

5-YEAR REVIEW

Chinese Camp Brodiaea (*Brodiaea pallida*)

GENERAL INFORMATION:

Species: Chinese Camp Brodiaea (*Brodiaea pallida*)

Date listed: October 14, 1998

Federal Register (FR) citation: 63 FR 49022 (Service 1998)

Classification: Threatened

State Listing:

Chinese Camp brodiaea was listed as endangered by the State of California in November 1978.

BACKGROUND:

Species overview:

Chinese Camp brodiaea is an erect, herbaceous perennial plant (Figure 1). It is known from three populations along limited stretches of intermittent streams in the western Sierra Nevada foothills of northern Tuolumne and southern Calaveras counties in California. Chinese camp brodiaea grows in overflow channels, seeps, and springs in clays that may be derived from serpentine soils (Safford et al. 2005, p. 246; Service 2008, p. 4). As with other brodiaea species, they reproduce through both asexual (daughter corms and vegetative growth of cormlets) and sexual reproduction (flowering stalks that produce seeds). Seedlings and plants from first-year cormlets are identical (Preston *in litt.* 2017).

The species has grass-like basal leaves that die back before the flowers appear atop scapes (slender, hollow flower stalks), which are 10 to 30 centimeters (3.9 to 11.8 inches) tall. The flowers are not differentiated into petals and sepals, but instead have six similarly-colored parts called tepals. Chinese Camp brodiaea typically have shiny lilac or pale purple tepals (Keator 1993, p. 1182), although some references have described the flower color as rose-pink (e.g., Niehaus 1971, p. 54; Service 1998, p. 49022). A few plants with dark bluish-colored flowers may be intermixed with the pale ones (Hrusa *in litt.* 2001). The flowers may darken as they dry (Hoover 1938, p. 129), and for this reason, fresh flowers are necessary for reliable identification (not pressed specimens).

A characteristic that distinguishes Chinese Camp brodiaea from most other species in the genus is that the flower tube is narrowed above the ovary (see photo showing perianth constriction; Figure 1). Harvest brodiaea (*B. elegans* ssp. *elegans*) is sympatric (overlapping in distribution) with Chinese Camp brodiaea, but can be differentiated because it does not have a narrowed flower tube, the flowers are larger and darker in color (blue-purple to violet), the staminodes are angled away from the stamens and differ in shape, and the flower lobes are not curved outward.



Figure 1. Chinese Camp brodiaea showing diagnostic perianth constriction slightly above the ovary. Photo credit: Jo-Ann Ordano, California Academy of Sciences

Most recent status review:

U.S. Fish and Wildlife Service. 2012. Chinese Camp brodiaea (*Brodiaea pallida*) 5-year review summary and evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 22 pp.

We did not recommend a status change in the 2012 status review.

FR notice citation announcing this status review:

U.S. Fish and Wildlife Service. 2021. Endangered and Threatened Wildlife and Plants; Initiation of 5-Year Status Reviews of 76 Species in California and Nevada. Federal Register 86:27462–27464.

We did not receive information from the public regarding Chinese Camp brodiaea 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 May 20, 2021. We also contacted species experts, performed a literature search, reviewed information from our own files, and obtained data from an occurrence search of the California Natural Diversity Database (Diversity Database) maintained by the California Department of Fish and Wildlife.

Since the last status review there have been monitoring surveys for two out of the three populations (addressed in **Abundance**), updates on threats and conservation (addressed in **Threats** and **Conservation**, respectively), and observations of Chinese Camp brodiaea hybrids (discussed in **Hybridization**).

Distribution:

The historical distribution of Chinese Camp brodiaea is not known, but it is likely that the species has always had a restricted range. At the time of listing, the species was only known from the town of Chinese Camp in Tuolumne County. At the time of our 2012 review (Service 2012, entire), two additional sites that support the species had been identified in southern Calaveras County, near Copperopolis, California. In the spring of 2000, the species was observed near the confluence of Sawmill Creek and Black Creek, and in 2010, the identification of plants from Littlejohns Creek was confirmed as Chinese Camp brodiaea by Barrett Anderson and Rob Preston after their initial detection in 2005 (Diversity Database 2019). The current species distribution of Chinese Camp brodiaea remains as described in our 2012 review (Service 2012, pp. 4–5): it is known to occur in at least three locations in different HUC12 (Hydrologic Unit Code) sub-watersheds (USGS 2013), all of which are on private lands (Figure 2).

For the purposes of this status review, we define a Chinese Camp brodiaea population as groups of plants within at least 3 kilometers (1.9 miles) of each other. Although this distance is outside the pollinator foraging distance of specialist pollinators, it is within the range of generalist pollinators, which makes it possible that pollination could occur over this distance. This differs from the way that element occurrences are defined in the Diversity Database, which defines an occurrence as a location occupied by the species that is separated by at least one-fourth mile from other locations that contain populations, individuals, or colonies of a species. Using the Diversity Database definition, the Littlejohns Creek site has three occurrences, but in this status review we lump these together as one population. This is consistent with the way that the occupied sites were treated in the 2012 review (Service 2012, pp. 4–5). Populations of Chinese Camp brodiaea at Chinese Camp, Sawmill/Black Creek, and Littlejohns Creek are described below.

Chinese Camp

At the time of listing, Chinese Camp brodiaea was described only from a reach of a stream no more than 1.2 kilometers (0.75 mile) long in an unnamed drainage in the Tuolumne River watershed at Chinese Camp. The site is approximately 384 meters (1,260 feet) in elevation (Niehaus 1971, p. 54). The species is usually found within the streambed and does not extend more than 10 meters (33 feet) out from the center (Skinner *in litt.* 1991).

The Diversity Database occurrence polygon of the Chinese Camp population is approximately 1.6 km in length, and occurs both to the north and south of Red Hills Road. South of the road, the Sierra Foothills Chapter of the California Native Plant Society (hereafter Plant Society) began leasing approximately one third of an acre of the site off of Red Hills Road in 1991, which was fenced in that year. The species is also found on privately owned lands north of the Plant Society fenced land, within the same watershed (Rogers 1982, p. 1). About half of the Chinese Camp population is found within the Plant Society fenced area, and half on private property north of Red Hills Road (Congdon *in litt.* 2017a). Observations in 2017 identified the species north of the Diversity Database polygon, and noted that the land to the south of the Plant Society fenced area does not appear to be good habitat for the species (Congdon *in litt.* 2017b).

Sawmill/Black Creek

Chinese Camp brodiaea grows in the channels of two converging intermittent streams, Sawmill Creek and Black Creek, in the watershed of the Stanislaus River above Tullock Reservoir (Diversity Database 2019). The site is approximately 168 meters (550 feet) in elevation. The species occurs for a total distance of approximately 4.8 kilometers (3 miles) along the two streams. During surveys conducted on June 2, 2008, surveyors found Chinese Camp brodiaea along a narrow band along the creek. Habitat with rock outcrops or gravel bars present had the highest densities of the plant and meadow areas had the lowest densities. Some reaches of the channels were dry and others were ponded with emergent tule marsh. The channel with tule marsh had few Chinese Camp brodiaea present (ICF Jones & Stokes 2009, p. 3).

Littlejohns Creek

A population along Littlejohns Creek occurs in three stretches, with elevations ranging from 171–206 meters (560–675 feet) (Diversity Database 2019). In all three stretches, Chinese Camp brodiaea grow within rocky substrate within the high water mark of the creek and were visible during periods of low flow and in summer months (Diversity Database 2019).

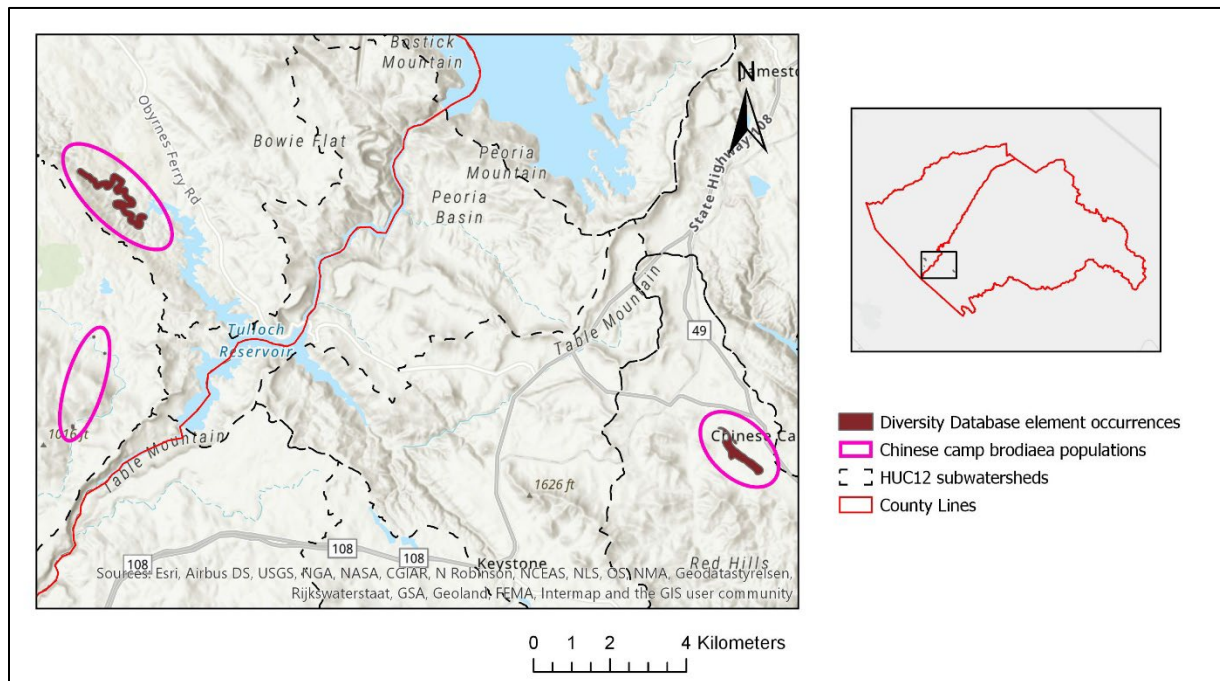


Figure 2. Distribution of Chinese Camp brodiaea populations. Each population is located in a separate HUC12 sub-watershed (USGS 2013; Wyoming Geographic Information Sciences Center 2014).

Abundance:

As perennial plants, Chinese Camp brodiaea individuals persist from year to year. Table 1 indicates survey estimates at the three known populations. It is important to note that the numbers in this document refer to above ground plant parts, whether genetic individuals or units of a clone. The number of flowering stalks is only an estimate of abundance because some plants

produce more than one flowering stalk, and because not all plants in a population bloom in any given year (ICF Jones & Stokes 2009, p. 2). In thread-leaved brodiaea (*Brodiaea filifolia*), a field study at the Santa Rosa Plateau Preserve revealed an 8:1 ratio of non-flowering corms to flowering plants (12.5 percent flowered), and that the number of flowering plants may vary up to tenfold from wet to dry years (Morey 1995, p. 2). At a residential development site in Carlsbad, California, less than 1 percent of thread-leaved brodiaea plants flowered (observation of 20 flowering plants in the spring in an area where contractors later dug up 8,000 corms that summer (Taylor and Burkhart 1992, p. 1-7)). Additionally, because of the prevalence of vegetative, or asexual, reproduction, and because no genetic analysis has been conducted, the numbers of genetically unique individuals in the populations are unknown.

Although the population at Chinese Camp was described as stable or increasing in the 1990s, the most recent visits have found small numbers of the plant within the Plant Society fenced area. Observations looking across to private property had substantially more flowering plants than the main population in 2017. At that time, the fenced area had very few pure Chinese Camp brodiaea and instead had more hybrids (see **Hybridization** below). It is difficult to determine an abundance trend at either of the Calaveras County populations because of limited surveys.

Table 1. Chinese Camp brodiaea abundance estimates or population trends and year(s) recorded.

Population	County	Year	Abundance/Trend	Source
Chinese Camp	Tuolumne	1982	1,600	Diversity Database 2019
Chinese Camp	Tuolumne	1990	1,600+	Diversity Database 2019
Chinese Camp	Tuolumne	1991	5,000	Diversity Database 2019
Chinese Camp	Tuolumne	1994	Increasing	Diversity Database 2019
Chinese Camp	Tuolumne	1999	Stable	Diversity Database 2019
Chinese Camp	Tuolumne	1992-2001	600–1,500 (in a small portion of the population)	Diversity Database 2019
Chinese Camp	Tuolumne	2007	Present	Diversity Database 2019
Chinese Camp	Tuolumne	2008	Present	Diversity Database 2019
Chinese Camp	Tuolumne	2017	0 (plus 3 hybrids)	Congdon <i>in litt.</i> 2017c
Chinese Camp/north of Diversity Database polygon	Tuolumne	2017	455	Congdon <i>in litt.</i> 2017b
Chinese Camp	Tuolumne	2018	52 (plus 24 hybrids)	Congdon <i>in litt.</i> 2018

Population	County	Year	Abundance/Trend	Source
Chinese Camp	Tuolumne	2021	10 in Plant Society fenced area and ~20 visible across the road	Krajnovich <i>in litt.</i> 2021a
Sawmill/Black Creek	Calaveras	2000	5,000+	Diversity Database 2019
Sawmill/Black Creek	Calaveras	2008	15,313	Diversity Database 2019
Sawmill/Black Creek	Calaveras	2017	6,800*	Forbes <i>in litt.</i> 2017
Littlejohns Creek	Calaveras	2005	112**	Diversity Database 2019

* Though 6,800 individuals were observed in flower in June 2017, one month later only 50 to 60 plants were observed due to effects of grazing. Survey at Sawmill Creek portion of the population.

** The approximately 112 plants in this population were divided among three stretches of the creek ranging from 11 to 69 individuals each.

Threats:

Prior to listing, large parts of the habitat of the type locality of Chinese Camp brodiaea were destroyed by non-permitted construction around 1982 (Rogers *in litt.* 1990). At the time of listing, the primary threat to the species was proposed construction of a subdivision. The listing rule also noted that uncontrolled collection or excessive visits by plant enthusiasts could become a threat following listing under the Act, and that small population size/habitat area of the only known population could increase susceptibility of extirpation from random demographic, environmental, or genetic events (Service 1998, p. 49028). In the 2008 and 2012 status reviews, proposed developments were still the primary threat to the species, and we did not make substantive changes to other threats included at listing (Service 2008, pp. 5–9; Service 2012, pp. 7–13). The 2012 status review (Service 2012, pp. 13–15) included nitrogen deposition, non-native vegetation, and climate change as additional threats. Appendix A includes a table that summarizes threats discussed in previous status reviews for this species and our current understanding of these threats. In addition, we provide updated information below related to threats from grazing and development; separate altered hydrology from development to describe different and separate potential impacts; and discuss hybridization as a potential future threat.

Grazing

In the final listing rule as well as in the subsequent status reviews, we noted that it is unclear whether grazing is beneficial or detrimental to Chinese Camp brodiaea (Service 1998, p. 49029; Service 2008, pp. 6–7; Service 2012, p. 9). Observation of herbivory are for the most part assumed to be from grazing, although it is also possible that herbivory by deer or other herbivores could impact the species. At this time, it appears that at least some level of grazing is likely beneficial to the species, but that herbivory between flowering and seed set could greatly impact sexual reproduction. The effects on plants from livestock grazing are highly variable and dependent on many factors, including but not limited to the timing, intensity, and duration of livestock use.

Negative impacts from grazing include direct consumption and habitat trampling. Grazing during flower development or blooming season could result in direct consumption of the above-ground parts of the plant (Niehaus 1977, p. 1), which can reduce or eliminate seed output. The potential for this to affect the species would be related to the grazing intensity, or the number of cattle or other livestock in an area. Although the primary method of propagation is asexual reproduction via corms, seed production is important for genetic diversity. Reduction in seeds could lead to short-term decreases in new growth, as well as limiting the ability of the species to produce a seedbank. Grazing can also result in trampling or soil compaction. While trampling from livestock could result in soil compaction, accelerated erosion of soils, and breaking of corms, the severity and magnitude of this stressor at any of the three known occurrences is unknown at this time. Trampling can also affect habitat by reducing rainfall infiltration rates (Warren *et. al.* 1986, pp. 493-494).

Although moderate-intensity cattle grazing at the Sawmill/ Black Creek location in 2008 was not thought to be having an adverse effect on Chinese Camp brodiaea plants (ICF Jones & Stokes 2009, p. 4), in 2017 severe damage to Chinese Camp brodiaea was noted (Brenneman *in litt.* 2017). Of the 6,800 plants counted in June of 2017, only 50 to 60 plants were counted in July of that year. At that time, the only surviving plants were found among the tall boulders inaccessible to grazing cattle.

While grazing at an inappropriate time or intensity can result in damaging effects to Chinese Camp brodiaea and its habitat, as stated above, it is possible for grazing to occur in a manner that supports and even encourages growth of Chinese Camp brodiaea. In areas that contain both Chinese Camp brodiaea and non-native plants, grazing that occurs after seed has matured and before substantial leaf emergence/flower development may be beneficial in reducing competing vegetation. The consumption and removal of non-native plants would increase bare soil areas, sunlight exposure, and access to water and minerals.

In April 1991, The Nature Conservancy and the Plant Society purchased and installed fencing and gates surrounding the Chinese Camp brodiaea population at Chinese Camp to protect the population from the effects of grazing (Lozier *in litt.* 1991; Stone *in litt.* 2001). At that time, the Plant Society also entered into a lease agreement with the landowner, paying him to exclude his cattle from the area for one year. Though to our knowledge this agreement has ended, the area is still ungrazed and the fencing and gates remain. The area has experienced an increase in weedy species such as barbed goatgrass (*Aegilops triuncialis*), wild oat (*Avena fatua*), tarweed (*Hemizonia* spp.), and spikeweed (*Centromadia pungens*) in recent years (Congdon *in litt.* 2018). Though annual trend data are not available, it is likely that the removal of cattle at the Chinese Camp population precipitated the increase in these non-native invasive plants and a decrease in Chinese Camp brodiaea. Therefore, it is likely that appropriate grazing, managed to reduce competing non-native plants, may have a beneficial effect on the species at the Chinese Camp site.

Development

Because all three Chinese Camp brodiaea populations are located on privately owned lands that are vulnerable to development impacts, with no provision for protection or management, development continues to be a threat. The General Plans for both Calaveras County and

Tuolumne County were updated in November 2019 and December 2018, respectively (Calaveras County 2019, entire; Tuolumne County Community Resources Agency 2018, entire).

Potential development in Calaveras County threatens both populations in that area. Black Creek Ranch, which contains the Sawmill/Black Creek population, was slated for development as of the last status review (Service 2012, p. 8). The property was recently sold to a different developer that plans to proceed with residential development on the hilltops surrounding the plants (Lewis *in litt.* 2020). Portions of the property that contain Chinese Camp brodiaea will not be developed according to the most recent plans, but the plant could still be affected by any increased run-off or irrigation. Also in Calaveras County, Sawmill Lake is a planned future community that consists of a 245-acre extension to the Copperopolis Town Square upstream of the Chinese Camp brodiaea occurrences and Copper Valley Ranch is a future community that is being developed on the North Shore of Lake Tulloch. An online website (Copper Valley Realty 2020) that has since been removed included detailed information about the type of residential units planned for the development; however, that information is no longer available and we are not aware of the current status of this project. A motion to amend the land use of Copper Valley from Resource Production to Working Lands, which would allow increased residential development of those lands, was voted down at a June 2019 planning commission meeting (Calaveras County Planning Commission 2019).

Overlaying the Calaveras County General Plan with Diversity Database occurrences of Chinese Camp brodiaea shows that the Sawmill/Black Creek population occurs on lands labeled as Resource Production, Working Lands, and Rural Residential, and that the Littlejohns Creek population is on parcels labeled as Working Lands and Resource Production (Calaveras County Open Data 2021). Descriptions of the land use designations are provided in the general plan (Calaveras County 2019, pp. LU5–LU7). Briefly, Resource Production identifies lands capable of and primarily used for agricultural operations, timber production and/or mineral resource production, and also includes lands with conservation easements. Working Lands have a slightly higher population density than Resource Production (0.06–0.12 person/acre compared to 0.015–0.06 person/acre) and are generally on smaller parcels than lands designated as Resource Production, but are still suitable for agricultural and forestry practices. The Rural Residential designation identifies rural residential uses in areas appropriate for or that were previously subdivided into lots of one acre or larger where public sewer is not available. The development agreement for the Oak Canyon Ranch development project (upstream of the Black Creek/Sawmill Creek and Littlejohns Creek populations) that was described in the previous status review (Service 2012, pp. 7-8) was rescinded in 2018. Oak Canyon Ranch is now under conservation easement (California Rangeland Trust 2020) (see *Land protection* below).

In Tuolumne County, proposed development projects described in the previous status review (Service 2012, p. 8) include development of 93 hectares (230 acres) at a private ranch, as well as an unnamed project at the junction of Highway 108 and Highway 120. The private ranch includes Chinese Camp brodiaea on the property, while the latter project could have potential impacts to hydrology. In 2016, the Tuolumne County Planning Department reported that both of these projects were on hold because of a lack of water accommodations (Paszkowski pers. comm. 2016). As of 2021, there is no active project for development at the private ranch. The Highway 108/120 junction project requires an Environmental Impact Report and there is no date or timeline for the project moving forward (Rizzi *in litt.* 2021).

Altered hydrology

Changes to the amount and/or inundation period of water in, upstream, or adjacent to Chinese Camp brodiaea habitat could impact the species. These changes could occur through a variety of mechanisms including, but not limited to, development, land use changes, increases in the frequency and severity of precipitation events associated with climate change (both deluges and droughts), and vegetative community changes. Development can lead to increased flows if irrigation or other sources discharge into streams, or can reduce flows if water is diverted away from the natural flow. For example, summer irrigation or upstream drainage (Tuolumne County Planning Department 1982, p. 3), or damming of a stream (Hrusa pers. comm. 2000 in Service 2008, p. 6) could lead to perennially wet conditions and prevent required drying of the soils supporting Chinese Camp brodiaea. Vegetation impeding drainage through a culvert near the Chinese Camp population has been observed in association with ponding above that area, which could make that habitat unsuitable for Chinese Camp brodiaea if excessive inundation causes corms to rot (Congdon *in litt.* 2020).

Land has been increasingly converted to cannabis farms in Calaveras and Tuolumne Counties, which can also alter hydrology. Land converted to this use, especially when irrigation water is illegally diverted from natural waterways, has the potential to impact Chinese Camp brodiaea habitat. The Calaveras County Board of Supervisors legalized commercial cannabis cultivation for approximately 190 formerly registered growers in 2018, despite objections from some that the county's environmental impact report does not address foreseeable impacts to water resources (Calaveras Enterprise 2019). Information has not been gathered to date on the total amount of water used, the extent of fertilizer and pesticide use, and the extent of habitat destroyed by cannabis cultivation. In Tuolumne County, commercial grows of cannabis are not legal (Tuolumne County 2021). A personal grow cannabis ordinance that passed in 2018 requires those planning outdoor grows to register for a permit and limits the number of plants allowed (Tuolumne County 2018, pp. 17-166–17-168).

Increases in greenhouse gas emissions during the 20th century have already resulted in global climate change characterized by: warming atmospheric and ocean temperatures, diminishing snow and ice, and rising sea levels (Intergovernmental Panel on Climate Change 2014, pp. 2–3). Climate change in the Sierra Nevada region specifically is predicted to lead to increases in temperature and extreme precipitation events (i.e., both deluges and droughts); a change in the elevation of transition from rainfall to snow, and more rainfall instead of snow at higher elevations; and substantial decreases in snowpack. Because the watersheds containing Chinese Camp brodiaea habitat are influenced by local rainfall rather than snowmelt (Preston *in litt.* 2020), changes to snowfall and snowpack are unlikely to impact the species. The increase in precipitation extremes (i.e., both deluges and droughts) may have a bigger impact on Chinese Camp brodiaea populations than the changes in average rainfall and snowfall.

Hybridization

A potential future threat to the species is hybridization with harvest brodiaea (*Brodiaea elegans*), a related native species common on drier ground (Niehaus 1971, p. 54). Because we have no information that hybridization is currently spreading or causing a trend towards endangerment or extinction, we do not consider hybridization a current threat to the species; however, additional

information about current trends or increases in the extent or areal coverage of hybrids could change this assessment. Hybridization could be a potential threat in the future because harvest brodiaea is associated with drier habitat and altered hydrology that reduces stream flow could theoretically increase populations of hybrids.

Hybrids can be distinguished from either of the two parent species by their appearance. Specifically, Chinese Camp brodiaea have staminodes near stamens and are not appressed to tepals, giving a “waist-like” appearance, whereas harvest brodiaea have staminodes held away from stamens and appressed to tepals (no waist); hybrids are intermediate between the two in these respects (Congdon *in litt.* 2020). At the time of listing, the Service specified that it was not listing hybrids between Chinese Camp brodiaea and harvest brodiaea (Service 1998, p. 49022). To our knowledge all hybrids occur in the immediate vicinity of the Chinese Camp population of Chinese Camp brodiaea.

Surveys in 2017 for Chinese Camp brodiaea at Chinese Camp found that predominantly hybrids appeared to be present within the Plant Society fenced area (Congdon *in litt.* 2017c), but in 2018 there were more Chinese Camp brodiaea than hybrids (Congdon *in litt.* 2018). Harvest brodiaea is common at that site, but uncommon at the sites in Calaveras County (Hrusa *in litt.* 2001).

Conservation:

Land protection

Land protection can temporarily or permanently restrict development and land use changes. In this section we describe land protection of an area upstream of the Calaveras County populations. As described above, all three populations are located on privately owned lands without temporary or permanent protections.

Oak Canyon Ranch, containing 1,318 hectares (3,256 acres) and including segments of Sawmill and Littlejohns Creeks upstream of known Chinese Camp brodiaea populations, was permanently protected through a conservation easement in 2020 (California Rangeland Trust 2020). Prior to the recording of this easement, the land was temporarily protected through a Williamson Act contract (also known as the California Land Conservation Act), which consisted of a voluntary agreement between private land owners and the county to restrict land to agricultural and open space uses in exchange for tax reductions. The land use and zoning of the property for 17 parcels contained within the Ranch was amended to Natural Resource Land, Agricultural Preserve when the land was placed under the contract (Calaveras County Planning Commission 2018a; Calaveras County Planning Commission 2018b).

Seed banking

Seed banks are a common tool for long term preservation of genetic diversity of plants. Seeds stored in seed banks can also be used in recovery strategies, including, but not limited to, outplanting to supplement existing populations or establish new populations, and species-specific research such as germination techniques or habitat needs.

Chinese Camp brodiaea seeds collected in 2017, including 549 seeds from 15 maternal lines, are banked at the University of California Botanic Garden at Berkeley (Forbes *in litt.* 2020). We are not aware of any studies on germination of seeds from storage.

Recovery criteria:

There is not a published recovery plan for the Chinese Camp brodiaea.

Conclusion:

After reviewing the best available scientific information, we conclude that Chinese Camp brodiaea 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 2012 status review (Service 2012, entire) remains an accurate reflection of the species' current status.

RECOMMENDATIONS FOR FUTURE ACTIONS:

Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Chinese Camp brodiaea. Some of these recommendations have already been discussed in previous recovery documents (Service 2008, pp. 9–10; Service 2012, p. 15) and remain valid.

1. *Complete and publish a draft recovery plan, and approve a final recovery plan.* The recovery plan will likely contain additional information about many of the elements described in the recommendations below.
2. *Habitat protection.* Work with private landowners to provide permanent protection for lands upstream and occupied by Chinese Camp brodiaea.
3. *Habitat management.* Work with private landowners and partners to implement habitat management practices that benefit Chinese Camp brodiaea. Volunteers from the Plant Society have expressed interest in helping to maintain the Plant Society fenced area (e.g., pulling weeds) given appropriate guidance from species experts and support from the land owner (Krajnovich *in litt.* 2021b).
4. *Monitor known populations.* Work with private landowners to determine the entire extent of the extant populations and monitor the status and trends of Chinese Camp brodiaea in order to estimate current population sizes (i.e., number of above-ground stems), the number and distribution of populations, and whether those populations are stable, increasing, or declining.
5. *Seed collection and accession.* Work with private landowners to obtain permission for seed collection if possible. Collect mature seed over a minimum of two years from the Sawmill Creek/Black Creek and Littlejohns Creek populations. Collect seed from no more than 5 percent of plants at each population in each year and store in at least two locations approved by the Service in the event that the population(s) fails. Seed storage

locations should be affiliates of the Center for Plant Conservation and seed collection should follow best plant conservation practices (Center for Plant Conservation 2019).

6. *Survey for additional populations.* Continue surveying for Chinese Camp brodiaea in suitable habitats on substrates other than serpentine to determine if additional populations exist.

Field Supervisor, Sacramento Fish and Wildlife Office

Approve _____ **Date** _____

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Appendix A

Summary of threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Endangered Species Act starting at listing and progressing through current threats. Additional information on some current threats is provided in the main text of this status review.

Factor	Threat	Listing Rule (1998) (1 population: Chinese Camp)	Status Review (2008) (2 populations: Chinese Camp and Sawmill/Black Creek)	Status Review (2012) (3 populations: Chinese Camp, Sawmill/Black Creek, and Littlejohns Creek)	Current (3 populations: Chinese Camp, Sawmill/Black Creek, and Littlejohns Creek)
A	Development	Primary threat to the species. Proposed construction of a subdivision would divide some of the habitat for the only known population into parcels, impacting about half of the individual plants.	Identified as a moderate threat to the species because of potential plans for development across Calaveras and Tuolumne Counties, but no immediate plans in place. Proposed future residential in Calaveras County and potential development in Tuolumne County were noted. Residential development outside of occupied habitat could also impact the species by altering hydrology or increasing risk of trampling.	Development and related changes to hydrology discussed as moderate to high level threats. Specific projects include: Oak Canyon Ranch Development Project (permitted; upstream of occupied habitat), Black Creek Ranch development (proposed; includes occupied habitat), and several other projects (outside of occupied habitat in planning phases) in Calaveras County; and, the Sinclair Ranch Project and an unnamed project, both proposed, in Tuolumne County.	Primary threat to all three populations.
A	Altered hydrology				Potential threat to all three populations.
B	Overcollection	Listed as a potential threat from increased notoriety upon listing	No change since listing	No change since the last status review.	No new information

Factor	Threat	Listing Rule (1998) (1 population: Chinese Camp)	Status Review (2008) (2 populations: Chinese Camp and Sawmill/Black Creek)	Status Review (2012) (3 populations: Chinese Camp, Sawmill/Black Creek, and Littlejohns Creek)	Current (3 populations: Chinese Camp, Sawmill/Black Creek, and Littlejohns Creek)
B	Overutilization for recreational purposes	Listed as potential threat due to visitation by rare plant enthusiasts after listing	No indication that this threat has increased since listing, and not considered a significant threat at this time.	No new information	No new information
C	Grazing	Mentioned, but indicates that there is no evidence whether grazing is beneficial or detrimental	No change since listing, and not considered a significant threat at this time. No information on existence or extent of grazing in species' habitat in Tuolumne County; grazing not occurring in the Calaveras County population.	No change in threat assessment since the last status review. Moderate cattle grazing was observed at the largest known occurrence in Calaveras County.	Some level of grazing likely to have a positive impact by reducing competition with non-native plants, but inappropriate levels of grazing (over- or under-) likely a threat to the species.
E	Small population size	The limited range of the species, in combination with past habitat destruction, resulted in small population size/habitat area of the only known population at this time and could reduce the species' ability to withstand demographic or environmental stochasticity.	No change since listing	No change	No new information, although the presence of three populations likely reduces the severity of the threat in comparison to the time of listing.
E	Lack of genetic diversity	Mentioned in concert with small population size.	Discussed as a possible threat because of the tendency towards vegetative reproduction and physical distance between the two populations.	No change	No new information, although the presence of three populations likely reduces the severity of the threat in comparison to the time of listing.

Factor	Threat	Listing Rule (1998) (1 population: Chinese Camp)	Status Review (2008) (2 populations: Chinese Camp and Sawmill/Black Creek)	Status Review (2012) (3 populations: Chinese Camp, Sawmill/Black Creek, and Littlejohns Creek)	Current (3 populations: Chinese Camp, Sawmill/Black Creek, and Littlejohns Creek)
E	Nitrogen deposition			Discussed as a general threat in relation to air pollution from vehicles and power plants	Not considered a significant threat in this region.
E	Non-native vegetation			Identified as a threat due to competition for space, and potential impacts to pollination. Non-native plants occur in habitat of at least two of the populations.	Likely a threat, particularly in habitat excluded from grazing.
E	Impacts to pollinators			Discussed as a potential threat associated with developments, which could increase use of insecticides or other pesticides or runoff of chemicals.	No new information
E	Climate change			Discussed in broad terms in relation to overall temperature increases, and disruption of weather patterns that could influence habitat and/or predators, parasites, and diseases.	No new information
E	Hybridization				Possible future threat, primarily Chinese Camp population