 2013 5-year review, is detailed in Table 4.

Table 4. Summary of recovery criteria for San Joaquin Valley Orcutt grass described in the Recovery Plan (Service 2005c). The current status of each criterion is compared with its status as described in the previous 5-year review (Service 2013). Overutilization for commercial, recreational, scientific, or educational purposes (Factor B) was not addressed in the Recovery Plan, as it was not considered a threat to the species.

Recovery Criteria	2013 status	2022 status
1A: Percent suitable vernal pool habitat within each prioritized core area for the species is protected (Fresno 85%, Madera 95%, Table Mountain 95%, and Tulare 85%).	Not met	Not met. As of 2018, approximately 15.7% (32,737 acres) of the vernal pool grassland habitat within the Southern Sierra Foothills Vernal Pool Region is protected (Witham et al. 2013; Witham 2021; Vollmar 2017). The percent of protected vernal pool grassland habitat within each core area as of 2018 is estimated to be 0.1% (18.0 acres) for the Fresno core area, 19.2% (24,564.0 acres) for the Madera core area, 84.0% (1,460.0 acres) for the Table Mountain core area, and 0.0% (0.0 acres) for the Tulare core area (Witham et al. 2013; Witham 2021; Vollmar 2017).
1B: 90% of the species localities distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there.	Partially met	Partially met. 70% (23 out of 33) of the presumed extant occurrences are currently protected from development by conservation easements or other land controls. The distribution of extirpated, possibly extirpated and presumed extant occurrences, as classified by the Diversity Database, are displayed in Figure 2.
1C: Reintroduction and introduction must be carried out and meet success criteria.	Not met	Not met. The Service is not aware of any introduction or reintroductions of San Joaquin Valley Orcutt grass since the single introduction event in 1993.
1D: Additional localities that are detected (and determined essential to recovery goals) are permanently protected.	Met	Partially met. At this time, the Service is aware of two additional localities that were not considered in the 2013 5-year review. Diversity Database occurrence #66 is part of the pending Fenston Mitigation Bank in Madera County. Diversity Database occurrence #68 is a private property with unknown protection status. There are also three additional occurrences on the Fenston Ranch property that have not yet been entered in the Diversity Database.
1E: Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average	Not met	Not met. Hydrologic monitoring has not occurred at any of the known extant occurrences; therefore, we are unable to determine whether the hydrology at extant sites has been maintained to sufficiently support San Joaquin Valley Orcutt grass viability.

Recovery Criteria	2013 status	2022 status
local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring.		
2A: Habitat management and monitoring plans have been developed and implemented within five years of individual parcel/property/area protection that facilitate maintenance of vernal pool ecosystem function and population viability by including provisions for managing nonnative and native competitors, appropriate grazing, fire or other management regimes, adaptive habitat management, incorporation of new information resulting from implementation of research actions and addressing site-specific threats.	Partially met	Partially met. While mitigation bank and conservation easement locations have habitat management and monitoring plans in place, information regarding the management of all areas containing San Joaquin Valley Orcutt grass remains incomplete.
2B: Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc.).	Partially met. There were 14 protected occurrences and 17 unprotected occurrences at the time of writing the 2013 5-year review.	Partially met. Twenty-three out of the 33 presumed extant occurrences are currently protected from development by conservation easements or other land conservation mechanisms. The remaining 10 presumed extant occurrences lack any known protection from urbanization or agricultural land conversion. Of the five new occurrences identified since the last 5-year review, four are under a conservation easement and one has unknown protection status.
2C: Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring.	Not met	Not met. Monitoring of ecosystem function has not occurred for any of the known occurrences of this species. Therefore, the Service is unable to determine if the ecosystem function has been sufficiently maintained at extant locations to sustain viable populations across variable hydrologic regimes.
2D: Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria.	Not met	Not met. The Service knows of no active seed collection for San Joaquin Valley Orcutt grass projects currently permitted and is not aware of any collections in botanical gardens.
3A: Status surveys, 5-year status reviews, and population monitoring show populations within each	Not met.	Not met. Annual monitoring has not occurred during a time period that meets the requirements specified in the Recovery Plan. Annual

Recovery Criteria	2013 status	2022 status
vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring.		surveys for this species are known to occur at the Muzzy Ranch Conservation Bank in Solano County. Since development of the Recovery Plan (Service 2005c) informal site visits confirming the presence of this species have been conducted at some of the known occurrences, but standardized survey protocols are still lacking. The most recent Diversity Database observation of species presence was in 2017.
3B: Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated.	Not met.	Not met. Systematic habitat monitoring has not occurred at any of the known San Joaquin Valley Orcutt grass occurrences since listing (see 3A, above). The Service does not have information indicating that these threats have been ameliorated or eliminated.
4A: Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions.	Not met.	Not met.
4B: Research on genetic structure has been completed and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in 1A-E, above.	Not met	Initiated. The Service is aware of two research efforts (at the California Botanic Garden and UC Merced) on vernal pool grass genomics, including San Joaquin Valley Orcutt grass. These studies are currently ongoing and aim to resolve species relationships, revisit the generic classification, and assess landscape-scale diversity of all currently recognized species (Sexton 2022 *pers. comm.*; Stone 2022 *in litt.*).

Recovery Criteria	2013 status	2022 status
4C: Research necessary to determine appropriate parameters to measure population viability for each species has been completed.	Not met	See 4A, above.
5A: Recovery Implementation Team is established and functioning to oversee range-wide survey efforts.	Met	Partially met. The Vernal Pool Implementation Team was established in 2009 to oversee the formation and functioning of multiple working groups focused at the scale of the vernal pool region. The Implementation Team was meeting quarterly in 2013 but is not currently active. The Service is in the process of organizing a more informal, internal vernal pool working group in the Sacramento Fish and Wildlife Office. The primary goal of this internal team will be to re-emphasize the recovery plan and incorporate recovery planning into our everyday workload. This team will not function as the official recovery implementation team as it will only consist of Service employees, but the hope is that this internal working group will eventually provide the basis for creating a true recovery implementation team as well as regional working groups.
5B: Vernal pool regional working groups are established and functioning to oversee regional recovery efforts.	Not met	Not met. There are currently no active working groups involving San Joaquin Valley Orcutt grass.
5C: Participation plans for each vernal pool region have been completed and implemented.	Not met	Not met.
5D: Vernal pool regional working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4.	Not met	Not met.

Conclusion:

After reviewing the best available scientific information, we conclude that San Joaquin Valley Orcutt grass remains a threatened species. The evaluation of threats affecting the species under the factors in 4(a)(1) of the Endangered Species Act and analysis of the status of the species in our 2013 5-year review (Service 2013) remains an accurate reflection of the species' current status.

RECOMMENDATIONS FOR FUTURE ACTIONS:

In this section we propose recommendations which will aid in the recovery and conservation of San Joaquin Valley Orcutt grass. The recommendations put forth in the Recovery Plan (Service 2005, p. ix–xii) and the previous 5-year review (Service 2013, p. 20–21) are still relevant and are expanded upon in this section. Additional recommendations have been identified based on communication with species experts, a literature search, and a status review of existing records.

1. **Preserve additional, known extant occurrences to reach recovery goals outlined in the 2005 Recovery Plan.** Preservation of large blocks of vernal pool habitat that contain complete or large portions of vernal pool complexes is needed to ensure the phenotypic and genotypic variation exhibited by this species is protected. The Service should also work with private landowners for the conservation of habitat for San Joaquin Valley Orcutt grass populations through conservation easements or other methods. Identifying and protecting additional populations of San Joaquin Valley Orcutt grass will be critical for the long-term viability of the species (Service 2005c; Service 2013).

2. **Develop or reinitiate regional and/or state-level working groups for vernal pool species.** Regional vernal pool working groups discussed in the previous 5-year review (Service 2013, p. 18) are not currently active. Reinitiating these regional working groups will develop the partnerships needed to oversee regional recovery efforts for vernal pool species, including San Joaquin Valley Orcutt grass.

3. **Conduct coordinated research for San Joaquin Valley Orcutt grass population status and population dynamics. Specific research items to achieve this recommendation include:**
    a. Design and implement reintroduction experiments.
    b. Genetic research should be conducted to refine our understanding of genetic diversity within and among extant populations and should be correlated with existing and anticipated (based on climate change models) environmental conditions. The Service is aware of two research efforts on vernal pool grass genomics including San Joaquin Valley Orcutt grass. These studies aim to resolve species relationships, revisit the generic classification, and asses landscape-scale diversity of all currently recognized species (currently ongoing at U.C. Merced and the California Botanic Garden).
    c. Investigate the two different morphological variations of San Joaquin Valley Orcutt grass. It may be beneficial to look through scanned botanical collections to identify plants with mixed characteristics, to explore the geographic range of the

characteristics, and the relative proportion of the two morphological types (Witham *pers. comm.* 2022).

4. **Develop and implement a standardized formal monitoring program that collects data in sufficient detail to evaluate species status and examine changes in population dynamics and community composition. Specific actions to achieve this recommendation include:**
    a. Conduct surveys in habitats that have been identified as suitable within the historical range of the species. Surveying locations identified in the most recent vernal pool habitat mapping report (Witham 2021) as potentially suitable habitat (i.e., large playa pools in the species range) could result in the discovery of additional occurrences of San Joaquin Valley Orcutt grass and/or identify suitable locations for future translocations or reintroductions of the species.
    b. Annual population stability and trend monitoring of all known extant locations. Without better understanding of the population dynamics of the species, we do not know the extent to which protected lands provide self-sustaining populations of this species within each vernal pool region. Monitoring of annual trends and stability needs to assess short- and long-term fluctuations of individual localities which would assist in anticipating demographic changes in response to climate change over time. Incomplete and infrequent monitoring of this species makes population status and trends difficult to assess. An effort should be made to conduct regular status surveys for San Joaquin Valley Orcutt grass (and other listed vernal pool plants, like Witham's 2013 survey) to make future species status assessments possible.

5. **Develop management indicators for identifying potential problems and assessing ecosystem health as it pertains to vernal pool species and establish requirements for appropriate management of vernal pool landscapes.** Due to urban encroachment and resulting hydrological changes, conservation efforts should be focused on retaining natural surface and subsurface watersheds and on managing for unseasonable sources of water that infiltrate to vernal pool preserves both of which result in changed site hydrology. The development of management indicators and the establishment of vernal pool habitat management requirements will help land managers maintain functional vernal pool landscapes.

6. **Conduct coordinated research for San Joaquin Valley Orcutt grass habitat requirements:**
    a. Assess the long-term effects on the hydrology of vernal pools from urbanization and agricultural-related alterations to vernal pool sub-watersheds. Efforts should lead to determinations of appropriate hydrology (or upland) buffers. Stone et al. (1988, pp. 10–11) also recommended research focused on assessing the range of inundation conditions necessary to maintain San Joaquin Valley Orcutt grass.
    b. Identify and understand the anticipated risks from climate change, specifically the effects of drought on the long-term viability of San Joaquin Valley Orcutt grass.
    c. Determine the degree of threat from grasshopper foraging, identify factors contributing to grasshopper herbivory, and develop remedies if this is a significant threat (Service 2005c, p. II–70).

d. Determine if and how pesticides may threaten San Joaquin Valley Orcutt grass population viability. Experiments evaluating if fungicides inhibit germination of San Joaquin Valley Orcutt grass, as is the case in other *Orcuttia* species (Keeley 1988, p. 1088), would be beneficial. Additional research is warranted on how pesticides, namely herbicides, impact sensitive vernal pool plants in conjunction with other stressors. Specifically, there is a need to identify the potential need for agricultural buffer zones and to evaluate the overall tolerances of vernal pools to pesticides (Johnson 2006, p. 5).

Field Supervisor, Sacramento Fish and Wildlife Office

Approve MICHAEL FRIS Digitally signed by MICHAEL FRIS Date: 2023.06.26 15:54:34 -07'00' **Date** _____

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Appendix A

Site-specific list of known ownership, protection status, and threats to each **extant** San Joaquin Valley Orcutt grass population (Stone *et al.* 1988; Diversity Database 2022; J. Vollmar *in litt.* 2012, C. Witham *in litt.* 2010, Witham 2013, Cannizzo *in litt.* 2022, O'Leary *in litt.* 2022, Foreman *in litt.* 2022, Vulcan Lands, Inc. and Sierra Foothill Conservancy 2021).

Occurrence Number	Core Recovery Area	Ownership	Protection Status	Threat(s)	Comments	Changes since previous 5-year review
4	Merced	UC Merced	Campus Vernal Pool Reserve	Inappropriate grazing; foot traffic/trampling	Last observed at site in 1980; not found in 1986, 2011, or 2017. Habitat present but very marginal (Witham 2013).	Threats identified
5	Merced	UC Merced	Campus Vernal Pool Reserve	Threat not identified	Last observed at site in 1980; not found in 1986 or 2011. Habitat still present (Witham 2013).	N/A
6	Merced	Private	Unknown	Invasive species impacts	Last observed at site in 1980; not found in 1985, 1986, 2010, or 2017. Habitat present but marginal (Witham 2013).	Threats identified
26	Merced	The Nature Conservancy	Flying M Ranch Easement	Inappropriate grazing	Thousands of plants observed in 2010 (Witham 2013). No plants observed in 2012, but it was an unusually dry year.	Threats identified
28	Merced	The Nature Conservancy	Flying M Ranch Easement	Inappropriate grazing; dam/inundation	Over a million plants observed in 2010 (Witham 2013). No plants observed in 2012, but it was an unusually dry year.	Threats identified
33	Merced	The Nature Conservancy	Flying M Ranch Easement	Inappropriate grazing; grasshopper damage noted in 1986.	Thousands of plants observed in 2010 (Witham 2013). No plants observed in 2012, but it was an unusually dry year.	Threats identified. Ownership now listed as Flying M Ranch.
34	Merced	The Nature Conservancy	Flying M Ranch Easement	Altered hydrologic regime; foot traffic/trampling	Last observed at site in 1981, with numbers in the thousands. No plants found in 1986, 2009, or 2010. Site may be mis-mapped; habitat present but not suitable (Witham 2013).	Threats identified

Occurrence Number	Core Recovery Area	Ownership	Protection Status	Threat(s)	Comments	Changes since previous 5-year review
35	Merced	Unknown	Unknown	Overgrazing: exotic weed (*Sida* sp.) competition	Last observed at site in 1986, with numbers in the thousands. Playa pool at base of spillway for Burns Creek Dam is of marginal depth and inundation period.	N/A
38	Merced	Private	Unknown	Overgrazing	Last observed at site in 1981 with <1,000 plants; 0 in 1986 or 1987.	N/A
39	Merced	Private	Unknown	Overgrazing	Last observed at site in 1986 with >10,000 plants.	N/A
41	Madera	Fenston Ranch	Unknown	Development; off-road vehicle activity; agriculture; inappropriate grazing; non-native plant impacts	8 plants observed in 2017; 500+ plants in 2016; 65 plants in 2010; ~1,100 plants in 1995; 400 plants in 1986; 100+ plants in 1983; 200 plants in 1982.	Additional threats identified
43	Madera	Caltrans	Caltrans In-House Mitigation Bank	Development; highway expansion; agriculture; non-native plant impacts; trash; road runoff; changed hydrology; discing; inappropriate grazing	100+ plants seen in 2017; 2,000 in 2016; ~350 in 2010; 3,000 in 2010: 0 in 2009; ~100 in 1995; >10,000 in 1992; >1,000 in 1986. Habitat present but degraded (Witham 2013, p.30).	Additional threats identified. Caltrans will be using the site for advance permittee responsible mitigation to be used to offset future projects (Marc Fugler, *in litt.* 2022).
47	Fresno	Bureau of Land Management (BLM) and Sierra Foothill Conservancy	Half of pool on public land; half on private grazed land.	At least two populations at this site, smaller population is on land administered by BLM and is fenced, larger population is subject to overgrazing and off-road vehicle use.	This is part of the Table Mountain vernal pool complex. Unknown number of plants seen in 2002; 5,000 in 1997; thousands in 1995; 560,000 est. in 1993; ~8,000 in 1990; 2,000 in 1987.	Sierra Foothill Conservancy now owns the land surrounding the BLM parcel.
48	Madera	Private	Unknown	Small population size, overgrazing, land conversion	Fewer than 10 plants seen in 1992.	N/A
49	Merced	U.C. Merced	Campus Vernal Pool Reserve	Threat not identified.	0 plants in 2021, 0 in 2020, 2 in 2019, 1 in 2018, 35 in 2017, 1 in 2016, 41 in 2011, unknown number in 1999.	N/A

Occurrence Number	Core Recovery Area	Ownership	Protection Status	Threat(s)	Comments	Changes since previous 5-year review
					From 2015-2021 surveys were conducted at 17-22 suitable deep vernal pool habitats on the Reserve, only 1 pool contained San Joaquin Valley Orcutt Grass.	
50	Merced	The Nature Conservancy	Flying M Ranch Easement	Small population size; inappropriate grazing; non-native plant impacts	No plants found in 2009; <500 plants seen in 1987.	Ownership now listed as Flying M Ranch.
51	Merced	Private	Unknown	Inappropriate grazing	10,000 plants seen in 1987.	N/A
53	Fresno	Private	Unknown	Small population size; urban development	300 plants seen in 1987.	N/A
54	Madera	Bureau of Reclamation	Federally owned land managed by Madera Irrigation District	5 of 6 pools fenced to exclude grazing; grasshoppers observed grazing on plants in 1995.	San Joaquin Valley Orcutt Grass was introduced in created vernal pools in 1993. 2 very dry plants seen in 2017; six extant populations verified in 1996 (Stebbins et al., 1996); several hundred plants in each pool in 1995.	N/A
55	Madera	Private	Kennedy Table Mt. Mitigation Bank	Threat not identified.	Millions of plants observed in 1995.	N/A
56	Tulare	California Department of Fish and Wildlife	Stone Corral Ecological Reserve	Non-native plant impacts	50 plants seen in 2020 (California Department of Fish and Wildlife), 4 plants in 2017, ~1,000 plants in 2011, 0 in 2009 or 2010, <100 in 2006, 0 in 2005, 250 in 1997.	N/A
57	Merced	Private	Ichord Ranch, Conservation Easement	Agriculture; inappropriate grazing; altered hydrologic regime	~7,500 plants seen in 2001; ~10,000 plants seen in 1999.	Threats identified
58	Merced	Private	Unknown	Overgrazing	>5,150 plants seen in 2011; >5,000 plants in 2000.	N/A
60	Merced	Private	Ichord Ranch, Conservation Easement	Overgrazing, and hydrologic modifications from	Possibly thousands of plants seen in 2001, but not counted.	N/A

Occurrence Number	Core Recovery Area	Ownership	Protection Status	Threat(s)	Comments	Changes since previous 5-year review
				undeveloped dirt road establishment.		
61	Merced	Private	Ichord Ranch, Conservation Easement	Overgrazing, and hydrologic modifications from undeveloped dirt road establishment; foot traffic/trampling	Unknown number of plants seen in 2001.	N/A
62	Merced	Private	Drayer Conservation Bank	Small population size; overgrazing; non-native plant impacts	Habitat present but no plants seen in 2010; 30+ plants in 2000.	Location is now part of the Drayer Conservation Bank.
63	Solano	Private	Muzzy Ranch Conservation Bank	Overgrazing; foot traffic/trampling	<181 plants observed in 2021; 287 plants in 2020; 0 plants in 2019; present but not surveyed in 2017 and 2018; 262,251 plants in 2011; 1,600 plants in 2003.	Location is now part of the Muzzy Ranch Conservation Bank.
64	Merced	Private	UC Merced, Chance Ranch Easement held by TNC	Threat not identified.	Possibly erroneous occurrence. No plants found in 2010; unknown number of plants seen in 2001.	N/A
66	Madera	Private	Fenston Ranch	Development; non-native plant impacts	~500 plants observed in 2017.	New occurrence
68	Madera	Private	Unknown	Development; inappropriate grazing; foot traffic/trampling by cattle	12 plants seen in 2017. Most showed signed of herbivory.	New occurrence
Unlisted 1	Madera	Private	Fenston Ranch	Threat not identified.	Some grazing disturbance, but habitat described as being in good condition. 127,001 plants in 2019 (Vulcan Lands, Inc. and Sierra Foothill Conservancy 2021).	New occurrence not yet listed in the Diversity Database
Unlisted 2	Madera	Private	Fenston Ranch	Threat not identified.	Native habitat intact, no threat of overgrowth of weeds. 49 plants in 2019 (Vulcan Lands, Inc. and Sierra Foothill Conservancy 2021).	New occurrence not yet listed in the Diversity Database

Occurrence Number	Core Recovery Area	Ownership	Protection Status	Threat(s)	Comments	Changes since previous 5-year review
Unlisted 3	Madera	Private	Fenston Ranch	Threat not identified.	Some grazing disturbance. Native habitat intact, no weed threats. 155 plants in 2019 (Vulcan Lands, Inc. and Sierra Foothill Conservancy 2021).	New occurrence not yet listed in the Diversity Database