5-YEAR REVIEW
San Joaquin wooly-threads (*Monolopia* [=*Lembertia*] *congdonii*)

GENERAL INFORMATION

Species: San Joaquin wooly-threads (*Monolopia* [=*Lembertia*] *congdonii*)
Date listed: July 19, 1990
Federal Register (FR) citation: 55 FR 29361 (Service 1990)
Classification: Endangered

State Listing: San Joaquin wooly-threads is not listed by the State of California.

BACKGROUND

Species overview:
San Joaquin wooly-threads (wooly-threads) is an herbaceous annual plant in the Asteraceae (sunflower) family. It has slender leaves and clusters of tiny yellow flowers at its branch tips. Depending on the growing conditions, each plant can have from one to 400 flower heads. The common name "wooly-threads" is derived from the tangled hairs covering the many trailing stems that grow up to 18 inches (in) (46 centimeters (cm)) long (Jepson Herbarium 2025, entire). However, plants may also be tiny and erect with a single stem. Germination occurs from November to February, with flowering from February to May (Jepson Herbarium 2025, entire). As an annual plant, it utilizes a seed bank to survive years of low rainfall or prolonged drought (Excoffier 2022, p. 2). Wooly-threads soil seed banks can contain 10 to 100 times the average number of emergent individuals, and seeds are viable for about 10 years (O'Dell 2024, p. 20). Wooly-threads is the only species in the genus *Monolopia* that exhibits heterocarpy, the production of fruits of different shapes. Wooly-threads produces two different shapes of cypselae (single-seeded fruit) from its ray and disk flowers. Heterocarpy is a form of bet-hedging as the two different cypselae have different dispersal, dormancy, and germination strategies to bolster the probability of survival in different conditions (Excoffier 2022, pp. 14–15). In San Joaquin wooly-threads, disk fruits are lighter, less energetically expensive to produce, and have the purpose of dispersing farther (Excoffier 2022, pp. 16, 29). In contrast, ray fruits are heavier, more energetically expensive to produce, and have the purpose of germinating near the parent plant to contribute to the existing population (Excoffier 2022, pp. 16, 29). The species is a strict sandy soil endemic and occurs in annual grasslands and saltbush scrub habitats (Jepson Herbarium 2025, entire). We discuss soil seed banks, seed longevity, and soil preference further in the **Conservation and research** section.

Most recent status review:
[Service] U.S. Fish and Wildlife Service. 2020. San Joaquin wooly-threads (*Monolopia* [=*Lembertia*] *congdonii*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 7 pp.

We did not recommend a status change in the 2020 status review.

FR notice citation announcing this status review:
[Service] U.S. Fish and Wildlife Service. 2024. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews for 59 Pacific Southwest Species. Federal Register 89:83510–83514.

We received information from the Center for Natural Lands Management regarding species monitoring on the Panoche Valley Preserve, which we discuss in **Distribution and abundance** (D. L. Rogers, C. Hauser, and M. Labbé, Center for Natural Lands Management, *in litt*. 2025).

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 Fish and Wildlife Office. Data for this review were solicited from interested parties through a Federal Register notice announcing this review on October 16, 2024. Additionally, we contacted federal agencies, state agencies, nongovernmental organizations, and species experts to request any data or information we should consider in our review. We also conducted a literature review, reviewed information in our files, including San Joaquin wooly-threads 10(a)(1)(A) recovery permit annual reports and Section 7 consultations, 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 status review, there have been regular monitoring surveys of the species (addressed in **Distribution and abundance**) and implementation of new research projects, such as on habitat preferences (addressed in **Conservation and research**). Additionally, new information about the potential threat of neonicotinoid pesticides has become available (addressed in **Threats**).

Distribution and abundance:
Historically, San Joaquin wooly-threads was found from the valley floor to the western hills of the San Joaquin Valley and in the Cuyama Valley in California. This area consisted of seven counties: San Benito, Fresno, Kings, Tulare, Kern, San Luis Obispo, and Santa Barbara. By 1989, 33 of 52 historical occurrences were extirpated, and wooly-threads was no longer present in Tulare County (Service 1998, p. 46; Service 2010, p. 2). The remaining 19 extant occurrences were distributed in four large metapopulations and several smaller, isolated populations. The largest of the four metapopulations occurred, and still occurs, on the Carrizo Plain in San Luis Obispo County. The other three metapopulations occurred in the Lost Hills, Kettleman Hills, and Jacalitos Hills in Kern, Kings, and Fresno Counties, respectively. Smaller, isolated populations occurred in Fresno and San Benito Counties, the valley floor near Bakersfield in Kern County, and the Cuyama Valley in Santa Barbara County (Service 1998, p. 46).

At the time of the 2010 status review, 66 occurrences were presumed to be extant across the same six counties (Service 2010, p. 2). In the most recent status review in 2020, 87 occurrences were presumed to be extant across these counties (Service 2020, p. 2). Both status reviews note that the growing number of occurrences was the result of increased survey effort and did not represent a notable expansion of the species' range or distribution (Service 2010, p. 9; Service 2020, p. 2). Distribution information provided in the 2010 and 2020 status reviews were gathered

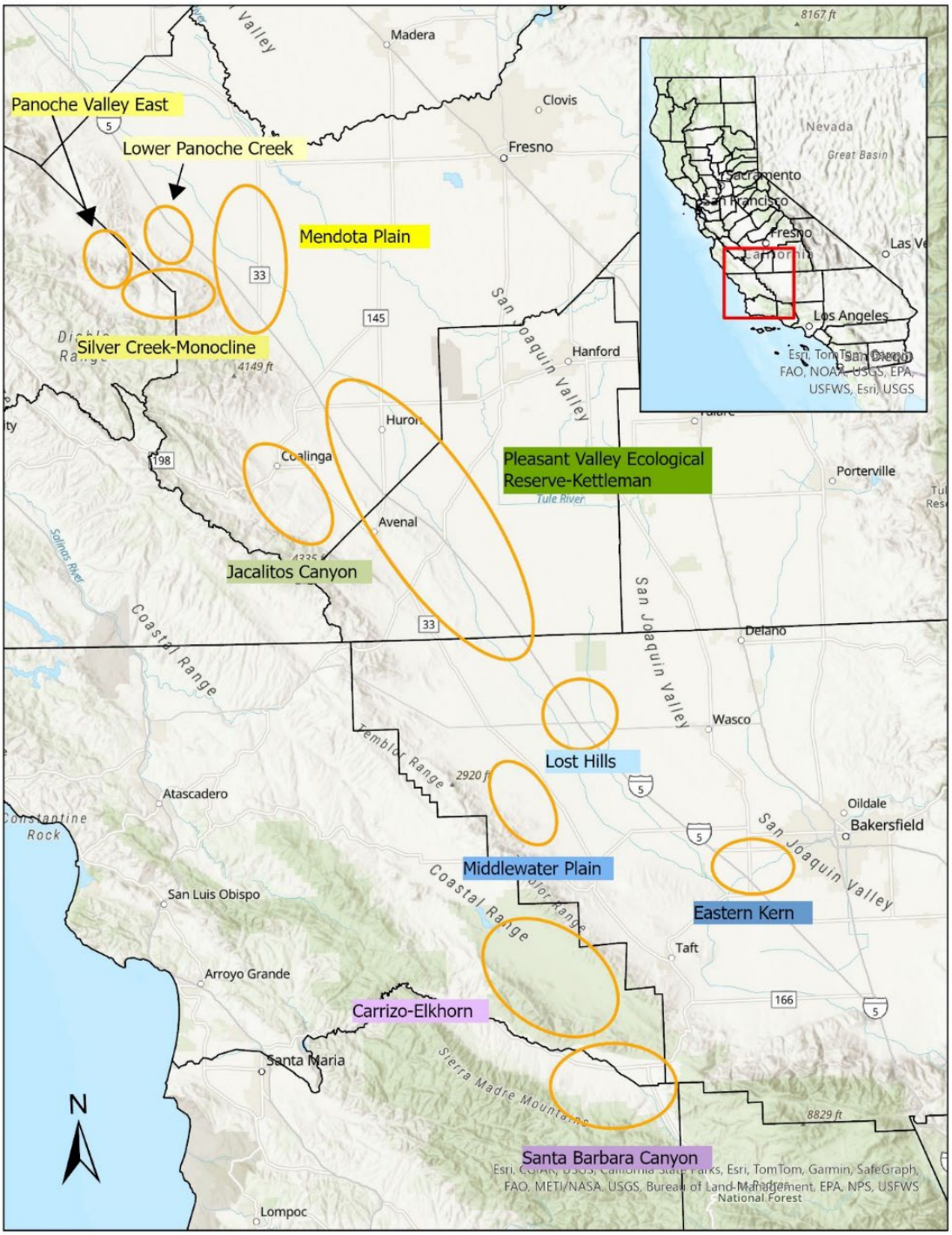
from the Diversity Database, which has not been updated since 2019. Comparison tables of the Diversity Database occurrence data can be found in the previous status reviews (see Service 2010, p. 9, and Service 2020, p. 2).

At the time of listing, many of the known populations of wooly-threads were located on Bureau of Land Management (Bureau) lands. Population and monitoring data by the Bureau dates back to 1991, with more intensive, annual monitoring beginning in 2008 (O'Dell 2025, Appendix 1). Compared to the Diversity Database occurrence data, the Bureau's distribution data is collected on a finer spatial scale, which facilitates more precise monitoring of wooly-threads locations and habitat requirements. The Bureau organizes wooly-threads data into suboccurrences and occurrences. "Suboccurrence" is used to describe discrete patches of individual plants. These suboccurrences can then be placed within an "occurrence", which describes a cluster of patches in the same area (O'Dell *in litt.* 2025a). These definitions are different than the Diversity Database's definition of an occurrence, which is a group of individuals separated by a quarter mile or less. Unless specifically stated, the Bureau definitions will be used in the remainder of this document.

The Bureau also describes wooly-threads distribution in genetic clusters, which are based on geographic distribution and the population genetics study in Bainbridge et al. (2017, entire). However, the genetic clusters designated by the Bureau do not completely align with the genetic structures proposed by Bainbridge et al. (2017, pp. 30–33), which is further discussed in **Conservation and research**. Specifically, the genetics study found evidence supporting four subregions and nine clusters within these subregions, and the Bureau further divided one of the clusters into three clusters for a total of 11 genetic clusters that are illustrated in Figure 1 (Bainbridge et al. 2017, p. 31; O'Dell 2025, p. 5).

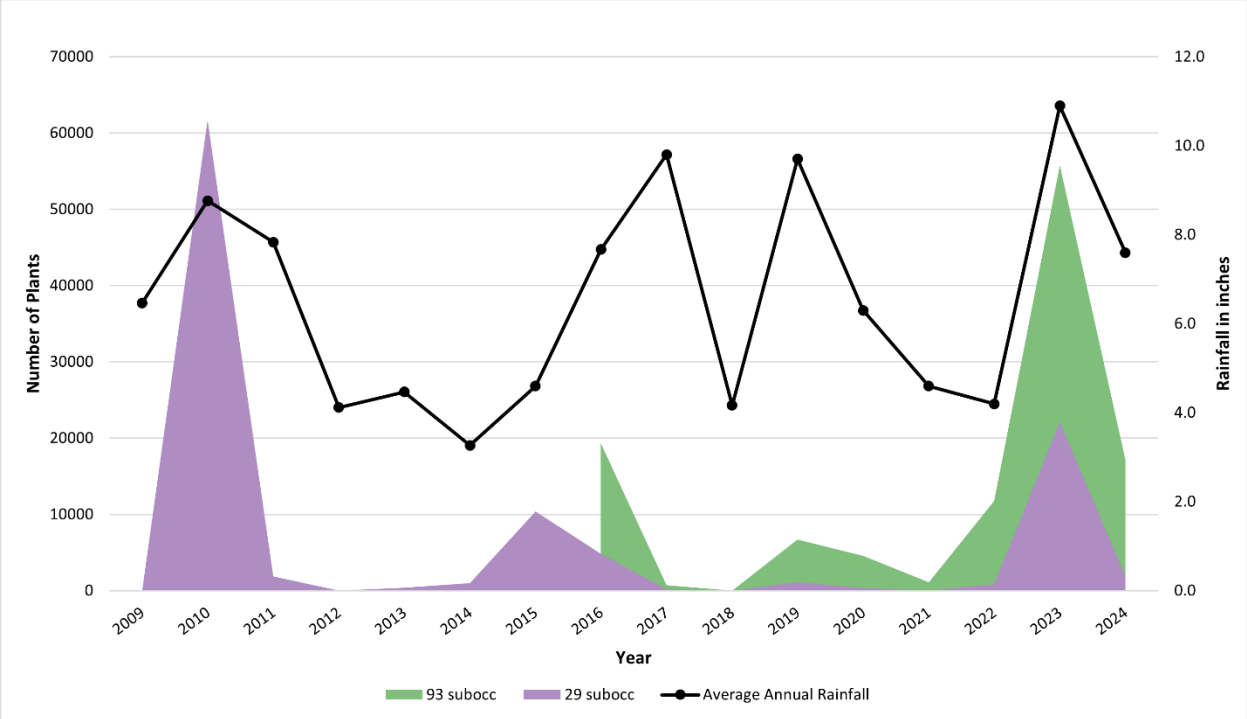
Table A in the **Appendix** shows the number of suboccurrences observed by Bureau biologists within each of the 11 genetic clusters between 2008 and 2024 (O'Dell 2025, p. 5). The number of known suboccurrences has increased from 81 to 636 between 2008 and 2024 (O'Dell 2025, p. 5). The largest increases occurred in the Panoche Valley East, Jacalitos Canyon, and Pleasant Valley Ecological Reserve-Kettleman genetic clusters (O'Dell 2025, p. 5). In particular, the Pleasant Valley Ecological Reserve-Kettleman genetic cluster dramatically increased from 168 suboccurrences in 2020 to 464 suboccurrences in 2024 (O'Dell 2025, p. 5). This increase is likely due to suitable environmental conditions that encouraged seed germination and allowed plants to survive to fruiting (O'Dell 2025, p. 1). The effects of rainfall and temperature are discussed further below. The number of suboccurrences has not increased for Middlewater Plain, Eastern Kern, Santa Barbara Canyon, and the likely extirpated Mendota Plain genetic clusters. In 2023, new suboccurrences found within the Panoche Valley East genetic cluster extended the westernmost known range limit of the species to near the mouth of Griswold Canyon (O'Dell 2024, pp. 12–13). Besides the small expansion in this portion of the range, the overall wooly-threads distribution remains similar to that described in the previous status reviews. However, the local-scale expansion of suboccurrences in some genetic clusters may contribute to increased population resilience as seed banks are being established over larger areas.

Figure 1. Map with circles indicating the approximate locations of 11 unique genetic clusters for San Joaquin wooly-threads as interpreted by the Bureau based on geographic distribution and Bainbridge et al. (2017, entire). Main colors of the cluster names (yellow, green, blue, and purple) correspond to the four subregional structures that are discussed further in **Conservation and research**. The gradient within each color shows further separation into each unique genetic cluster. The same color scheme is used in **Appendix** Table A.



Annual plant population sizes can vary drastically from year to year as they are largely influenced by environmental conditions. The Bureau closely monitors suboccurrences of wooly-threads in the northern end of the range. Monitoring data for 29 suboccurrences are available beginning in 2009, and data for an additional 93 suboccurrences are available beginning in 2016. Along with gathering annual monitoring data for these suboccurrences, the Bureau has been documenting average annual rainfall through three weather stations located in the northern portion of the wooly-threads range. Figure 2 illustrates the relationship between rainfall and wooly-threads abundance. Fifteen years of data show that few to no wooly-threads emerge in years where average annual rainfall is 4 in (10 cm) and below (O'Dell 2025, p. 1). For example, in 2018, the average annual rainfall across all 122 monitored suboccurrences was 4.2 in (10.7 cm), resulting in no plants being seen that year. In contrast, years where average annual rainfall is greater than 8 in (20 cm) may have exceptional emergence (O'Dell 2025, p. 1). For example, in 2023, average annual rainfall across all 122 suboccurrences was 10.9 in (27.7 cm), and roughly 78,000 individuals were documented (O'Dell 2025, pp. 2–4).

Figure 2. Wooly-threads abundance in the northern end of the species range based on monitoring by the Bureau. The graph shows the number of individual plants observed within the initial 29 monitored suboccurrences (purple shading; 2009–2024) and 93 additional suboccurrences (green shading; 2016–2024), compared to average annual rainfall (black line), which is the average of three weather towers found within the areas monitored. Figure created from data in O'Dell (2024, p. 4).



However, 2017 and 2019 were also high rainfall years, but plant emergence was markedly low. Bureau biologists attribute this to the interacting effects of rain and temperature (O'Dell 2023, p. 1). Wooly-threads, as an annual species, are sensitive to the quantity and timing of rainfall and temperature fluctuations during their germination and growth periods. Germination of wooly-

threads occurs in the winter when temperatures drop below 60 ˚F (15.5 ˚C) and following the first significant rainfall event of more than 1 in (2.5 cm) (O'Dell 2024, p. 20). For the newly germinated seed to survive and flower, continued rainfall throughout winter and early spring is critical. Additionally, if temperatures rise too early during the germination process, it can negatively impact soil moisture availability and jeopardize germination success (O'Dell 2023, p. 1). These climatic factors play a crucial role in yearly wooly-thread abundance, as well as other invasive annuals abundance that may compete with wooly-threads for space and resources. While rainfall amounts may have been sufficient for wooly-threads in 2017 and 2019, the timing of rainfall or temperatures were not conducive for germination. When climatic conditions are not ideal and there are no aboveground plants, wooly-threads are able to persist at the site through the soil seed bank, which is further discussed in **Conservation and research**.

Abundance numbers have also been collected in the Carrizo Plain National Monument, Panoche Valley Preserve, and Pleasant Valley Ecological Reserve by the California Native Plant Society (Plant Society), Center for Natural Lands Management, and Department, respectively. The largest metapopulation of wooly-threads is in the southwest of the species' range in the Carrizo Plain National Monument. In 2023, the Plant Society found over 10,000 individuals in Diversity Database occurrence #31 of this metapopulation (Plant Society 2023, p. 4). In Panoche Valley Preserve, wooly-threads occur across 38 of the 26,400 acres (Center *in litt.* 2025). In 2019–2024, numbers fluctuated between 950 and 7,500 individuals, and these abundance numbers were incorporated into the Bureau data compiled in O'Dell (2025, Appendix 1) (Rogers et al., *in litt.* 2025). The Panoche Valley Preserve manager also noted that the species occurs in consistent cluster locations from year to year, indicating a strong preference for specific microhabitat conditions (Hauser *in litt.* 2025). The Pleasant Valley Ecological Reserve consists of three units, with wooly-threads only occurring on the Phelps unit. Surveys have detected fluctuating population sizes of between 100 and 15,000 individuals in recent years (Currier pers. comm. 2025). However, due to varying survey methodology and efforts, numbers cannot be accurately compared across years.

Threats:

By the time the San Joaquin wooly-threads was listed in 1990, 63 percent of the historical populations had been lost (Service 1990, p. 29363). These losses were attributed to agricultural land conversion, urbanization, gravel and sand extraction, oil and gas development, continued overgrazing, off-road vehicle use, and invasive annual grasses (Service 1990, pp. 29363, 29367). In the 2010 status review, the same threats to wooly-threads were identified, with the addition of solar facilities, nitrogen deposition, trampling by livestock, climate change, and the caveat that effects from cattle grazing are more complex than originally stated (Service 2010, pp. 12–22). In the last status review in 2020, no new threats were mentioned (Service 2020, pp. 2–3). Currently, the previously identified threats continue to impact the species, and the primary threats are urban development and invasive grasses (O'Dell pers. comm. 2025). Information on the new potential threat of neonicotinoid pesticides is described below.

The Environmental Protection Agency (Agency) released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species in 2022 (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting

on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. San Joaquin wooly-threads is known as mostly a self-fertilizing taxon, but some insect pollination is considered likely (O'Dell pers. comm. 2025). The Agency's final biological evaluations determined that all three pesticides are highly toxic to invertebrate pollinators and may indirectly adversely affect the species if affected insect population declines occur near wooly-threads and if insect pollination is important for reproduction of wooly-threads (Agency 2022a, pp. 4, Appendix 4-1; Agency 2022b, pp. 2, Appendix 4-1; Agency 2022c, pp. 3, Appendix 4-1).

Conservation and research:
Conservation efforts for the San Joaquin wooly-threads include research and seed bulking. Since 2010, multiple studies on the species' habitat preferences, genetics, community dynamics, and life history have been completed. Many of these projects were completed by the Bureau's Central Coast Field Office, including one project in partnership with the University of California, Berkeley (UC Berkeley), and another completed as a thesis at California State Polytechnic University, San Luis Obispo. Seven separate research studies and the seed bulking program are discussed below, each adding new insights about the San Joaquin wooly-threads.

In 2010, Bureau biologists launched a study to examine how different grassland densities affect wooly-threads and its capacity to grow and establish (O'Dell 2013, p. 22). The study tested three plot treatments: 1) control plots with no intervention, 2) clipped plots with clipping of vegetation every two weeks to imitate a severe grazing impact, and 3) scraped plots where the top 1.2 in (3 cm) of soil is removed to eliminate residual dry matter and invasive annual plants' seed banks (O'Dell 2013, p. 22). After the initial growing season, wooly-threads growth in the scraped plots significantly outperformed that of the control and clipped plots. The results were consistent in the second growing season, confirming that the percentage of bare ground is a crucial factor influencing the establishment and growth of wooly-threads (O'Dell 2013, p. 26). The research, which continued from 2010 to 2018, concluded after eight years of data collection. Throughout this period, the presence of bare ground consistently emerged as the most important factor, with soil disruption and removal of residual dry matter identified as additional contributing factors (O'Dell 2020b, p. 7). The study discussed how livestock grazing and herbivory and burrowing by rodents could replicate the effects observed in the scraped plots, as these actions have been found to effectively reduce invasive vegetation enough to expose bare soil (O'Dell 2020b, p. 7).

The 2010 5-year review described suitable soils for wooly-threads as sandy loam soils on the valley floor and silt-rich soils on the Carrizo Plain (Service 2010, p. 10). In 2013, the Bureau conducted a study on soil texture affinity and found that sandy soils are the dominant soil type where wooly-threads are found (O'Dell 2013, p. 16). Further samples at Carrizo Plain and Elkhorn Plain found wooly-threads growing on sandy loam or loamy sand soils (O'Dell 2013, p. 21). Subsequent Bureau studies found that 51 to 100 percent sand in the soil is a characteristic of high-quality habitat to support the species, while soils with lower than 26 percent sand cannot support the species (O'Dell 2016, p. 25).

In 2013, the Bureau initiated a study to explore the impact of kangaroo rats (*Dipodomys* spp.) on the establishment and success of wooly-threads amid competition from invasive annual grass species. Kangaroo rats facilitate conditions favorable for wooly-threads growth when they loosen soil and expose bare ground while creating burrows and when they browse on annual grasses and reduce residual dry matter. A previous study found that giant kangaroo rat activity is correlated

with larger wooly-threads individuals and increased flower head production likely by decreasing competition from other plants and increasing available soil nutrients (Cypher 1994, pp. 15, 30). Initial findings from O'Dell (2013, pp. 27–31) indicated a positive relationship between wooly-threads growth and presence of kangaroo rat burrows. However, the study was discontinued as wooly-threads failed to establish in the chosen plots, potentially due to drought (O'Dell 2014, p. 19; O'Dell *in litt*. 2025a). Future studies should further explore the ecological dynamics between wooly-threads and kangaroo rats, as the findings may inform management actions beneficial to multiple species (see **Recommendations for Future Actions**).

In 2015, Bureau biologists began habitat suitability modeling for wooly-threads as no previous modeling had been conducted despite well-known habitat parameters. The model aimed to identify suitable habitat areas for further monitoring and potential reintroduction efforts (O'Dell 2016, p. 25). The model incorporated variables such as a high percentage of sandy soil, relatively level to gently sloped landscapes, and undisturbed habitats (O'Dell 2016, p. 25). Modeling results, available on Calflora (www.calflora.org), indicated that most of the remaining suitable habitat for wooly-threads is located along the western edge of the San Joaquin Valley (O'Dell 2016, p. 26). The habitat suitability mapping also includes projections of potential future habitats if average and maximum temperatures increase (O'Dell 2022, pp. 5–6). However, a 2023 report from the Bureau points out that the initial 2015 mapping may have overpredicted the extent of suitable habitat due to reliance on imprecise soil mapping data. Therefore, the report recommends using the modeled mapping as a general guide for identifying suitable habitats rather than relying on it for pinpointing exact locations (O'Dell 2024, p. 13).

The Bureau conducted another study in 2015 to investigate the survival rates of wooly-threads from seedling to flowering, building on earlier research from 1993 on the Carrizo Plain that reported survival rates of 64.6 percent to 78.4 percent across these life stages (O'Dell 2016, p. 53). For the 2015 study, researchers evaluated survival across 12 suboccurrences of wooly-threads, with results indicating an average survival rate of 84.8 percent, which was comparable to those collected in 1993 (O'Dell 2016, p. 53). Wooly-threads typically germinate during the first significant rain event in the fall or early winter, after temperatures drop below 60 °F (55 °C) (O'Dell 2016, pp. 53–54; O'Dell 2024, p. 20). Additional winter rainfall is crucial for maintaining soil moisture, enabling the plants to grow and eventually flower (O'Dell 2016, pp. 53–54). Notably, high mortality rates tend to occur when there is little to no rainfall during the winter months following germination, or when delayed germination coincides with rising temperatures due to late rains (O'Dell 2016, pp. 53–54). While both the 1993 and 2015 studies observed relatively high survival rates under favorable climatic conditions, these results may not be representative of all years (O'Dell 2016, pp. 53–54). Consequently, further research was recommended to examine how variable annual climate parameters influence seedling survival (O'Dell 2016, pp. 53–54).

In 2017, the Bureau and UC Berkeley collaborated on a study on wooly-threads population genetics, emphasizing the importance of conserving genetic variability as a strategy for protecting vulnerable species. As a self-fertilizing plant, wooly-threads has an increased risk of extinction at sites with small population sizes due to reduced genetic diversity within metapopulations and the overall species range (Bainbridge et al. 2017, p. 1). Self-fertilizing species typically exhibit higher levels of homozygosity and lower effective population sizes, making landscape-scale conservation efforts essential for maintaining both population stability

and genetic diversity (Bainbridge et al. 2017, p. 1). The study utilized 881 tissue samples collected from various sites across the species' range in 2013, 2015, and 2016, as well as 27 herbarium accessions from locations where wooly-threads may have been extirpated (Bainbridge et al. 2017, p. 4). The findings revealed that more than 50 percent of the sites were composed entirely of homozygous individuals (Bainbridge et al. 2017, p. 19). The genetic and geographic analyses identified four to seven population subregions with genetic structuring within these subregions that should be factored into management plans (Bainbridge et al. 2017, p. 41). In particular, the Monocline-Panoche-Silver Creek subregion has high conservation value as it is likely the most genetically distinct subregion due to the presence of unique genes (Bainbridge et al. 2017, p. 41). The genetic differentiation is likely due to the founder effect, where the subregion was established by a small group of individuals representing a subset of the genetic diversity present in the species, and genetic diversity in the subregion stayed low or decreased due to isolation and limited gene flow over time (Bainbridge et al. 2017, p. 42). Due to these processes, this subregion has the lowest genetic diversity, so specific management recommendations were made to safeguard the unique genes in this subregion (Bainbridge 2015, entire; Bainbridge et al. 2017, pp. 42–44).

In 2021, the Bureau initiated a wooly-threads seed bulking program following insights from the population genetic study and recommendations from Bainbridge et al. (2015 and 2017, entire). Seeds had been collected in 2016 from five distinct genetic clusters representing high genetic conservation value in the northern subregion (Bainbridge 2015, entire; Bainbridge et al. 2017, pp. 42–44; O'Dell 2020a, pp. 6–22; O'Dell 2020b, pp. 5–18). To prevent cross-contamination between genetic clusters, five seed increase fields were established, each enclosed by a barrier fence (O'Dell 2020a, pp. 7, 14). By the 2024 growing season, seeds collected from Panoche Valley successfully germinated, yielding approximately 132,000 seeds, predominantly from disk fruit (O'Dell 2025, pp. 5–6). These seeds were used for population reintroduction efforts at three designated locations in Upper Panoche Creek in the northern subregion, where they will be monitored annually to assess their establishment and survival (O'Dell 2025, pp. 14–15). The Bureau plans to continue the seed bulking program to bolster the abundance and genetic diversity of wooly-threads.

Lastly, a thesis project completed in 2022 investigated the viability, longevity, and climatic tolerance of wooly-threads seeds (Excoffier 2022, entire). The first part of the study found that, overall, San Joaquin wooly-threads seeds have lower viability than seeds in the other three tested *Monolopia* species (Excoffier 2022, p. 22). However, this may be due to a greater proportion of immature seeds in the San Joaquin wooly-threads samples compared to the other tested species (Excoffier 2022, p. 28). The study also assessed the maximum longevity of wooly-threads seeds stored at room temperature, revealing that some (2 of 660) seeds from ray fruit were viable for up to 16 years (Excoffier 2022, p. 22). After five years, the average viability across seeds from both disk and ray fruit was 13 percent, and only one out of 10 samples had greater than 50 percent viability (Excoffier 2022, p. 22). Across the four tested *Monolopia* species, 98 percent of seeds were not viable after 10 years, which suggests to Bureau biologists that the natural seed bank of wooly-threads likely lasts no more than 10 years (O'Dell 2023, p. 6; O'Dell pers. comm. 2025). Therefore, if wooly-threads is not present at a site for a decade, it is probable that the seed bank is depleted, and the species may be extirpated from that location (O'Dell pers. comm. 2025). Additionally, the study revealed that wooly-threads seeds can withstand periods of extreme drought longer than the typical three to five year drought periods in the San Joaquin

Desert and western Mojave Desert, suggesting that the seeds may persist through the predicted drought conditions in the species range through the end of the century (Excoffier 2022, p. 34; O'Dell 2023, p. 6).

The second part of the study aimed to determine the minimum soil water availability threshold necessary for growth and survival to flowering among annual plants in the San Joaquin Desert, including wooly-threads. However, due to wooly-threads' failure to germinate, this aspect of the research was ultimately abandoned for this species (Excoffier 2022, p. 55). However, the closest relative, common monolopia (*M. lanceolata*), successfully survived throughout the experiment, allowing researchers to draw inferences regarding wooly-threads. The findings demonstrated that all participating annuals, including common monolopia, ceased to grow when soil water content dropped to 2 percent or lower, and none produced significant biomass or reproduction with less than three inches of precipitation per growing season (Excoffier 2022, pp. 55, 58; O'Dell 2023, pp. 6–7). Given the anticipated increases in temperature and prolonged drought periods resulting from climate change effects, wooly-threads are projected to face a decline that may lead to extirpation in the future, although the drought-tolerance of seeds may buffer the effects of drought on plants (Excoffier 2022, p. 82; O'Dell 2023, pp. 6–7).

Recovery criteria:
Recovery criteria for downlisting and delisting the San Joaquin wooly-threads are found in the Recovery Plan for Upland Species of the San Joaquin Valley (Service 1998, pp. 181, 185). Downlisting criteria for San Joaquin wooly-threads have been partially but not fully met, thus delisting criteria are not assessed here. The recovery goal is to maintain self-sustaining populations in protected areas representative of the former geographic and topographic range of the taxon and in a variety of appropriate natural communities (Service 1998, p. 49). Areas are considered secured and protected when they are (1) protected for open space purposes through fee title ownership or conservation easement and (2) secured from incompatible uses with San Joaquin wooly-threads.

Occurrence information is cited from the Diversity Database (2025, entire) and Bureau monitoring results (O'Dell 2025, Appendix 1). Land status information is cited from the California Conservation Easement Database (2023, entire), California Protected Areas Database (2023, entire), and the Bureau's Geospatial Business Platform (2024, entire).

Downlisting criteria

1) Secure and protect 95 percent of occupied habitat on public land from incompatible uses. In the recovery plan, public lands are defined as federal, state, and conservation lands (Service 1998, p. 225).
    a. 2010 status: **Not met.** The 2010 status review assessed all occurrences on public land at the time of the review. Twenty-four Diversity Database occurrences were found entirely on Bureau lands, while six occurrences were partially found on Bureau lands. Other Diversity Database occurrences were known on lands owned or managed by the Department or non-profit organizations. It could not be determined what percentage of habitat had been protected in perpetuity because the extent of protection in each parcel was unclear (Service 2010, pp. 5–6).
    b. 2025 status: **Fully met.** Under this criterion, we are assessing all occurrences on public land at the time the recovery plan was published, rather than all occurrences currently on

public land. 100 percent of occurrences on public land at the time the recovery plan was published is now secured and protected from incompatible uses. Public lands where the species occurs includes: Pleasant Valley Ecological Reserve, Panoche Valley Preserve, Semitropic Ecological Reserve, Carrizo Plain National Monument, Carrizo Plains Ecological Reserve, 2800 Acre Water Bank, and the following Bureau Areas of Critical Concern: Panoche/Coalinga, Kettleman Hills, and Upper Cuyama Valley (Bureau's Geospatial Business Platform 2024, entire; California Conservation Easement Database 2023, entire; California Protected Areas Database 2023, entire; Diversity Database 2025, entire; O'Dell 2025, Appendix 1). Areas of Critical Concern are designations on Bureau lands where special management requirements are in place to protect and preserve species with important historical, cultural, or scenic values (Service 2010, pp. 5–6). Livestock grazing occurs on most habitat occupied by wooly-threads on Bureau lands, but grazing is managed to be compatible with the species' needs (O'Dell *in litt.* 2025b, O'Dell 2013, p. 26–27).

2) Approve and implement management plans for all protected areas identified as important for continued survival.
   a. 2010 status: **Not met.** Bureau lands occupied by wooly-threads fell under the Bakersfield and Hollister Field Offices' jurisdictions. The resource management plan for the Hollister Field Office was finalized in 2007. The Bakersfield Field Office was revising its resource management plan at the time our status review was published in 2010 (Service 2010, p. 6). As the resource management plans were not fully implemented at the time our status review was published, this criterion was not met (Service 2010, p. 7).
   b. 2025 status: **Partially met.** Some wooly-threads occurrences on public lands have approved and implemented management plans. The Bureau Central Coast (formerly Hollister) Field Office has jurisdiction over the Panoche/Coalinga Area of Critical Concern and parts of the Kettleman Area of Critical Concern. The Bureau Bakersfield Field Office has jurisdiction over the remaining parts of the Kettleman Area of Critical Concern and the Carrizo Plain area. Both field offices have resource management plans in place, with the Bakersfield Field Office completing their plan in 2014. Both plans mention survival and appropriate management of threatened and endangered species as an objective (Bureau 2007, p. 35; Bureau 2014, p. 18). Furthermore, a Bureau management plan was established specifically for the Carrizo Plain National Monument in 2010, furthering the protection of vulnerable species in the area (Bureau 2010, entire). The Department made a draft of their land management plan for Carrizo Plains Ecological Reserve available to the public in 2019, but a final draft has not been published (Department 2019, entire). Management plans for other wooly-threads occurrences on public lands are not approved and implemented at this time.

3) Population monitoring in specified recovery areas shows stable or increasing numbers in all protected areas through one precipitation cycle. A precipitation cycle is defined as a period when annual rainfall includes average to 35 percent above-average through 35 percent below-average and back to average or greater.
   a. 2010 status: **Not met.** Consistent population surveys and monitoring did not occur so status and trends could not be assessed. Data that were collected showed a vast range in population numbers that was not consistent with a stable or increasing population (Service 2010, pp. 7–8).

b. 2025 status: **Partially met.** Of the protected areas, only the 122 suboccurrences monitored in 2009–2024 by the Bureau in the Panoche/Coalinga Area of Critical Concern and Panoche Valley Preserve are monitored regularly enough to assess population trends (see **Distribution and abundance**). In that area, average annual rainfall in 2009–2024 is 6.5 in (16.5 cm), 35 percent above-average is 8.8 in (22.4 cm), and 35 percent below-average is 4.2 in (10.7 cm). This monitoring time-period encompasses multiple precipitation cycles (see Figure 2). While population abundance fluctuates depending on environmental conditions, the wooly-threads populations in these monitored areas are likely stable and have large emergent populations when conditions are suitable, even after multiple years of low emergence numbers, due to the soil seed banks. Therefore, these protected areas contribute to meeting this criterion.

Conclusion:
After reviewing the best available scientific information, we conclude that San Joaquin wooly-threads remains an endangered 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 2020 status review remains an accurate reflection of the species' current status.

RECOMMENDATIONS FOR FUTURE ACTIONS

Here we propose several management, conservation, and research recommendations which will aid in the recovery and conservation of the San Joaquin wooly-threads. Some of these recommendations have already been discussed in previous recovery documents (Service 1998, p. 49; Service 2010, pp. 24–25; Service 2020, p. 5) and remain valid.

1. *Protect and restore occupied and suitable habitat.* All occurrences of San Joaquin wooly-threads should be protected and secured through land acquisition, conservation easement, or other means. In particular, wooly-threads in the Lost Hills genetic cluster and throughout eastern Kern, which are not on public lands, should be prioritized for protection as they are vulnerable to land conversion. Additional suitable but unoccupied habitat should be protected and restored, specifically areas in the west of the San Joaquin Valley, where development intensity is lower than the valley floor, that are adjacent to occupied areas.

2. *Consider genetic implications during introductions and reintroductions of the species.* Genetic management recommendations in Bainbridge (2015, pp. 1–2) and Bainbridge et al. (2017, pp. 40–44) should be incorporated in introduction and reintroduction plans. Due to the genetic structuring discussed in **Distribution and abundance**, barrier fences should be used to prevent seed mixing and cross-pollination between genetic clusters during seed bulking. Introductions and reintroductions should be prioritized in the northern portion of the range where the populations contain unique genes with high conservation value but overall low genetic diversity that makes the populations more vulnerable to extirpation.

3. *Conduct research on species ecology and life history.* Investigate the interaction between kangaroo rats and wooly-threads to inform management actions that may benefit multiple species. Estimate the seed bank sizes of different wooly-threads populations to gauge the

resiliency of each population under changing climate conditions, such as the likelihood of emergent individuals after multiple years of drought and unsuitable conditions.

4. *Compare and consolidate occurrence data.* Wooly-threads occurrence data is available from multiple sources, including the Diversity Database, Bureau, Plant Society, and Center for Natural Lands Management. However, occurrence data from different sources may use different survey methodology and different terminology to describe distribution and abundance. A standardized survey methodology for the species should be developed, and occurrence data should be compared and consolidated by developing a data crosswalk.

5. *Develop a Species Status Assessment*. For the next 5-year status review of the species, the Service should conduct a Species Status Assessment (SSA). The SSA will assess the current and future condition of the San Joaquin wooly-threads to help determine whether downlisting is appropriate.

Acting Field Supervisor, Sacramento Fish and Wildlife Office

Approve AMBER AGUILERA Digitally signed by AMBER AGUILERA Date: 2025.08.13 08:59:08 -07'00' **Date** _____

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APPENDIX

Table A. Number of suboccurrences found within the 11 unique genetic clusters discussed in **Distribution and abundance** during surveys in 2008–2024. Table obtained from O'Dell (2025, p. 5). Main colors (yellow, green, blue, and purple) correspond to four subregional structures. The gradient within each color shows further separation into each unique genetic cluster.

Genetic Cluster	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Panoche Valley East	0	0	0	0	0	0	0	0	34	34	34	48	49	49	50	81	81
Lower Panoche Creek	1	1	1	1	1	1	1	4	10	10	10	14	14	14	16	18	18
Silver Creek-Monocline	2	2	2	2	2	3	3	3	4	4	4	5	5	5	7	7	7
Mendota Plain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jacalitos Canyon	10	10	10	10	10	10	10	24	26	26	26	28	29	29	29	37	37
Pleasant Valley Ecological Reserve-Kettleman	44	49	49	49	49	49	49	59	116	117	117	163	168	170	214	460	464
Lost Hills	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	11	11
Middlewater Plain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Eastern Kern	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Carrizo-Elkhorn	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	14	14
Santa Barbara Canyon	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
TOTAL	**81**	**86**	**86**	**86**	**86**	**87**	**87**	**114**	**214**	**215**	**215**	**282**	**289**	**291**	**340**	**632**	**636**