

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

California Endangered Species Act



5-Year Species Review for Lake County stonecrop (*Sedella leiocarpa*)

Report to the Fish and Game Commission

JUNE 2024



Cover Banner (Alternative text: San Joaquin Valley habitat image overlaid by CDFW shield and text "California Department of Fish and Wildlife [line break] California Endangered Species Act")

Cover photo by Cherylyn Burton (Alternative text: A closeup photograph of a small, fleshy, yellow and red plant with small, single yellow flowers that are subtended by bracts, which are yellowish-red and pointy leaves longer than the flower petals at the end of the stem.)

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III. EXECUTIVE SUMMARY

Lake County stonecrop (*Sedella leiocarpa*) is currently listed as endangered under the California Endangered Species Act (CESA). Pursuant to Fish and Game Code section 2077, subdivision (a), the California Department of Fish and Wildlife (Department) has prepared this Five-Year Species Review to evaluate whether conditions that led to the original listing of this species are still present. This species review is based on the best scientific information currently available to the Department regarding each of the components listed under section 2072.3 of the Fish and Game Code, and Section 670.1, subdivisions (d) and (i)(1)(A), of Title 14 of the California Code of Regulations. In addition, this document contains a review of the species' habitat that may be essential to its continued existence, and the Department's recommendations for management activities for recovery of the species (Fish & G. Code, § 2077, subd. (a)).

Lake County stonecrop is an extremely small, reddish-yellow, annual plant. The species grows on the edge of vernal pools. Its current range covers about 1.2 ha (3 ac). Its current distribution consists of four extant occurrences and one possibly extirpated occurrence. The last complete census of the species was in 1986 with only 4,400 individuals, down from 59,000 or more plants counted in 1975. The counts at any single occurrence have been below 1,000 individuals.

The Department identified habitat destruction and modification, limited distribution, small population sizes, and human-related activities as the most immediate threats of extinction. Additional threats to the species include competition from plants, herbivory and trampling, and climate change. There is currently no active management for the species at any of its presumed extant occurrences. Recommendations for management include landowner outreach, establishment of conservation easements, improvement to vernal pool hydrological function, monitoring efforts, surveys for new populations and suitable habitat, and seed collection for long-term conservation storage.

After reviewing the best available scientific information, the Department determined there is sufficient scientific information to indicate that the conditions that led to the original listing of Lake County stonecrop as endangered are still present and recommends no change to the status.

IV. INTRODUCTION

A. Five-Year Species Review

This Five-Year Species Review (Species Review) addresses Lake County stonecrop (*Sedella leiocarpa* H.K. Sharsmith, synonym *Parvisedum leiocarpum*), which is designated as an endangered species under the California Endangered Species Act (CESA) (Fish and G. Code § 2050 et seq.; Cal. Code Regs. tit. 14 § 670.2, subd. (a)(11)(C)). Upon a specific appropriation of funds by the Legislature, the California Department of Fish and Wildlife (Department) shall, or if other funding is available, in the absence of a specific appropriation, may, review species listed as endangered or threatened under CESA every five years to determine if the conditions that led to the original listing are still present (Fish and G. Code § 2077, subd. (a)). Lake County stonecrop is also listed as endangered under the Federal Endangered Species Act. The Department contacted the United States Department of the Interior, U.S. Fish and Wildlife Service (USFWS) on January 5, 2023, to request coordination with their five-year review for Lake County stonecrop (Fish & G. Code, § 2077, subd. (b); A. Aguilera and E. Tattersall, 2023, USFWS, pers. comm.). The USFWS completed a species review for Lake County stonecrop in 2009 and is due to complete another review in 2024 (S. Hibbs, 2023, USFWS, pers. comm.).

Using the best scientific information available to the Department, this Species Review includes information on the following components pursuant to section 2072.3 and section 2077, subdivision (a), of the Fish and Game Code and section 670.1, subdivision (d), of Title 14 of the California Code of Regulations: species' population trend(s), range, distribution (including a detailed distribution map), abundance, life history, factors affecting the species' ability to survive and reproduce, the degree and immediacy of threats, the impact of existing management efforts, the availability and sources of information, identified habitat essential for the continued existence of the species, and the Department's recommendations for future management activities and other recovery measures to conserve, protect, and enhance the species.

B. Listing and Review History

On July 1, 1988, the Fish and Game Commission (Commission) received a petition to list Lake County stonecrop as endangered (Patterson 1988) pursuant

to CESA (Fish & G. Code, § 2050 et seq.). On August 26, 1988, the Commission determined the petitioned action may be warranted and accepted the Petition for consideration (Fish & G. Code, § 2074.2). In August 1989, the Department provided the Commission with a Status Review (CDFG 1989) and a recommendation to list the species as endangered. In January 1990, Lake County stonecrop was listed as endangered by the Commission under its previous scientific name *Parvisedum leiocarpum*. At the time of the initial listing the main identified threats to the species included: present or threatened modification or destruction of its habitat, predation, and limited distribution and small population sizes (CDFG 1989). After taxonomic considerations, the scientific name of Lake County stonecrop was changed from *Parvisedum leiocarpum* to *Sedella leiocarpa*, and the California Code of Regulations (OAL 2006) was updated on May 26, 2006, to reflect that change.

On June 18, 1997, the USFWS listed Lake County stonecrop as endangered under the Federal Endangered Species Act. The USFWS identified the following threats to the species: alterations to hydrology, conversion of habitat to agriculture, effects from road maintenance or widening activities, effects from off-road vehicle use, effects from livestock use on habitat, and random natural events from the combination of a restricted range and limited size and number of populations (USFWS 1997, 2009).

This Species Review was prepared by Mariel Boldis, in the Department's Habitat Conservation Planning Branch, Native Plant Program.

C. Notifications and Information Received

On the following dates, the Department either sent formal notifications announcing the commencement of the review of Lake County stonecrop, or received information in response to its notifications:

- November 26, 2019—the Department notified persons who had expressed their interest in CESA actions in writing to the Commission and had provided contact information to the Commission (Fish and G. Code, § 2077(a)). The e-mail notification included a link to the Department's dedicated web page for five-year species reviews of threatened and endangered species at <https://www.wildlife.ca.gov/Conservation/CESA/Five-Year-Reviews>.

- August 3, 2023—the Department sent 26 Tribal Notification letters (paper and electronic) to the list of tribes provided by the California Native American Heritage Commission that are within the species range of Lake County stonecrop.
- November 1, 2023—the Department followed up with the Tribes that had not yet responded to the Tribal Notification letters sent by the Department.
- The Department received responses from two Tribes. No information was received in time to be included in this Species Review, but any information received at a later date will be retained by the Department for future management, recovery, or reviews of the species.

The Department also conducted a literature review and individually contacted, on various dates, local botanists, the California Department of Transportation (Caltrans), the California Native Plant Society Sanhedrin Chapter, Lake County Resource Conservation District, and private landowners in the areas where Lake County stonecrop occurs. In Spring 2023, the Department joined Caltrans to survey for Lake County stonecrop at one occurrence within the current range in Lake County, California. In Fall 2023, the Department met with staff managing a private vineyard at an occurrence of Lake County stonecrop on the vineyard property to discuss conservation opportunities and future botanical surveys.

D. California Native People and Traditional Ecological Knowledge

California Native People have lived alongside Lake County stonecrop for time immemorial and they have an important role in the life histories of many of the state's fish, wildlife, and native plants. California Native People possess unique and valuable knowledge and have long served as stewards of the land for conserving and sustainably using native plants. When available, including traditional ecological knowledge and practices alongside western science, supports a deeper understanding of a species' life history and management for its recovery.

The Department sought to include traditional ecological knowledge and practices related to Lake County stonecrop and its habitat in this Species Review. Two Tribes contacted the Department and indicated they would review their available resources that may relate to Lake County stonecrop and provide

a response in the future. The Department is committed to seeking and establishing meaningful engagement with Tribes and tribal communities to ensure collaboration and incorporation of mutually agreed upon principles of co-management in discussions of Lake County stonecrop conservation.

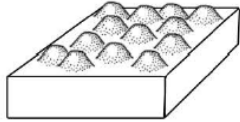
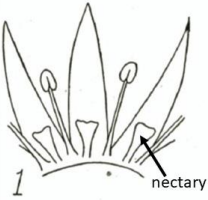
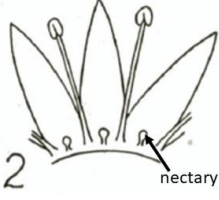

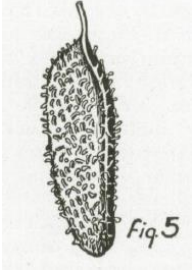

V. BIOLOGY

A. Physical and Taxonomic Description

Lake County stonecrop is an extremely small, annual succulent with reddish stems that is only 2.5-5 cm (1-2 in) tall (Boyd 2012a). The leaves are fleshy, less than 6 mm (0.25 in), and they fall off the stem before the plant flowers; however, bracts (small leaflike structure beneath the flower) persist on the plant long after flowering. Lake County stonecrop has tiny, bell-shaped flowers that are pale yellow to chartreuse with reddish lines on the back of the petals. The flowers are crowded together in two rows on curving stems, all on the same side. Each flower has five small petals (2.5–3.8 mm; 0.10-0.15 in long), that are slightly fused at their base. Each petal has a flattened, reddish, nectar-producing gland attached at its base called a nectary. These nectaries are large (0.5-0.8 mm; 0.02-0.03 in long), conspicuous, red, and club-shaped. The fruits are dry, hairless, and 1.5-2.5 mm (0.06-0.10 in) long. Each fruit contains a single seed that is <2 mm (0.08 in).

Lake County stonecrop was first described by Helen K. Sharsmith in 1940 as *Sedella leiocarpa* (Sharsmith 1940). In 1946, the name was changed to *Parvisedum leiocarpum* by R.T. Clausen (Clausen 1946) because the genus *Sedella* was used for a different group of plants. In 1997, Moran returned to using *Sedella leiocarpa* after a different taxonomist determined that the genus *Sedella* was used improperly for the aforementioned group of plants (Moran 1997). The genus *Sedella* contains three species (Lake County stonecrop, Mt. Hamilton mock stonecrop (*S. pentandra*), and Sierra mock stonecrop (*S. pumila*)), all of which grow in California (Table 1). Lake County stonecrop's petals, fruits, and seeds are larger than those of Mt. Hamilton mock stonecrop, and Lake County stonecrop has five stamens compared to 10 stamens found in Sierra mock stonecrop (Boyd 2012a, 2012b, 2012c). The nectaries of Lake County stonecrop are red and are larger than the other two stonecrop species (Sharsmith 1936, 1940).

Table 1. Traits to distinguish between Lake County stonecrop, Mt. Hamilton mock stonecrop, and Sierra mock stonecrop (Sharsmith 1936, 1940; USFWS 2005; Boyd 2012a, 2012b, 2012c). Defining features for Lake County stonecrop are underlined. Sources for the following images: carpel papillae surface (Wilhelm and Rericha 2017), nectaries (Sharsmith 1940), fruits (Sharsmith 1936, 1940).

Trait	Lake County stonecrop	Mt. Hamilton mock stonecrop	Sierra mock stonecrop
Stems	lower branches shorter than main stem	lower branches always shorter than main stem	lower branches as long as main stem
Petals	2.5–3.8 mm (long); pale yellow	1.3–2 mm (short); greenish-yellow	4-7 mm (longest); straw yellow
Carpel (style, stigma, ovary)	<u>Glabrous (without hairs) and smooth</u>	smooth or with glandular papillae (glands on bumps)	Fringed row of papillae (bumps) along suture
			
Stamens	five	five	ten
Nectaries	<u>large, red, club-shaped</u>	small, club-shaped	none
			
Fruit	glabrous surface	stipitate-glandular (glands on end of hairs)	glabrous to glandular
			

B. Life History and Ecology

As an annual, endemic vernal pool plant, Lake County stonecrop grows in pools with short inundation (i.e., flooding) periods from seed produced in previous years that remains in and on the soil. Endemic vernal pool plants naturally have variable seed production from year to year due to inconsistent environmental factors that influence germination, flowering, and successful pollination (Bliss and Zedler 1998; Sloop and Brown 2012). Lake County stonecrop seeds likely germinate sometime during the fall and winter wet season, and plants grow to maturity in the following months. Lake County stonecrop blooms from mid to late spring in April and May.

Given that vernal pools are patchy and can be separated by long distances, much like islands (Zedler 2003), pollinator visitation is highly important for reproductive success. The pollinators for Lake County stonecrop are unknown. The large, red nectaries attached to the petals of Lake County stonecrop suggest that the flowers are insect-pollinated (USFWS 2005). Many vernal pool plants that co-occur with Lake County stonecrop (e.g., *Lasthenia* spp., *Downingia* spp., *Limnanthes* spp.) can have very specific insect pollinators which coincide with the timing of emergence for both the pollinators and plants of interest (CDFG 1989; Thorp and Leong 1996; Thorp 2014; Gilmore 2018). Different types of pollinators may drive selection of floral traits (e.g., flower color, nectary size) which are known as pollinator syndromes (Waser et al. 1996; Rosas-Guerrero et al. 2014). These pollinator syndromes can be used to form hypotheses on the type of pollinator(s) most likely to visit. Lake County stonecrop has small, yellow flowers that open during the day with upright, bell-shaped corollas and large, red nectaries. These characteristics resemble pollinator syndromes associated with pollination by flies (excluding carrion and long-tongued flies), bees, and butterflies (Rosas-Guerrero et al. 2014). Pollination by flies may be most likely, especially during prolific bloom years for Lake County stonecrop (Lanuza et al. 2023).

Burke's goldfields (*Lasthenia burkei*), another state and federally-endangered plant which grows with and has an overlapping blooming period with Lake County stonecrop, has a strong association to *Conophorus cristatus* (a bombyliid fly), and is also pollinated by bees (Sloop and Brown 2012; Gilmore 2018). Given what we know about vernal pool endemism, pollinator associations with Burke's goldfields and inferences of pollinator syndromes with Lake County

stonecrop, the likelihood of the same pollinators visiting both Burke's goldfields and Lake County stonecrop may be high (Cross and Bohart 1960; Faist et al. 2015; Gilmore 2018). Although these predictions are not always accurate, the likelihood of correctly predicting a pollinator from only a few floral traits has shown to be highly supported (Ollerton et al. 2009; Rosas-Guerrero et al. 2014; Dellinger 2020; Lanuza et al. 2023).

Seed dispersal is likely limited to its immediate vicinity since the seeds remain inside the fruits, and the fruits remain attached to the plants after senescence, ensuring the seeds do not stray far from the pool edge (Moran 1997). Many vernal pool species have evolved ways to prevent seed dispersal (e.g., glabrous surface of fruit) with the benefit of remaining within their specialized habitat as a way to maximize their potential to persist (Witham et al. 2018).

VI. DISTRIBUTION AND ABUNDANCE

A. Range and Distribution

Range is the general geographical area in which an organism occurs. For purposes of CESA, the range is the species' California range only (*Cal. Forestry Assn. v. Cal. Fish and Game Com.* (2007) 156 Cal.App.4th 1535, 1551). Species distribution describes the actual sites where the species occurs within the species' range.

The range of Lake County stonecrop is entirely within Lake County, between 4 km (2.5 mi) and 18 km (11 mi) south of Clear Lake. (Patterson 1986; USFWS 2005). The western-most occurrence is about 12 km (7.5 mi) southeast of the City of Kelseyville and the eastern-most occurrence is about 11 km (7 mi) southeast of the city of Clearlake. At the time of listing, the total known range (based on specimen collections) encompassed an area within a 16 km (10 mi) radius from Seiglar Springs, which is 8 km (5 mi) south of Clear Lake (CDFG 1989). The USFWS indicated the extant occurrences of the species' range now covers a total area less than 1.2 ha (3 ac) (USFWS 2009), likely due to habitat modification or conversion where specimens were once collected from.

The current distribution of Lake County stonecrop consists of five populations that are documented by the California Natural Diversity Database (CNDDDB) as five Element Occurrences (EOs; Figure 1). The CNDDDB is an inventory of the

status and geographical locations of rare plants and animals in California that is managed by the Department. These EOs are mapped populations greater than 0.4 km (0.25 mi) apart (Table 2, Figure 1). It is important to note that sometimes EOs are not numerically consecutive due to being combined with another EO, a new EO was added later, or for other reasons. The five occurrences include Whispering Pines (EO 1), Manning Flat (EO 3), Thurston Creek (EO 4), Little High Valley (EO 5), and Diamond Flats (EO 6) (CDFG 1989; CNDDDB 2024a). Some occurrences consist of multiple parts, and these parts will be referred to as sub-occurrences in this species review. Today, only four of the five occurrences are presumed extant with Whispering Pines (EO 1) likely extirpated (CNDDDB 2024a).

Table 2. Five California Natural Diversity Database Element Occurrences (EOs) of Lake County stonecrop and two additional historical localities referenced in the original Status Review (CDFG 1989). The historical, extirpated localities not included in CNDDDB were sourced from specimen collections and habitat characterizations of the areas (Hoover 1941; Patterson 1986; CCH2 2024).

EO	Occurrence	Sub-Occurrences	Species Status	Last Seen
1	Whispering Pines	1	Possibly Extirpated	1940
3	Manning Flat	4	Extant (presumed)	2011
4	Thurston Creek	1	Extant (presumed)	1986
5	Little High Valley	2	Extant (presumed)	1987
6	Diamond Flats	1	Extant (presumed)	2007
-	Hesse Flat	-	Extirpated	1940
-	"Four miles west of Lower Lake"	-	Extirpated	1941

Whispering Pines (EO 1) – The recorded location of Lake County stonecrop at Whispering Pines (4.3 miles south of Adam Springs along Highway 175) is not specific enough to exactly pinpoint the population. Since this occurrence was first recorded, the area has been largely developed (e.g., housing) and converted (e.g., orchards, vineyards, pasture), often in the flat areas where Lake County stonecrop most likely occurred.

Manning Flat (EO 3) – This area is located 8 km (5 mi) west of Lower Lake, with the occurrence on both the north and south sides of Highway 29 (two sub-occurrences on either side). Surveys in 1986 still identified extant vernal pool

habitat on the north side of the highway, but it was highly disturbed from previous discing and rutting by vehicles (Patterson 1986). The habitat for the two sub-occurrences on the south side of the highway are still intact and are surveyed annually by Caltrans.

Thurston Creek (EO 4) – This area is located between Hesse and Manning Flats, approximately 2 km (1.3 mi) west of Manning Flat (EO 3). Intact vernal pools still exist in this flat area (CDFW 2023a), bordered by a vineyard to the north (USFWS 2009).

Little High Valley (EO 5) – This area is about 6 km (4 mi) southeast of Manning Flat (EO 3) (CNDDDB 2024a). This occurrence was first documented and only surveyed once in 1986 and is located on the Diamond B Ranch (a vineyard and horse ranch listed for sale since 2021). The species was observed on small pieces of bedrock with a thin layer of moss. Although it is unknown if vernal pools exist within the species' vicinity, the combination of moss and bedrock likely created pockets of moist conditions for the species to grow in. The current condition of the species' habitat is unknown.

Diamond Flats (EO 6) – This area is approximately 7 km (4.5 mi) southeast of Manning Flat (EO 3) and about 6 km (3.6 mi) west of Little High Valley (EO 5). There are two sub-occurrences—one on each side of a road (CNDDDB 2024a). This occurrence is on land that was set aside for conservation in 2002 by the previous property owners of Snows Lake Winery (Snows Lake Vineyard 2007). No records indicate a formal conservation easement was set up, and its current condition or the status of the species is unknown.

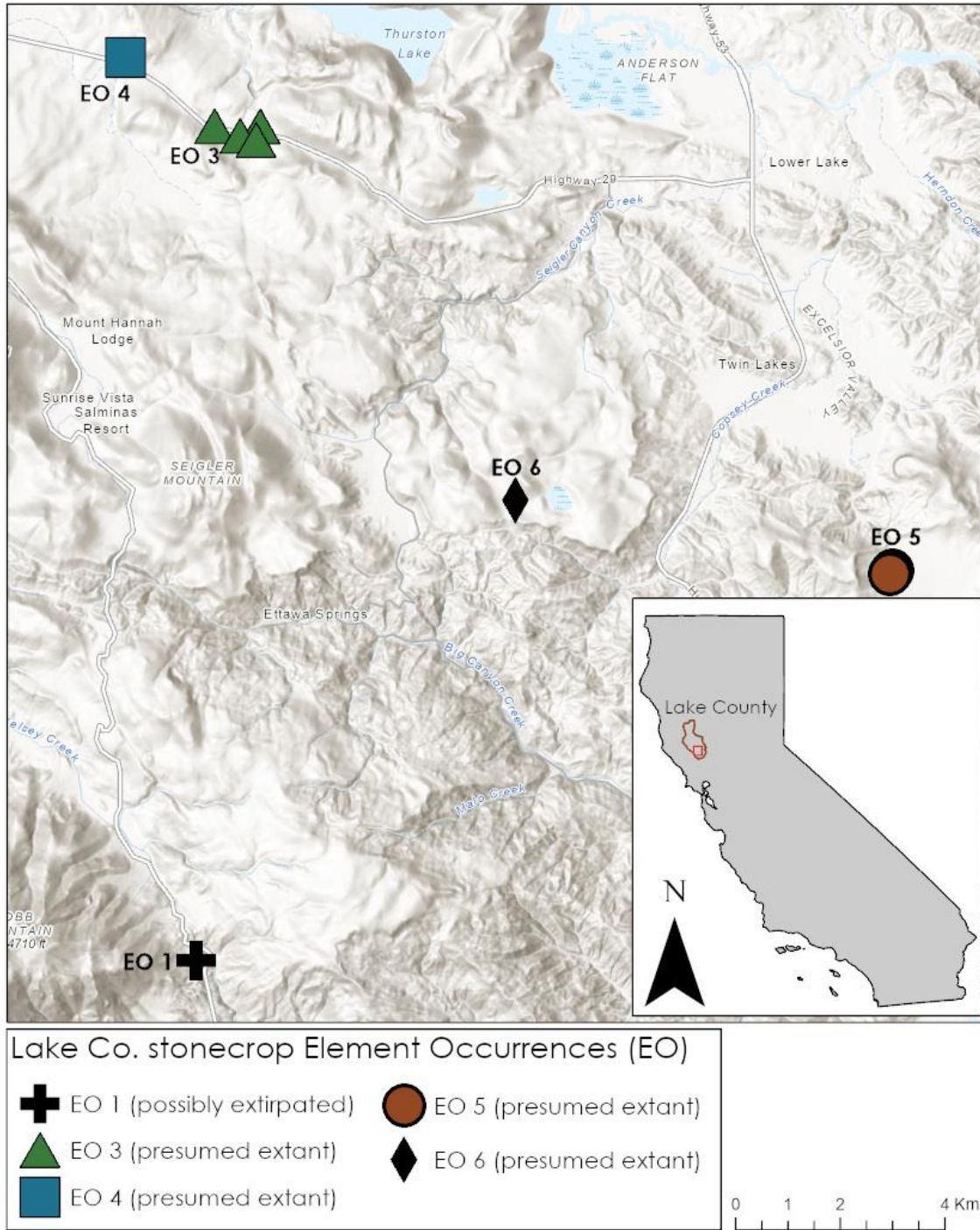


Figure 1. Distribution and range map of the five Lake County stonecrop occurrences.

B. Population Trend and Abundance

The four presumed extant occurrences of Lake County stonecrop are small and disconnected from each other, covering an estimated total area of less than 1.2 ha (3 ac) (USFWS 2009). The area covered by the possibly extirpated occurrence (EO 1) is unknown. The last complete census for the species was in 1986, when approximately 4,400 individuals were counted and covered less than about 372 m² (4,000 ft²) (Patterson 1986; CDFG 1989). Diamond Flats (EO 6) was documented at Snows Lake Vineyard in 1995 and was considered “locally common” (CNDDDB 2024a). The historical, extirpated localities not included in CNDDDB known as Hesse Flat (“6.9 miles west of Manning Flat”) and “four miles west of Lower Lake” (Hoover 1941) were sourced from specimen collections (Patterson 1986; CDFG 1989; CCH2 2024). By 1986, about 60-94% of Lake County stonecrop plants were already lost, and the range of the species was estimated to have already been reduced by 60% (Patterson 1986). These estimates were based on periodic specimen collections (1936-1961) and their accompanied vague descriptions of marginal habitat where the species may have once occurred (Patterson 1986). Overall, it is difficult to quantify population trends and abundance of Lake County stonecrop given the lack of consistent, available information over time.

Whispering Pines (EO 1) – Lake County stonecrop was first documented in this area from specimen collections in 1940 (Koch 1940). The area was searched in 1978 (CNDDDB 2024a) and a few open grassy areas were searched in 1986, but no plants were found in these two years (Patterson 1986). No plants and no vernal pool habitat were found during surveys in 2006 and 2007, so Lake County stonecrop may be extirpated from this site (USFWS 2009; CNDDDB 2024a).

Manning Flat (EO 3) – Lake County stonecrop was first documented in this area with specimen collections in 1952 (Sweeney 1952). Approximately 59,000 Lake County stonecrop plants were observed in 1975. About 3,300 plants were seen across three sub-occurrences in 1986, occupying approximately less than 279 m² (3,000 ft²) (Patterson 1986; CDFG 1989). Small, dense clumps of the species have even been found growing on top of a small drainage ditch's berm (Patterson 1986; CDFG 1989). An unspecified number of plants were observed in 1988. Over 10,000 plants were observed in 2003 on the south side of Highway 29, and an unspecified number of plants were seen on the north side of Highway 29 in 2007 (CNDDDB 2024a). Surveys in 2011 documented about 400 plants on the south side

of Highway 29 in two vernal pools (CNDDDB 2024a). No plants were found during a Department site visit with Caltrans staff (J. Marquardt, 2023a, Caltrans, pers. comm.) or subsequent Caltrans site visit in 2023 (J. Marquardt, 2023b, Caltrans, pers. comm.).

Thurston Creek (EO 4) – Specimen collections in 1936 first documented Lake County stonecrop in this area (Baker 1936). The species was documented from another specimen collection in 1951 in habitat adjacent to a 1950 burn (Sweeney 1951). No known surveys were recorded until 1986 when about 100 Lake County stonecrop plants were counted (Patterson 1986). No plants were found during surveys in 2006 and 2007.

Little High Valley (EO 5) – About 1,000 Lake County stonecrop plants were counted here in 1986 (Patterson 1986). They occupied a total area of approximately 1.4 m² (15 ft²). Permission to access the land has not been granted since 1986, and the current status of the occurrence is unknown (M. Dreyfus, 2023, The Dreyfus Group, pers. comm.).

Diamond Flats (EO 6) – Lake County stonecrop was reported as locally common at this occurrence in 1995; however, the number of plants observed is unknown. Surveys in 2007 resulted in the observation of thousands to possibly hundreds of thousands of Lake County stonecrop plants (K. Tarp and E. Schwab, 2009, pers. comm.; CNDDDB 2024a). This occurrence has not been surveyed since.

VII. HABITAT NECESSARY FOR SPECIES SURVIVAL

Lake County stonecrop grows in seasonally moist, flat areas known as vernal pools. Vernal pools are shallow depressions that fill with water in the winter and then dry in spring and summer, and are often dominated by native, annual plants that are restricted to them (Barbour et al. 2003). The species is found in microhabitats of Northern Basalt Flow (NBF) vernal pools, Northern Volcanic Ashflow (NVAF) vernal pools (Sawyer and Keeler-Wolf 1995; USFWS 2005), or in depressions of rocky outcroppings (Patterson 1986; CDFG 1989; USFWS 2009). Lake County stonecrop is usually found near or on the edge of vernal pools, on ground with little to no topsoil and little other vegetation that might shade it or compete for resources (J. Owen, 2023b, Caltrans, pers. comm.).

A. Vegetation Communities

Lake County stonecrop is restricted to the Lake-Napa Vernal Pool Region described in the Manual of California Vegetation (Sawyer and Keeler-Wolf 1995; Keeler-Wolf et al. 1998). This region is located in the inner coast ranges, north of the San Francisco Bay and south of Clear Lake (Keeler-Wolf et al. 1998). The species grows in association with other small, annual vernal pool plants (Patterson 1986; CDFG 1989). Vegetation of adjacent habitat is dominated by non-native grasslands or meadows surrounded by oak woodland or chaparral (CDFG 1989).

Plants most commonly associated with Lake County stonecrop include:

- butter 'n' eggs (*Triphysaria eriantha*),
- goldfields (*Lasthenia* spp.),
- filaree (*Erodium* spp.),
- peppergrass (*Lepidium* spp.),
- popcornflower (*Plagiobothrys* spp.),
- Tricolored monkeyflower (*Diplacus tricolor*),
- wild onion (*Allium* spp.), and
- various annual grasses (e.g., *Bromus* spp., *Vulpia* spp.) (Patterson 1986, CDFG 1989).

Manning Flat (EO 3)—the habitat consists of vernal pools, surrounded by annual grasses, and blue oak (*Quercus douglasii*) (Figure 2). The surrounding uplands are dominated by stands of Konocti manzanita (*Arctostaphylos manzanita* ssp. *elegans*). Associated plant species include one state-listed endangered plant (bold) and the following:

- Bolander's horkelia (*Horkelia bolanderi*),
- **Burke's goldfields (*Lasthenia burkei*)**,
- cowbag clover (*Trifolium depauperatum*),
- few-flowered blue-eyed Mary (*Collinsia sparsiflora*),
- few-flowered navarretia (*Navarretia leucocephala* ssp. *pauciflora*),
- Fremont's goldfields (*Lasthenia fremontii*),
- hairypink (*Petrorhagia* spp.),
- inch-high rush (*Juncus uncialis*),
- large water-starwort (*Callitriche heterophylla*),
- longhorn seablush (*Plectritis macrocera*),

- purslane speedwell (*Veronica peregrina* ssp. *xalapensis*),
- Sacramento beardstyle (*Pogogyne zizyphoroides*),
- sandweed (*Athysanus* spp.),
- sandwort (*Sabulina* spp.),
- smooth brome (*Bromus hordeaceus*),
- silver-hairgrass (*Aira caryophylla*), and
- toothed calicoflower (*Downingia cuspidata*) (Patterson 1986; CNDDDB 2024b).



Figure 2. Lake County stonecrop habitat showing a) one of the vernal pools during a Spring 2023 survey, and b) the surrounding blue oak habitat on the outer edges of the vernal pool on the south side of Highway 29 at Manning Flat, Lower Clearlake, CA. Photos by Mariel Boldis, CDFW.

Thurston Creek (EO 4)— the vernal pools are surrounded by annual grasses and some scattered oaks (*Quercus* spp.), with a vineyard to the north (CDFW 2023b). The associated species include two state-listed threatened or endangered plants (**bold**) and the following:

- **Burke's goldfields,**
- button-celery (*Eryngium* spp.),
- popcornflower,
- **few-flowered navarretia,** and
- toothed calicoflower (Patterson 1986; CDFG 1989; CNDDDB 2024a).

Little High Valley (EO 5)— Lake County stonecrop was found growing on several, very small, exposed rocks that were relatively level, but allowed for water collection (Patterson 1986). The surrounding habitat consist of annual grasses (CNDDDB 2024a). Associated species include:

- California goldfields (*Lasthenia californica*),
- California plantain (*Plantago erecta*),
- cotton top (*Micropus californicus*),
- moss pygmyweed (*Crassula tillaea*), and
- silver-hairgrass (Patterson 1986; CNDDDB 2024a).

Additional information of site-specific vegetation for Whispering Pines (EO 1), and Diamond Flats (EO 6) are not available.

B. Geology and Soils

Lake County stonecrop occurs in the Lake-Napa Vernal Pool Region which is geologically characterized by volcanic rock (Keeler-Wolf et al. 1998) on areas with restricted drainage that allow water to collect and be retained seasonally at the soil surface (CDFG 1989). Lake County stonecrop is associated with NBF and NVAF vernal pools with short inundation periods, and these pool types are small and restricted in distribution (USFWS 2009). A soil series consists of grouped soils that share similar properties as part of the U.S. Department of Agriculture Soil Taxonomy classification system established by the Natural Resource Conservation Service (Soil Survey Staff 2024a). NBF vernal pools are typically of the Konocti soil series (e.g., cobbly loams), while NVAF vernal pools are characterized by deep volcanic ash flows usually of the Oxalis series (e.g., silty loams) (Keeler-Wolf et al. 1998; USFWS 2005). While the Konocti and Oxalis series are most closely associated to NBF and NVAF, which have been mapped coarsely in the area (Figure 3), there are additional soil series and complexes that occur where Lake County stonecrop is known to grow (Table 3). A closer look at the distribution of the Oxalis series in relation to the distribution of Lake County stonecrop occurrences are mapped in Figure 4.

Table 3. A list of soil series map units found across the four presumed extant Element Occurrences (EOs) of Lake County stonecrop (Soil Survey Staff 2024b).

EO	Occurrence	Soil Series Map Unit(s)
3	Manning Flat	<ul style="list-style-type: none"> Glenview-Arrowhead complex Glenview-Bottlerock complex Oxalis variant silt loam
4	Thurston Creek	<ul style="list-style-type: none"> Glenview-Bottlerock complex
5	Little High Valley	<ul style="list-style-type: none"> Konocti variant-Konocti-Hambright complex Mocho variant loam
6	Diamond Flats	<ul style="list-style-type: none"> Aiken-Sobrante association Collayomi-Aiken-Whispering complex Collayomi-Whispering complex Maymen-Hopland-Mayacama association Maymen-Etsel-Snook complex Neice-Sobrante-Hambright complex

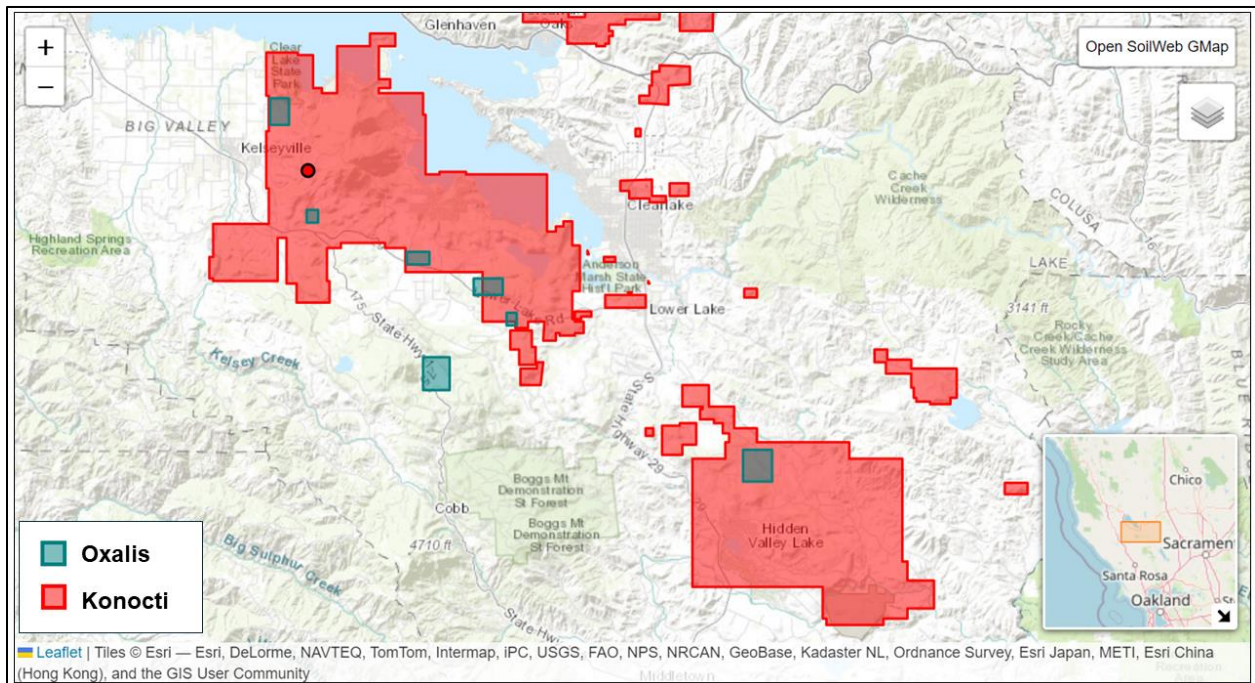


Figure 3. Distribution of the two soil series most geographically associated with Northern Volcanic Ashflow and Northern Basalt Flow vernal pools within the general geographic area of where Lake County stonecrop occurs (Soil Survey

Staff 2024a; UCD 2024). Oxalis soils are most associated with NVAF vernal pools and Konocti soils are most associated with NBF vernal pools (Keeler-Wolf et al. 1998; USFWS 2005).

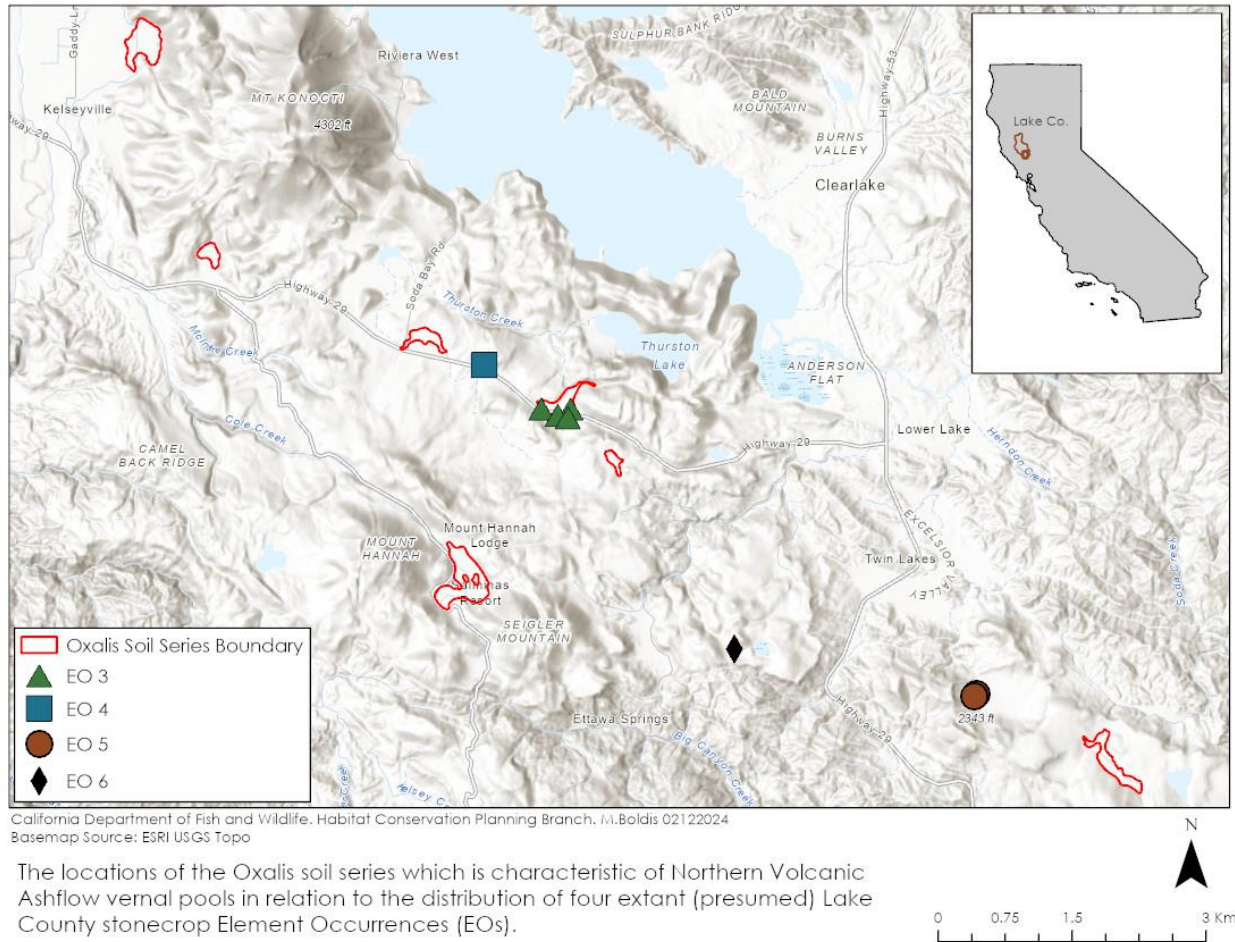


Figure 4. The mapped boundaries of the Oxalis soil series most geographically associated with Northern Volcanic Ashflow vernal pools in relation to the four presumed extant Lake County stonecrop occurrences.

The species has been observed growing in areas with very little soil, likely possible due to its small size and succulent-like leaves which allow the plant to store water and grow in less hospitable places. At the Little High Valley occurrence, the species grows on small, exposed pieces of bedrock with a thin layer of moss (CDFG 1989). Additional information on the specific characteristics of site geology and soils for Whispering Pines (EO 1), Thurston Creek (EO 4), and Diamond Flats (EO 6) are not available.

C. Climate and Hydrology

Lake County stonecrop grows in a Mediterranean climate that is characterized by warm to hot, dry summers, and cool, wet winters. Precipitation is primarily in the winter months (Dec – Feb), with the PRISM climate modeled data indicating little variation in winter precipitation between occurrences (179-230 mm; 7-9 in) (PRISM Climate Group 2021). Estimated monthly precipitation drops significantly during the species' flowering season in April and May (Figure 5) where averages are 54-65 mm (2-3 in) in April and 36-38 mm (1-1.5 in) in May (PRISM Climate Group 2021). Mid-April to early May is typically when vernal pools are no longer inundated and are drying down which are conditions that appear most optimal for positive detection of Lake County stonecrop. Averaged across the four presumed extant occurrences, the coldest month is January with a monthly minimum low of 4°C (38°F), and the hottest month is July with a monthly maximum high of 33°C (92°F) (PRISM Climate Group 2021).

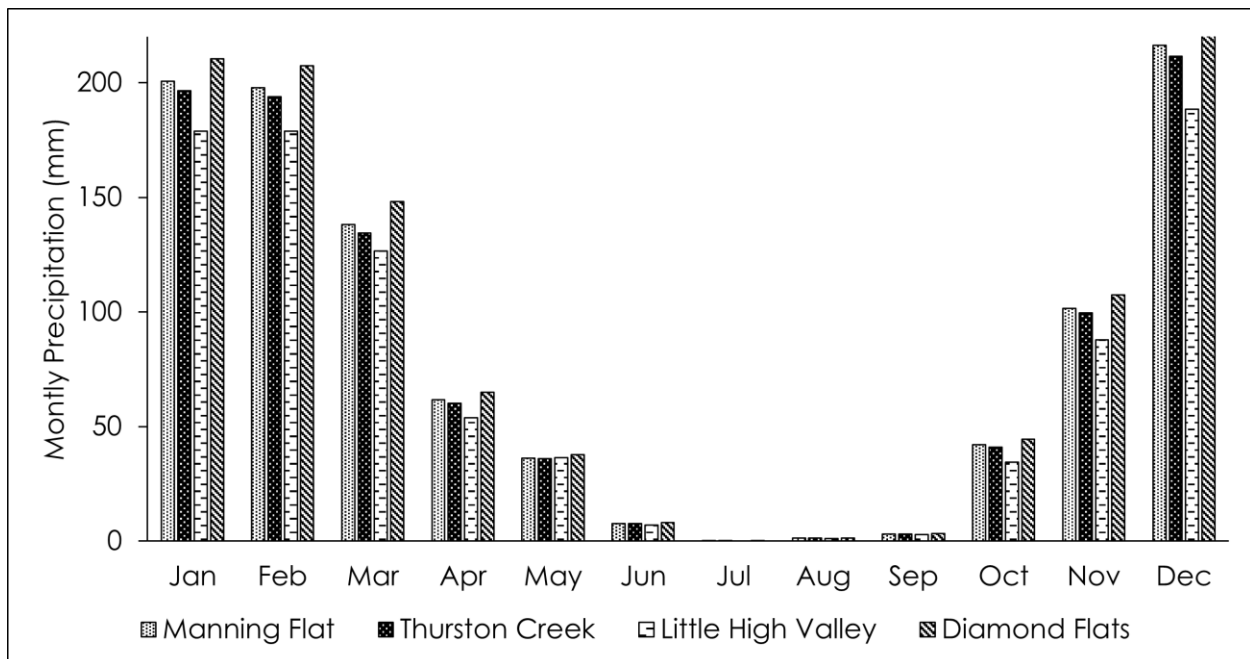


Figure 5. The monthly 30-year normal precipitation for the four presumed extant Lake County stonecrop occurrences. The PRISM time series uses the Norm91m dataset which averages monthly conditions over the most recent three full decades 1991-2020 at a resolution of 800 m.

VIII. THREATS AND SURVIVAL FACTORS

A. Factors Affecting Ability to Survive and Reproduce

When Lake County stonecrop was listed as endangered under CESA in 1989, threats to the species included: a) modification or destruction of habitat, b) predation (in the form of herbivory and trampling), and c) limited distribution and small population sizes (CDFG 1989). For this species review, the Department identified three additional threats: human-related activities (insecticides, off highway vehicle (OHV) use, road maintenance, changes to hydrology), competition, and climate change.

a. *Habitat Destruction and Modification*

Development and conversion to agriculture (e.g., vineyards) was and still is a serious threat to Lake County stonecrop. All Lake County stonecrop occurrences are on privately owned lands that are zoned for agriculture (general crops, but predominantly grapes), farm, ranch, quarry (sand, gravel, rock), or residential. In addition, there are no formal conservation easements in place, which intensifies the threats to the species if landowners decided to move forward with development or conversion of areas where Lake County stonecrop may still occur.

Whispering Springs (EO1) – This area has been subject to residential development and conversion to agriculture. In addition to development and habitat conversion, extensive grazing and trampling suggests that the occurrence is likely extirpated. The property underwent many changes since 1940, but no formal surveys occurred during that time. During surveys in 1986, where accessible, no observations of vernal pool habitat or Lake County stonecrop plants were found (Patterson 1986). The species was likely already extirpated from this site before it was listed under CESA.

Manning Flat (EO 3) – The two sub-occurrences on the north side of Highway 29 have been negatively impacted by extreme erosion. In the 1860s, removal of a natural dam in an attempt to drain the vernal pool on the north side of the highway caused soil instability which rapidly created an incised channel (Wilson 2007a; Scavone 2020). The fine sediments in Manning Flat eroded, deposited, and continue to do so into the Thurston Lake watershed which causes Thurston

Lake to become more turbid (i.e., cloudy) (Wilson 2007a, 2007b; Scavone 2020). These fine sediments reportedly can be suspended in the water for more than 100 years (J. Owen, 2023b, Caltrans, pers. comm.). Today, a large, active erosional feature known as “Lake County’s Grand Canyon” (Wilson 2007a) occurs here (Figure 6a), with buried pvc pipe of unknown use (Figure 6b) and under-road drainage (Figure 6c). The erosional feature in the shape of a large circle (Figure 6d) was likely caused by a dirt racetrack from the 1950s or 1960s, further intensifying the incision of the channel (Wilson 2007b). Aerial imagery shows that erosion was exacerbated sometime between 1993 and 2003 (Figure 7a,b), and vehicle use across the vernal pool appeared to be extensive along the path of power lines in 2018 (Figure 7c) (Google Earth Pro 2022). What appears to be tractor mower lines in 2021 and continuing into 2023 run across the vernal pool and within the area that previously had observations of Lake County stonecrop (Figure 7d). A Department site visit with Caltrans in 2023 to survey the sub-occurrences on the south side of the highway, confirmed the incised channel on the north side of the highway have not been stabilized (CDFW 2023a), and much of this habitat may no longer support Lake County stonecrop due to the changes in hydrology.

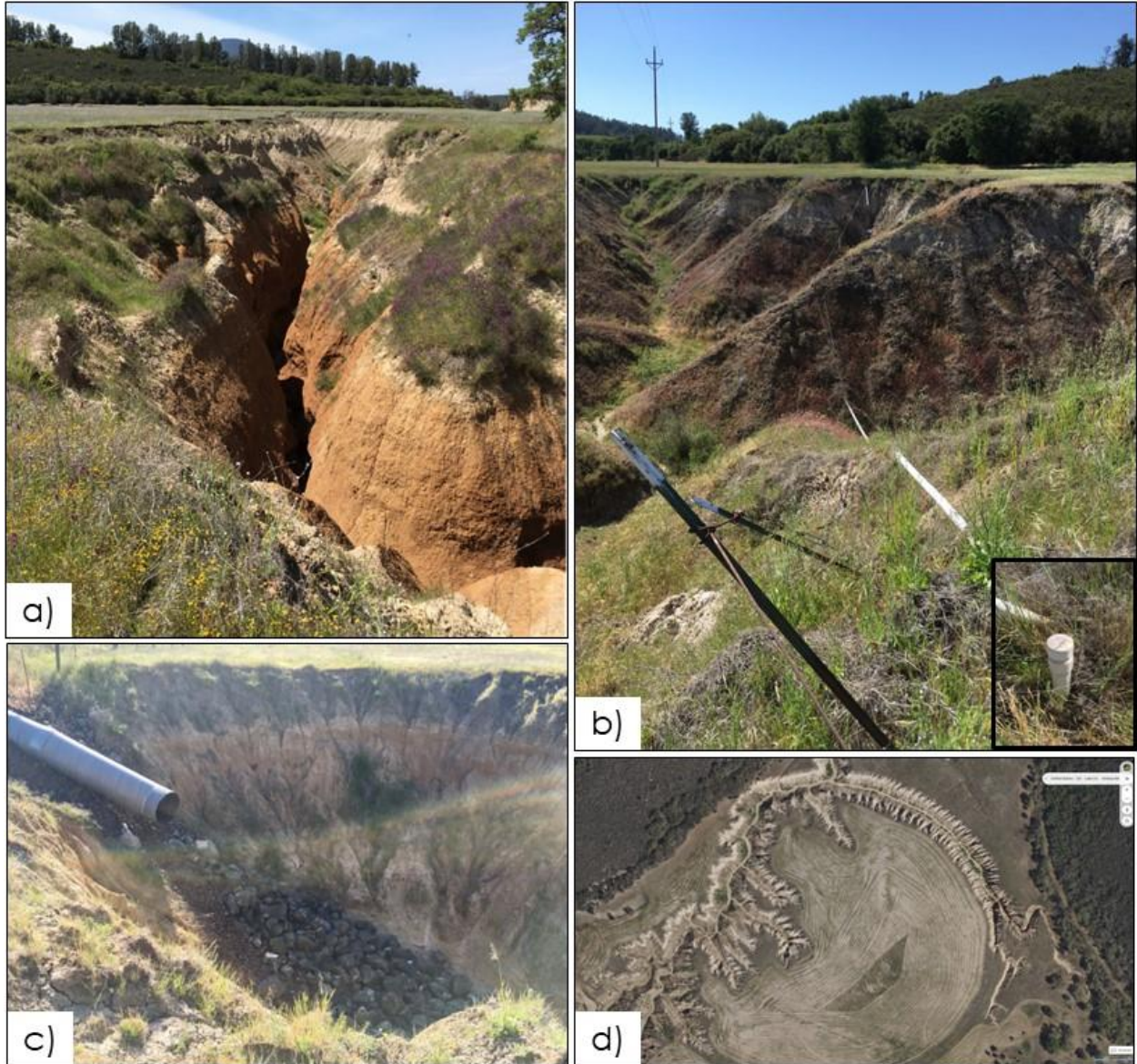


Figure 6. Site photos of Manning Flat in 2018 showing the (a under-road drainage, b) erosion from the east end, c) erosion from the west end and pvc piping buried in the ground, and d) aerial view of the overall site conditions. Photos by Raffica La Rosa, CDFW. Aerial image from Bing.

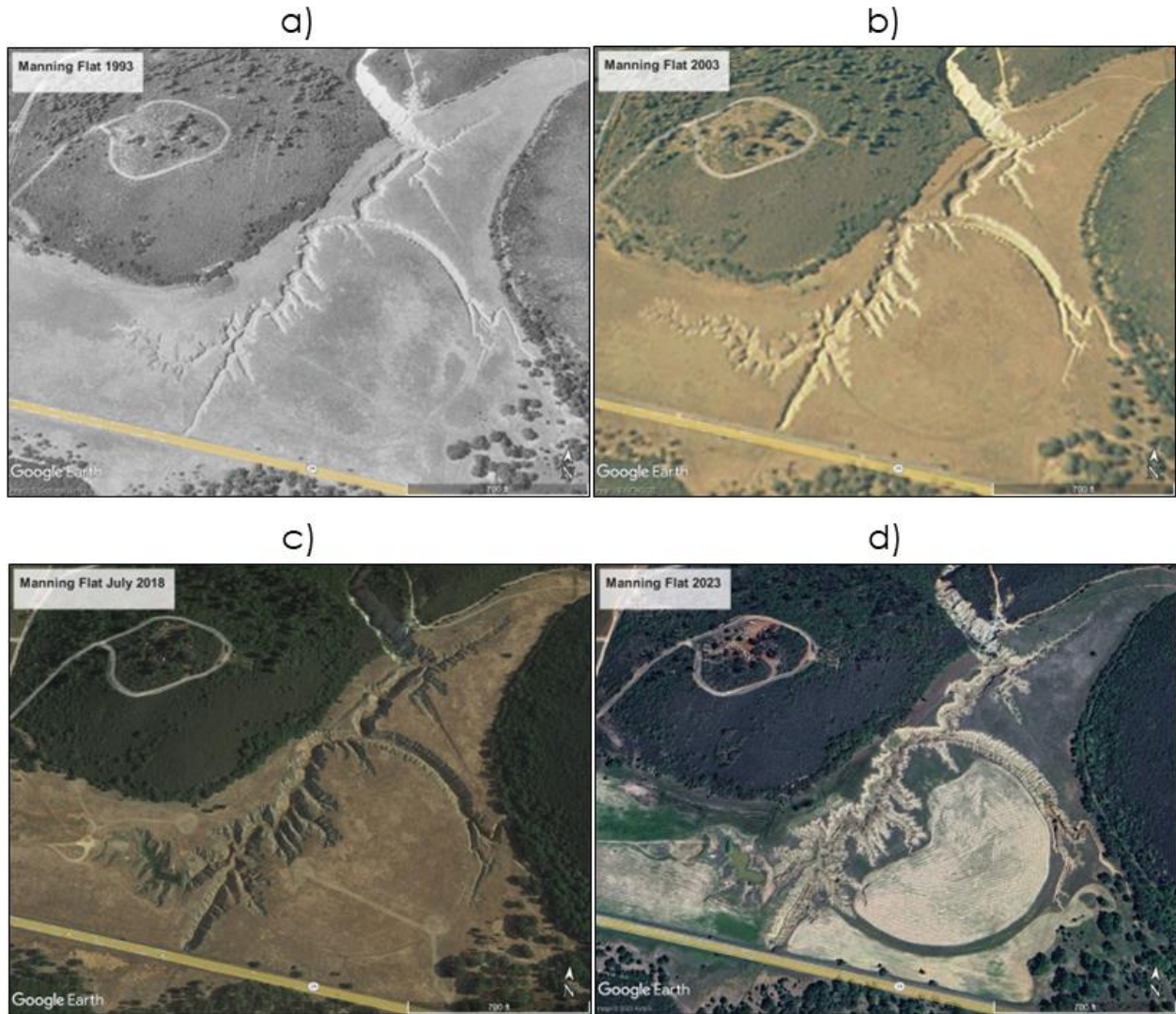


Figure 7. Aerial imagery in a) 1993, b) 2003, c) 2018, and d) 2023, at the Manning Flat occurrence of Lake County stonecrop on the north side of Highway 29.

Removal of a natural dam in the 1860s created a rapidly eroding incised channel. The circular erosion occurred over time and was likely made worse by impacts from a dirt racetrack from the 1950s or 1960s. Remnant vernal pools may still exist on this part of Manning Flat; however, the hydrology has forever been altered. Images from Google Earth Pro.

Thurston Creek (EO 4) – This occurrence has been subject to habitat modification and destruction for a long time due to ranching and agriculture upslope from the occurrence, and its proximity to Highway 29. The 1951 specimen collections (UC1025829, UC936163) indicate that Lake County

stonecrop was found in obsidian rubble adjacent to an area that burned in the 1950 Seigler Canyon fire, which burned areas that overlap with Manning Flat (EO 3) (CAL FIRE 2023; CCH2 2024). However, this is the only occurrence where fire was noted in a collection or survey. While it is unknown how fire may generally impact Lake County stonecrop, it is important to note that subsequent fires have burned areas overlapping with other occurrences (1, 5, and 6). Little High Valley (EO 5) burned in 1947 (unknown fire), Diamond Flats (EO 6) burned in 1966 (Howard Fire), and both Whispering Springs (EO 1) and Diamond Flats (EO 5) burned in 2015 (Valley Fire) (CAL FIRE 2023). Thurston Creek (EO 4) was known to be grazed and disced at the time of listing in 1990, and may have been much larger prior to that disturbance (CDFG 1989). A small vernal pool remained in 2007 and appeared to be impacted by runoff from the adjacent walnut orchard (K. Tarp and E. Schwab, 2009, pers. comm.; USFWS 2009). In 2011, part of the land adjacent to the vernal pools on the west side was developed into a winery. Like at Manning Flat (EO 3), aerial imagery shows moderate vehicle use across the vernal pool in 2011 (Figure 8a), 2013, and in 2017, when imagery was available (Google Earth Pro 2022). The landowner eventually sold their property in 2017, and the walnut orchards located north of this occurrence were converted into a vineyard. Shortly after, a permitted access road was created that went through the wetland area and heavily modified at least one vernal pool and potentially changed the hydrology of the others (Figure 8b; J. Owen, 2023b, Caltrans, pers. comm.). Like at Manning Flat (EO 3), tractor mower lines appear to run extensively in 2021 across the vernal pool and the area known to have Lake County stonecrop (Figure 8c); however, the vernal pools still appear to persist and bloom in spring (Figure 8d). During a Department site visit in fall 2023, a ditch or sink hole was observed a few hundred feet from the highway and south of the access road to the west of Thurston Creek (EO 4) (Figure 9). The flat area adjacent to the ditch may still be flood prone. It is unknown when the ditch was formed but aerial imagery indicates it was there in 2005 and possibly prior (Google Earth Pro 2022). The ditch may pose a threat to remaining vernal pool habitat if further erosion occurs.

Little High Valley (EO 5) – At the time of listing, this area was the least disturbed of all the sites (CDFG 1989). The land was grazed by cattle; however, the species likely persisted because they grew on exposed rocks which cattle typically avoid. Aerial imagery shows the area to be generally undisturbed except in 2018 when there appeared to be more off-road vehicle use than in years prior

(Google Earth Pro 2022). Silt runoff from the adjacent, graded access road may potentially threaten this occurrence if no mitigation measures are in place during rainstorms. Several attempts by the Department in 2023 to reach the landowner for permission to survey this occurrence and the surrounding area were unsuccessful (M. Dreyfus, 2023, The Dreyfus Group, pers. comm.).

Diamond Flats (EO 6) – In 2002, the previous landowners of Snows Lake Winery informally set aside a 97 ha (240 ac) area for conservation in response to a permit violation with the county (Snows Lake Vineyard 2007), where the developer cleared almost 80 ha (200 ac) more than their permit allowed, including wildlife habitat and vernal pools (Brazil 2002). The vineyard has since changed ownership, and efforts to contact the landowner to confirm whether the conservation area continues to be maintained or managed for Lake County stonecrop remain unanswered (M. Boldis, 2023, CDFW, pers. comm.). Aerial imagery shows little to no disturbance of this area despite being adjacent to a permanent access road with large boulders on either side (Google Earth Pro 2022).

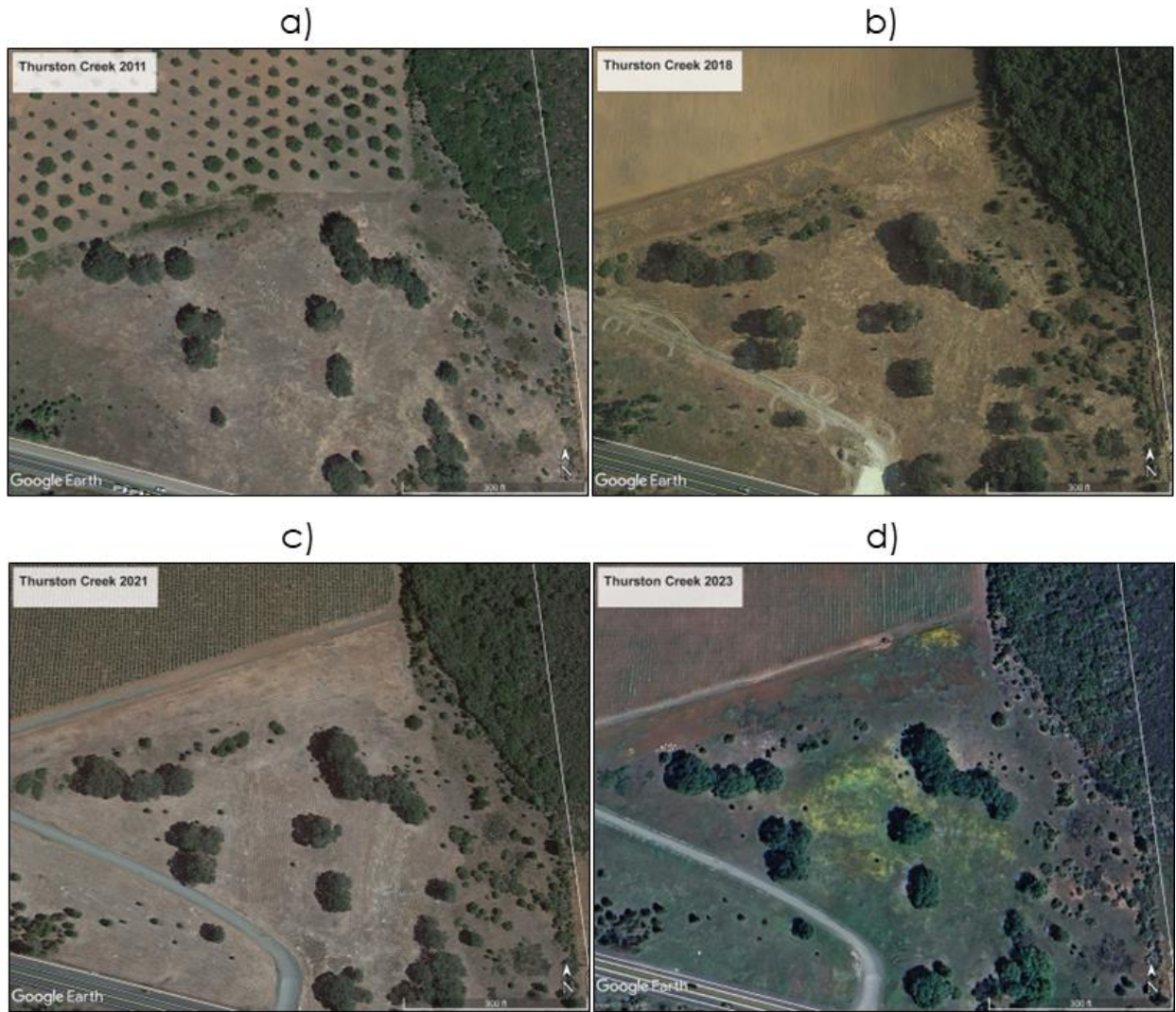


Figure 8. Aerial imagery in a) 2011, b) 2018, c) 2021, and d) 2023, at the Thurston Creek occurrence of Lake County stonecrop. Images from Google Earth Pro.



Figure 9. A ditch observed nearby Thurston Creek (EO 4) of Lake County stonecrop during a Department site visit in fall 2023. Parts of the habitat adjacent to the ditch still appear to be vernal pool habitat. Photo by Mariel Boldis, CDFW.

b. Herbivory and Trampling

At the time of listing, one major threat to significant portions of the occurrences was trampling by animals grazing the vernal pools that support Lake County stonecrop (CDFG 1989). Although evidence of direct herbivory of the species is unknown, fresh deer prints through Manning Flat (EO 3) were observed during a Department site visit (CDFW 2023a). During a Department site visit to the Thurston Creek (EO 4) in fall 2023 (CDFW 2023b), vineyard staff confirmed this area was once used for cattle grazing (P. Rubio and B. Sears, 2023, Beckstoffer Vineyards, pers. comm.). Herbivory during the species' growing season and before the plants have set seed may cause consumption and/or trampling of Lake County stonecrop plants. Herbivores may also indirectly impact the species through introduction of new or the spread of existing non-native plants across vernal pools (Keeler-Wolf et al. 1998).

c. Limited Distribution and Small Population Sizes

The general distribution of Lake County stonecrop is restricted to microhabitats within NBF and NVAF vernal pools. With only five total occurrences and one of these possibly extirpated (Patterson 1986; USFWS 2009), the species' spatial distribution remains extremely fragmented. The combined estimated total area occupied by the species is less than 1.2 ha (3 ac) (USFWS 2009). Habitat fragmentation may make the species more vulnerable to factors not yet known to be threatening the species (e.g., inbreeding depression through the loss of genetic diversity), especially if Lake County stonecrop abundance and distribution continues to decline (Wiens 1976; Parker 2012). Many of the species' occurrences are near or adjacent to roads, which create edge effects (i.e., habitat patches that are isolated by surrounding boundaries). These edge effects impact the species at different magnitudes and may further fragment its available habitat if the boundaries between habitat and edges (e.g., roads) grow without mitigation (Wiens 1976).

Occurrence sizes during years of observation vary drastically (few to 10,000+ plants). Its small occurrence size puts the species at risk of extinction from human related activities (e.g., development, OHV use) that may inevitably result in catastrophic erosion of these fragile soils. Extreme fluctuations in weather can influence consecutive years of low plant abundance, which may alter demographics if not punctuated by years with high numbers of the species. The Manning Flat occurrence on the north side of Highway 29 is likely at the most risk of extinction due to the instability of the incised channel continuing to erode, and any type of random event could cause the occurrence to become extirpated.

d. Human-Related Activities (OHV Use, Road Maintenance, Changes to Hydrology, Insecticides)

Lake County stonecrop is at risk of extinction from a number of human-related activities, including OHV use, road maintenance activities, and changes to vernal pool hydrology (e.g., drainage, diversion). Plants can be destroyed by OHVs passing between agricultural fields at sites like Thurston Creek (EO 4) and Diamond Flats (EO 6). Plants can also be destroyed by tractors mowing an area for the purpose of managing other vegetation. OHV use may also result in soil

compaction or the introduction of non-native invasive plants into the vernal pools.

Several occurrences grow near roadsides, and regular road maintenance activities by Caltrans (e.g., re-paving sections of Highway 29) or by private landowners (e.g., grading access roads) may disturb populations growing closest to the road. Roadwork in and around Lake County stonecrop may further fragment existing habitat and disturb fragile soils. Caltrans provided an Environmental Impact Report (EIR) in 2016 for the Lake 29 Improvement Project (now called Konocti Corridor) as part of a widening project to improve safety (Caltrans 2016). Stabilizing erosion on the north side of the highway at Manning Flat is incorporated into the project and is meant to minimize further impacts to sensitive species like Lake County stonecrop but may still impact the plants if special attention to staging equipment, runoff, and other ground disturbing activities are not monitored closely.

Lake County stonecrop is also susceptible to changes to hydrological function of their vernal pool habitat. Water diversions for agriculture may reduce the amount of water available for vernal pools, impacting the period of water retention and availability for vernal pool plants. Unmitigated erosional features or draining of vernal pools, such as on the north side of Highway 29 at Manning Flat (EO 3), may disconnect water sources and decrease water availability for any remaining portions of a vernal pool. This can further fragment habitat and occurrences of Lake County stonecrop that are at risk of extirpation. Encroaching non-native annuals (e.g., Thurston Creek (EO 4)), especially during consecutive years of drought, can shade out or outcompete vernal pool plants. The vernal pool edges, where Lake County stonecrop has been observed to grow, are the most susceptible to encroaching vegetation.

Lake County stonecrop is susceptible to pesticide use in the surrounding agricultural areas, which are predominantly vineyards. The U.S. Environmental Protection Agency (EPA) recently published a report that identified a group of federally listed species and their habitats that are predicted to face the greatest risks from specific insecticides known as neonicotinoids (clothianidin, imidacloprid, and thiamethoxam). Neonicotinoids are used to control piercing and sucking insects on agricultural crops and for other residential and commercial indoor and outdoor uses (EPA 2023). Lake County stonecrop was listed as a species that may be negatively impacted by the insecticides

thiamethoxam and clothianidin (PC Codes: 060109, 044309) (EPA 2023), which are sometimes applied to vineyards and can run off into surrounding habitat. Thiamethoxam may also degrade to clothianidin as plants metabolize the insecticide (EPA 2023). The magnitude of effect (i.e., combined indirect and direct effects) of these two insecticides on the species' vulnerability is rated high, as indicated in Appendices H and I in the EPA report (EPA 2023). In addition, thiamethoxam and clothianidin are highly toxic to bees. This is important to note because while Lake County stonecrop is not linked to specific pollinators, its biology and floral traits predict pollination by flies and/or bees (Patterson 1986; CDFG 1989; USFWS 2009; Rosas-Guerrero et al. 2014).

e. Competition

Lake County stonecrop at Manning Flat (EO 3) may be susceptible to competition from non-native plants (e.g., pink (*Petrohagia* spp.), filaree (*Erodium* spp.)) that appear to be creeping along the edges of the vernal pools (CDFW 2023a). Non-native invasive species like Italian thistle (*Carduus pycnocephalus*), yellow starthistle (*Centaurea solstitialis*), and various annual grasses also surround the outside the pools beneath the tree canopy. Consecutive years of drought and changes in the hydrology of Manning Flat due to erosion may favor the encroachment of non-native species into Lake County stonecrop habitat (J. Marquardt, 2023a, Caltrans, pers. comm.). In addition, a dense layer of decomposing leaves from nearby trees was observed on the soil surface throughout the pools (Figure 10), which is not characteristic of vernal pools and may suppress Lake County stonecrop germination and growth (CDFW 2023a).

At Thurston Creek (EO 4), extensive stands of medusahead (*Elymus caput-medusae*) were observed in fall 2023 during a Department site visit. Thatch of medusahead was observed within and around the vernal pools at this occurrence (Figure 11). Medusahead is rated as a highly invasive plant (Cal-IPC 2023), which means the species has severe ecological impacts to biological communities, disperses easily, establishes readily, and is responsible for complete shifts in vegetative communities. Medusahead out-competes native plants while also persisting in dense leaf litter and thatch layers, which further prevents germination of native plants like Lake County stonecrop (DiTomaso and Kyser 2013).

Although these observations are from Manning Flat (EO 3) and Thurston Creek (EO 4), competition from non-native species may also be occurring at the other Lake County stonecrop occurrences.



Figure 10. One of the vernal pools at Manning Flat on the north side of Highway 29 in a) late spring 2023 once pools were dry, and b) a dense layer of leaf litter on the vernal pool surface. Photos by Jana Marquardt, Caltrans.



Figure 11. One of several vernal pools located at Thurston Creek (EO 4) of Lake County stonecrop in fall 2023. These vernal pools were predominately covered

by the non-native, invasive grass, medusahead. The inset photo is a closeup of paired glumes of a senesced medusahead spikelet. Photo by Mariel Boldis, CDFW, and inset photo by Matt Lavin (Lavin 2009).

f. Climate Change

The Department does not have any data on the extent to which predicted climate changes will affect the demographics of Lake County stonecrop (e.g., seed production and mortality) in the foreseeable future. As an annual plant, Lake County stonecrop may have some resilience to increased summer aridity and temperatures because the species persists as seeds in the soil during the hottest and driest portions of the year. However, during the winter and spring growing season, Lake County stonecrop will likely be sensitive to changes in precipitation and temperature patterns. Given that Lake County stonecrop grows in vernal pools with shorter inundation periods, extended drought may severely shorten inundation periods restricting the species ability to complete its life cycle and recruit successfully into the seed bank (USFWS 2009; Faist and Collinge 2015; Montrone et al. 2019).

Department staff assessed the vulnerability of Lake County stonecrop to climate change using the NatureServe Climate Change Vulnerability Index (CCVI) Version 3.02 (Young et al. 2016, CDFW 2023b). The CCVI is a way to estimate a plant or animal species' relative vulnerability to climate change. The CCVI analyzes exposure to local climate change within a species' range and assesses indirect climate change effects and the species' sensitivity and adaptive capacity to provide a qualitative assessment of how the abundance and/or range extent of the species may change due to climate change. The results of the CCVI indicated that Lake County stonecrop is moderately vulnerable, indicating that the abundance and/or the range extent within the geographical area assessed is likely to decrease by 2050. While climate change is a potential threat to the species, there is not enough information to sufficiently predict how exactly climate change will impact Lake County stonecrop.

B. Degree and Immediacy of Threats

The most immediate threat at the time of listing was habitat destruction and modification by conversion, and development of the species' habitat (CDFG 1989). At present, the Department considers habitat destruction and

modification, limited distribution and small population sizes, and human related activities (i.e., OHV use, road maintenance, changes to hydrology) to be the most immediate threats to extinction. These are serious and immediate threats since none of the five occurrences are protected formally via conservation easements or other means. The degree (intensity) of the most immediate threats is exacerbated by the threats from ill-timed or high-intensity herbivory by livestock, use of agricultural insecticide in the vicinity which may be found in runoff, competition from non-native plants, and climate change.

The severity of the threats that Lake County stonecrop faces impacts the species most by the cumulative interaction of multiple threats, especially given its limited distribution and small population size. Most of the occurrences are adjacent to vineyards and near roads that experience moderate to high vehicle traffic. A greater magnitude of edge effects on Lake County stonecrop's vernal pool habitat may influence non-native plant expansion, reduce native biodiversity within habitat, and intensify insecticide exposure to the species (Prosser et al. 2016). In addition, consecutive years of shortened inundation periods may increase the potential for competitive non-native plants to encroach the species' habitat. These factors may further exacerbate the impacts of fragmentation on species' resiliency, especially during prolonged periods of drought where inundation is shortened.

IX. MANAGEMENT AND RECOVERY

A. Impact of Existing Management Efforts

All five occurrences of Lake County stonecrop are on private property and are not currently being managed for conservation of the species; however, Department staff, local land managers, local ecologists, and the Lake County Resource Conservation District (RCD) have all expressed interest in conservation and management of the species and related vernal pool habitat (J. Bush, 2023, CDFW, pers. comm.; L. Ray, 2023, Lake Co. RCD, pers. comm.; P. Rubio, 2023, Beckstoffer Vineyards, pers. comm.; P. Rubio and B. Sears, 2023, Beckstoffer Vineyards, pers. comm.; B. Sears, 2023, Beckstoffer Vineyards pers. comm.).

The Diamond Flats occurrence is in an area the Snows Lake Vineyard set aside for conservation (Snows Lake Vineyard 2007), following environmental violations in 2002 (Brazil 2002). However, no formal conservation easement or

management plan is on record (K. Tarp and E. Schwab, 2009, pers. comm.; CNDDDB 2024a). The Department attempted to contact the new landowner, regarding the current status of the conservation area, but has not received a response to date. (M. Boldis, 2023, CDFW, pers. comm.).

B. Recommendations for Management Activities and Other Recommendations for Recovery of the Species

The goal of management and recovery is to alleviate threats, stabilize number of plant, and protect occurrences and the soil seedbank of Lake County stonecrop. The most urgent action to take for the survival of Lake County stonecrop is to protect vernal pool habitat where the species occurs or may occur and actively manage for the species. The USFWS established a Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon in 2005, which includes an ecosystem-level approach for multiple listed species that share similar habitat and threats, as well as downlisting criteria for Lake County stonecrop (USFWS 2005, 2009). The criteria include habitat protection, seed banking, reintroductions, filling data gaps through research on the species' biology and ecology, research on vernal pool ecosystem function, implementation of adaptive habitat management, outreach to landowners, and conducting range-wide surveys for the species.

Vernal pools are one of the most vulnerable native plant habitats at risk of being lost and converted to agriculture or development (Barbour et al. 2003). Working with private landowners to protect remaining vernal pool habitat through conservation easements, safe harbor agreements, or other landowner agreements would be a starting point to ensure Lake County stonecrop occurrences persist. For example, Mead Ranch, which is a privately owned parcel, protects the largest remaining vernal pools in Napa County through a Napa Land Trust conservation easement (Keeler-Wolf et al. 1998).

Areas that contain vernal pools that currently support, or may potentially support, Lake County stonecrop include Manning Flat, Hesse Flat, Thurston Creek, Thurston Lake, Ely Flat, Konocti Camp Flat, Pinkeye Lake, Cole Creek (south of Mt. Hannah Lodge), and Shaul Valley (J. Owen, 2023b, Caltrans, pers. comm.; CNDDDB 2024. Hesse Flat ("6.9 miles west of Manning Flat"), and Ely Flat (northwest of Thurston Creek occurrence) may be worth exploring further for possible restoration and introduction efforts. Both Hesse Flat and Ely Flat are

geographically associated with the Oxalis and Konocti soil series of NVAF and NBF vernal pools, respectively (Figure 3, Figure 4), and severe erosion issues do not need to be remediated at these sites (J. Owen, 2023b, Caltrans, pers. comm.). Ely Flat and Thurston Creek (EO 4) are close to each other and owned by the same entity. The land manager has previously expressed interest in discussing management and monitoring for Lake County stonecrop (P. Rubio, 2023, Beckstoffer Vineyard, pers. comm.). Coordinating surveys of the species and habitat assessments for management at both sites or introduction efforts at Ely Flat would be beneficial since the conservation potential for both areas is high. At minimum, establishing habitat management of vernal pools at Thurston Creek (EO 4) and Ely Flat would also serve to protect three additional CESA-listed plant species (few-flowered navarretia, Burke's goldfields, and Boggs Lake hedge-hyssop (*Gratiola heterosepala*)).

The Department recommends that the following actions be conducted in coordination with a broad group of partners including Tribes, local, state, and federal governments, organizations, private citizens, or scientists consistent with California's goals of conserving biodiversity and preventing the extinction of rare, threatened, and endangered species:

1. Conduct outreach to landowners and other interested parties to protect habitat from development and degradation through conservation easement or fee title acquisition.
 - a. Raise awareness and discuss opportunities with landowners for conservation of the species and its habitat.
 - b. The presumed extant occurrences at Manning Flat (EO 3), Diamond Flats (EO 6) and Thurston Creek (EO 4) should be conserved. Manning Flat (EO 3), south of Highway 29, is currently regularly monitored by Caltrans, has relatively intact vernal pools, is easily accessible which makes it susceptible to threats from human activities, and has the most recent observation from 2011. Diamond Flats (EO 6) was set aside in 2002 for conservation and would benefit from formal permanent protections if it remains undeveloped. The current landowners of Thurston Creek (EO 4) are open to working with the Department to promote conservation and to identify management actions for the vernal pools.

- c. Continue conversations with Lake County RCD, Tribes, local agencies, and others to develop a Resource Conservation Investment Strategy (RCIS) that will include conservation actions that can be implemented for Lake County stonecrop and its habitat.
2. Survey and monitor known occurrences and search for undiscovered occurrences.
 - a. Establish regular monitoring at the four presumed extant occurrences, following survey protocols that consider maintaining a systematic approach for assessing rare plant communities such as the protocols provided by the Department (CDFW 2018).
 - b. Survey Hesse Flat, a historic location for Lake County stonecrop (Patterson 1986), for habitat suitability for potential reintroductions. Some hydrological improvements to the floodway of Hesse Flat may still make this location suitable for Lake County stonecrop (J. Owen, 2023b, Caltrans, pers. comm.).
 - c. Establish criteria for identifying and evaluating potential suitable habitat that may contain NVAF or NBF vernal pools and has the potential to support undiscovered occurrences or (re)introduced, populations of Lake County stonecrop.
 - d. Using the criteria from 2(c), evaluate habitat suitability at Ely Flat, Konocti Camp Flat, Thurston Lake, Shaul Valley, Pinkeye Lake, and Cole Creek south of Mt. Hannah Lodge. These sites have degraded freshwater and seasonal marshes, as well as existing vernal pools (J. Owen, 2023b, Caltrans, pers. comm.).
3. Preserve population genetics from all four extant occurrences.
 - a. Collect seeds from all four presumed extant occurrences for long-term conservation storage, following protocols that consider genetic diversity and rarity such as the protocols provided by the California Botanic Garden (RSABG 2009).
4. Restore or improve hydrological function at Manning Flat (EO 3) and Thurston Creek (EO 4).

- a. Stabilize the erosion occurring north of the highway of the extant Manning Flat (EO 3) occurrence to mitigate further loss of the species' habitat.
 - b. Remove or mitigate the effects of the ditch that is south of the access road near the Thurston Creek (EO 4) occurrence to improve inundation of the vernal pools.
5. Increase the size and/or number of occurrences.
 - a. Work with landowners and research institution(s) to assess the seedbank and feasibility of reintroductions to expand the size of extant occurrences.
 - b. Introduce Lake County stonecrop to sites identified as potential suitable habitat under 2c and 2d.
6. Conduct research that expands our understanding of the species' ecological requirements.
 - a. Conduct studies to identify effective pollinators, seed germination needs, and seed viability in the seedbank and in long-term storage.
 - b. Evaluate the effects of extended drought and changes to periods of inundation on Lake County stonecrop.
 - c. Evaluate the effects of fire and its potential role on NVAF and NBF vernal pools and Lake County stonecrop.
7. Manage encroaching vegetation into vernal pools.
 - a. Reduce encroaching vegetation (e.g., pinks (*Petrohagia* spp.), storks-bills (*Erodium* spp.)), invasive plants (e.g., medusahead, yellow starthistle, Italian thistle) and remove thatch or leaf litter buildup in vernal pools, especially at Manning Flat (EO 3) and Thurston Creek (EO 4).
 - b. Establish long-term management plans with landowners to reduce encroaching plants (native and/or non-native) into vernal pools that maintains open habitat for Lake County stonecrop.
8. Reduce impacts to habitat from human-related activities and herbivores.

- a. Protect the extreme edges of habitat from OHV use or road maintenance activities by using and following appropriate signage and staying on existing roads.
- b. Mitigate disturbance from road maintenance activities by restricting staging areas for heavy equipment on existing, disturbed lots (e.g., pull outs) and at an adequate distance away from vernal pools.
- c. Avoid the use of neonicotinoids in agricultural systems near or adjacent to Lake County stonecrop habitat and work with local government agencies and landowners for outreach and to develop policies or guidelines restricting the use of these insecticides.
- d. Work with landowners to mitigate soil compaction and trampling of plants from grazing. August through October is conservatively the safest time to graze Lake County stonecrop vernal pool habitat. It is important to restrict grazing to before germination of Lake County stonecrop or after the plant has set seeds.

X. RECOMMENDATION TO THE COMMISSION

Pursuant to Fish and Game Code section 2077, the Department has prepared this Five-Year Species Review based upon the best scientific information available to the Department to determine if conditions that led to the original listing are still present. Based on this Five-Year Species Review, the Department submits the following recommendation to the Commission:

NO CHANGE IN STATUS

In completing this Five-Year Species Review for Lake County stonecrop, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Lake County stonecrop as endangered are still present, and recommends no change to the status of Lake County stonecrop at this time.

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XII. PERSONAL COMMUNICATION (PERS. COMM.)

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