CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

California Endangered Species Act

5-Year Species Review for Boggs Lake hedge-hyssop (*Gratiola heterosepala*)

Report to the Fish and Game Commission

JUNE 2025

Cover Banner (Alternative text: San shield and text "California Department of Fish and Wildlife [line break] California Endangered Species Act")

Cover photo by Jeb Bjerke (Alternative text: A closeup photograph of a small, green plant with two tubular flowers with yellow throats and fused petals, generally all yellow, except for the lower three outer lobes are white. The fused petals are subtended by sepals that are unequally fused at the base and with rounded tips.)

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III. EXECUTIVE SUMMARY

This 5-year species review for Boggs Lake hedge-hyssop (*Gratiola heterosepala*), which is currently listed as endangered, has been prepared by the California Department of Fish and Wildlife (Department) for the California Fish and Game Commission (Commission) pursuant to the requirements of the California Endangered Species Act (CESA; Fish & G. Code, § 2077, subd. (a)). This 5-year 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. The Department prepared this 5-year species review to evaluate whether conditions that led to the original listing of this species are still present or have changed. In addition, this document contains a review of the identification of habitat that may be essential to the continued existence of the species, and the Department's recommendations for management activities and other recommendations for recovery of the species (Fish & G. Code, § 2077, subd. (a)).

Boggs Lake hedge-hyssop is a small, annual plant. The species grows on the edge of vernal pools in moist soil and up to three inches of water. Its current range extends from Fresno to Modoc counties. Since becoming listed in 1978, its known distribution increased from three populations to 110; however, 60% of populations have not been revisited since 1998. Boggs Lake hedge-hyssop's estimated abundance is low, which may be partly due to its small stature, short window of detection, and extreme annual variation in population size. The temperature, timing of precipitation, and natural draw-down of water most impact the species' ability to germinate, survive, and reproduce.

Present or threatened habitat modification or destruction of habitat is the most immediate threat of extinction, followed by direct impacts from grazing, pollution and runoff, competition, and climate change. An estimated 92 populations (84%) are on land with no permanent protection. Long-term monitoring is ongoing at two sites. Most populations occur on lands that experience grazing of some kind. The Department includes recommendations for management to provide better information on the species' abundance across its range and on its recovery potential.

The Department has determined there is sufficient scientific information to indicate that the conditions that led to the listing of Boggs Lake hedge-hyssop as endangered—i.e., the presence of serious and immediate threats and the need for management activities and other actions to recover the species—are still present and put the species in danger of becoming extinct. For these reasons, the Department recommends no change to the endangered status of Boggs Lake hedge-hyssop at this time.

IV. INTRODUCTION

A. 5-Year Species Review

This 5-year species review addresses Boggs Lake hedge-hyssop (*Gratiola heterosepala*), 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)(23)(A)). 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)).

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. CESA Listing and Review History

On August 25, 1978, the Department proposed to list Boggs Lake hedge-hyssop as endangered (CDFG 1978). In November 1978 the Fish and Game Commission (Commission) listed Boggs Lake hedge-hyssop as endangered under the Native Plant Protection Act (NPPA) of 1977 (Fish & G. Code, § 1900 et seq.). In 1984, plants listed as endangered under the NPPA were designated as endangered under CESA and added to the CESA list of endangered plants (Fish & G. Code, § 2062).

C. Federal Listing History

Boggs Lake hedge-hyssop is not currently listed under the Federal Endangered Species Act (FESA). The species was first proposed for listing under the ESA in 1975. The U.S. Fish and Wildlife Service (USFWS) determined that a listing was not warranted in 1993. In 2005, the USFWS developed a recovery plan for vernal pool ecosystems of California and southern Oregon to conserve FESA-listed species, and address conservation needs for 13 species of concern including Boggs Lake hedge-hyssop (USFWS 2005).

D. California Native American People and Traditional Ecological Knowledge

Since time immemorial, California Native American tribes have lived alongside the fish, wildlife, and native plants of California, including Boggs Lake hedge-hyssop. California Native American people have collected a growing body of knowledge of the environment over thousands of years. This body of knowledge is often referred to as Traditional Ecological Knowledge (TEK) and encompasses the world view where ecology, spirituality, human-animal relationships, and more are all interconnected. TEK and related practices support a deeper understanding of a species' life history and inform its management.

Through our tribal engagement process, the Department sought to understand how tribes would like to engage with TEK and tribal practices of stewardship, restoration, and conservation as it relates to Boggs Lake hedge-hyssop and its habitat. The Department ensures permission is received from tribes before the Department includes any shared information in a 5-year species review. While the Department did not receive any tribal comments or information to be included for this species review, the Department is committed to providing opportunities to engage in future conservation discussions and actions related to Boggs Lake hedge-hyssop and to promote collaborative management of California's natural resources.

E. Notifications and Information Received

The following is a summary of notifications sent to inform partners, including California Native American tribes, of the Department's initiation of a species review of Boggs Lake hedge-hyssop and information received in response to the notifications:

- February 2024—the Department notified in writing to the Commission of a list of species that the Department expects to initiate or continue 5-year species reviews on, including Boggs Lake hedge-hyssop (Fish and G. Code, § 2077(a)). The Commission then sent an email notification of this information to persons subscribed to the Commission's CESA actions listserv (CFGC pers. comm. 2024). The e-mail included a link to the Department's web page for 5-year species reviews at: https://www.wildlife.ca.gov/Conservation/CESA/Five-Year-Reviews.

- April 12, 2024—the Department sent 190 tribal notification letters (paper and electronic) to the list of tribes provided by the Native American Heritage Commission (NAHC) as having a cultural or traditional affiliation with the geographic area of Boggs Lake hedge-hyssop.

- July 8, 2024—the Department followed up with the tribes that had not yet responded to the Tribal Notification letters via email and phone calls.

- The Department received responses from the following six Tribes:
    - Amah Mutsun Tribal Band
    - Big Valley Band of Pomo Indians
    - North Fork Rancheria of Mono Indians
    - Sherwood Valley Band of Pomo Indians
    - Mooretown Rancheria
    - Xolon Salinan Tribe

Any information requested by the Tribes was provided to them by the Department. No information related to Boggs Lake hedge-hyssop was added from Tribes for this species review, but any information received at a later date will be retained by the Department for future tribal engagement for management, recovery, or reviews of the species.

The Department also conducted a literature review and individually contacted local botanists, The Nature Conservancy, the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), Lake County Land Trust, Sacramento Valley Conservancy, the Center for Natural Lands Management, Pepperwood Preserve, County of Sacramento, and private landowners in the areas where Boggs Lake hedge-hyssop occurs. In Spring 2024, the Department conducted three surveys for Boggs Lake hedge-hyssop. The first survey occurred in Tehama County with BLM staff, followed by a survey at Mather Field Vernal Pools in Sacramento County, which was then followed by a final survey in coordination with staff managing an area owned by a private vineyard in Lake County.

V. SPECIES DESCRIPTION AND TAXONOMY

A. Species Description

Boggs Lake hedge-hyssop was first collected in 1923 (Mason and Bacigalupi 1954) and then later collected as herbarium specimens in 1929 from Boggs Lake in Lake County, California (Blankinship 1929). The species was later described by Herbert L. Mason and Rimo Bacigalupi following a 1953 collection from Boggs Lake (Mason and Bacigalupi 1954). Boggs Lake hedge-hyssop is an annual and herbaceous plant that grows upright and is 2-10 cm (0.8-4 in) tall. The upper portion of the plant is sticky with small glands. The species has 4-7 leaves, paired opposite along the stem. The species has one to three tube-like flowers with fused petals (five lobes), that are yellow except for three lobes, which are white. The leaf-like parts under the petals (sepals) are unequally fused at the base with rounded tips that are sometimes notched. The fruit is an egg-shaped capsule, and the tips of the valve (where the fruit comes apart) are blunt.

B. Species Taxonomy and Similar Taxa

In California, the genus *Gratiola* contains three native species (Boggs Lake hedge-hyssop, bractless hedge-hyssop (*G. ebracteata*), and clammy hedge-hyssop (*G. neglecta*) that can overlap in the same habitat. In the field, Boggs Lake hedge-hyssop is most often misidentified as bractless hedge-hyssop Table 1). Clammy hedge-hyssop is more easily distinguishable from the other two species because it contains two opposing bractlets (leaf-like) beneath the sepals that subtend the flower.

VI. LIFE HISTORY AND ECOLOGY

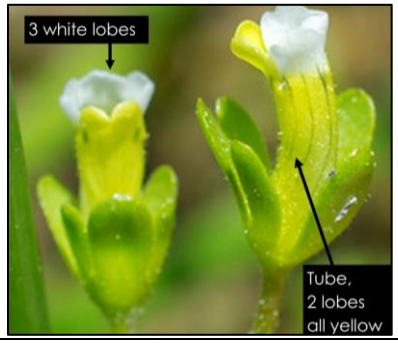
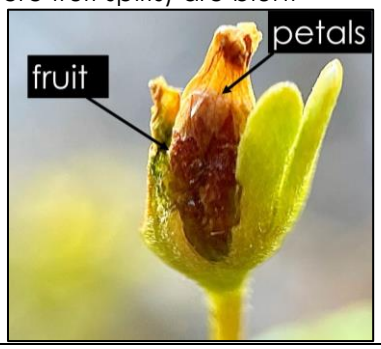
This section considers the best available scientific information regarding the species' life history (Fish & G. Code, § 2072.3; Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)).

Boggs Lake hedge-hyssop flowers between April and August depending on its locality. Its life cycle and window of detection is very short, and may be less than four weeks (Kramer pers. comm. 2024; Witham pers. comm. 2024). At Kiefer Landfill Wetland Preserve, for example, the best time to observe the species is mid-to-late May (Sacramento Valley Conservancy 2023); while the populations in Lassen National Forest and in Alturas bloom in July to August (Corbin et al. 1994). Boggs Lake hedge-hyssop often emerges in lukewarm, shallow water (0.1 - 10 cm (0.5 – 4 in)), then blooms and the fruits mature1-2 weeks after it flowers, setting seeds before the pool is dry, and thereafter disintegrates (Kaye et al. 1990; Kramer pers. comm. 2024; Witham pers. comm. 2024). The species is capable of being pollinated by insects; however, it is unknown the type of insects or how important insect pollination is to the species. The species can also be self-pollinated (Kaye et al. 1990; USFWS 2005; Barbour et al. 2007), which is a reproductive strategy where the plant can self-fertilize without insects.

There is very little information about how Boggs Lake hedge-hyssop seeds are dispersed and how long they remain viable in the soil seedbank. The genus *Gratiola* is known to have a method of "splash seed dispersal by raindrops" (Nakanishi 2002). This dispersal mode occurs when the shape of the sepals (calyx) are cup-like with fused bases, with the fruit capsule containing seeds perched in the center (like in *G. heterosepala*). Subsequently, rain hits the cup and splashes the seeds out of the cup (Nakanishi 2002; CDFW 2011). While seed bank dynamics are unknown for the species, field experts infer that the seed bank is likely persistent for at least 6 years (Kramer pers. comm. 2024; Witham pers. comm. 2024), which is similar to many other annual plants that depend on their annual seed production to replenish their populations. The seeds of the species are most likely to germinate in response to fall or winter rains, including after low winter rainfall (Snow 2022), considering that the plants are often budding or in flower by the time the pools begin to recede (USFWS 2005). Some populations grow in areas where grazing occurs (e.g., Dye Creek Preserve and Kiefer Landfill Wetland Preserve);

however, it is unknown if Boggs Lake hedge-hyssop is adapted to grazing at these locations since the species is found in artificially created pools and grazing has been a part of locality for many years (Kramer pers. comm. 2024).

Table 1. Traits to distinguish Boggs Lake hedge-hyssop from bractless hedge-hyssop. Defining features for Boggs Lake hedge-hyssop are underlined. Sources: petals, sepals by Jeb Bjerke, fruits by Mariel Boldis and Jordan Collins.

Trait	Boggs Lake hedge-hyssop	Bractless hedge-hyssop
CESA Status	Listed as Endangered	Commonly found, not listed
Stems	4-7 leaves, opposite along stem	6-12 leaves, opposite along stem
Petals	Fused petals, <u>all yellow</u>, except <u>3 lobes are white.</u> 	Fused petals, tube all yellow, lobes all white/pink-tinged. 
Sepals (leaf-like parts under petals)	Tips <u>round</u>, sometimes notched. Sepals <u>unequally fused at base.</u> 	Tips have long, tapered, sharp ends. Sepals are separate. 
Fruit	<u>Capsule is egg-shaped</u>, tips of valve (where fruit splits) are blunt 	Capsule is rounded, tips of valve abruptly pointed 

VII. DISTRIBUTION AND ABUNDANCE

A. Range and Distribution

This section considers the species' range and distribution and provides a detailed distribution map (Fish & G. Code, § 2072.3; Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)). A species' range for the purposes of CESA and this review is the species' California range (*Cal. Forestry Assn. v. Cal. Fish and Game Com.* (2007) 156 Cal.App.4th 1535, 1551). Range is the general geographical area where a species occurs. Distribution are the actual sites where individuals and populations occur within the species' range.

Boggs Lake hedge-hyssop's range extends from Fresno to Modoc counties. At the time of listing in 1978, there were only three known populations (Boggs Lake in Lake County, Rio Linda in north Sacramento, and Kennedy Table in Madera County). Since then, many new populations have been documented. Eighty-five new populations were first recorded in the 1980s and 90s in northeastern and central California when the USFWS was considering a federal listing of the species (Corbin et al. 1994; USFWS 2005; CNDDB 2025). There are currently 110 populations (Figure 1), also called Element Occurrences (EOs), which are mapped areas of species presence that are at least 0.4 km (0.25 mi) apart, by the California Natural Diversity Database (CNDDB). Four populations are extirpated and one is possibly extirpated. EOs are not always numerically consecutive due to being combined with other EOs, new EOs that are added later, or for other reasons. For the rest of this document, the term "population" means "EO" as defined by the CNDDB. Most populations are located on private and federally owned lands (Table 2; Figure 2), where most are concentrated in the Modoc Plateau and Northeast Sacramento Valley Vernal Pool Regions (Keeler-Wolf et al. 1998; USFWS 2005). There are 14 populations within urban areas (Figure 3; Caltrans 2024), nine are on non-profit preserves, two are on lands with special designations (Murken Botanical Special Interest Area, South Warner Wilderness), and four are in wilderness study areas (USFWS 2005).

Table 2. Land ownership of the 110 known populations of Boggs Lake hedge-hyssop. [1]Three populations on private lands are protected under conservation easements.

Ownership	No. of Populations	Percentage
Private[1]	41	37.3%
U.S. Forest Service	31	28.2%
BLM	18	16.4%
Non-Profit Preserves, Trusts	9	8.2%
CDFW	6	5.5%
Local Government	5	4.5%

Some of the better documented or more recently documented Boggs Lake hedge-hyssop populations are further described below.

a. Boggs Lake Preserve (EO 2)

Boggs Lake is where the species was first found in 1923 (Mason and Bacigalupi 1954), and is one of the largest, intact vernal pools in California (over 80 ha (200 ac)). Boggs Lake is located between Kelseyville and Cobb Valley, south of Clear Lake, Lake County. The species is distributed on the south and northeastern edges of Boggs Lake, and occurs as scattered individuals in two main areas (CNDDB 2025).

b. Kiefer Landfill Wetland Preserve (EO 18)

The Kiefer Landfill Wetland Preserve is located northwest of Kiefer Landfill, at the southeast corner of the intersections of Grant Line Rd and Kiefer Blvd in Rancho Cordova, Sacramento County. Boggs Lake hedge-hyssop occurs across 14 vernal pools. Most of the observations occur in the shallowest areas of several of the deeper pools (Witham 2016; Sacramento Valley Conservancy 2023; Witham 2023b). There is little to no variation in spatial distribution of this population across 19 years of monitoring (2006-present) (Sacramento Valley Conservancy 2023).

c. Hog Lake (EO 27)

Hog Lake is located along Highway 36, approximately 16 km (10 mi) northeast of Red Bluff in Tehama County. Boggs Lake hedge-hyssop occurs in patches on the northern end of Hog Lake and on the margins of a smaller vernal pool, (i.e., Little Hog Lake), approximately 400 m (1300 ft) north of Hog Lake (BLM 2024b).

d. Montelena Wetland Preserve (EO 57)

The Montelena Wetland Preserve is 20 ha (50 ac) and is located about 4 km (2.5 mi) northwest of Kiefer Landfill Wetland Preserve in Rancho Cordova, Sacramento County (CNDDB 2025). Boggs Lake hedge-hyssop has been found in two vernal pools at the Preserve (Witham pers. comm. 2024).

e. Dye Creek Preserve (EOs 115 – 118)

The Dye Creek Preserve is over 15,000 ha (37,000 ac) located in the Lassen foothills in Tehama County between Redding and Chico, California. There are about 30 pools on the Preserve, and Boggs Lake hedge-hyssop has been found in about six of them. Boggs Lake hedge-hyssop is found in patches in the most shallow vernal pools and stock ponds that are no deeper than 0.6 m (2 ft) (Kramer pers. comm. 2024).

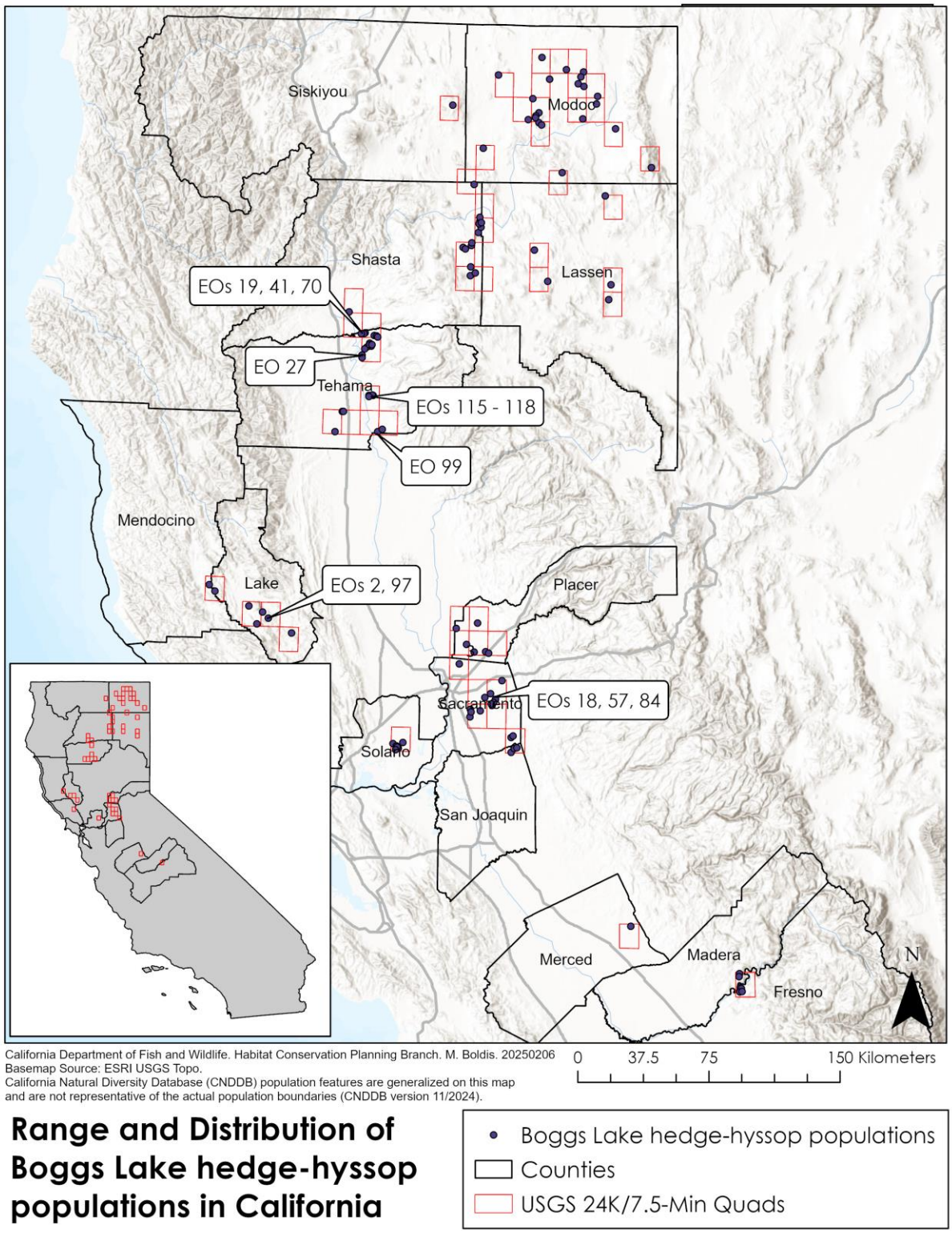
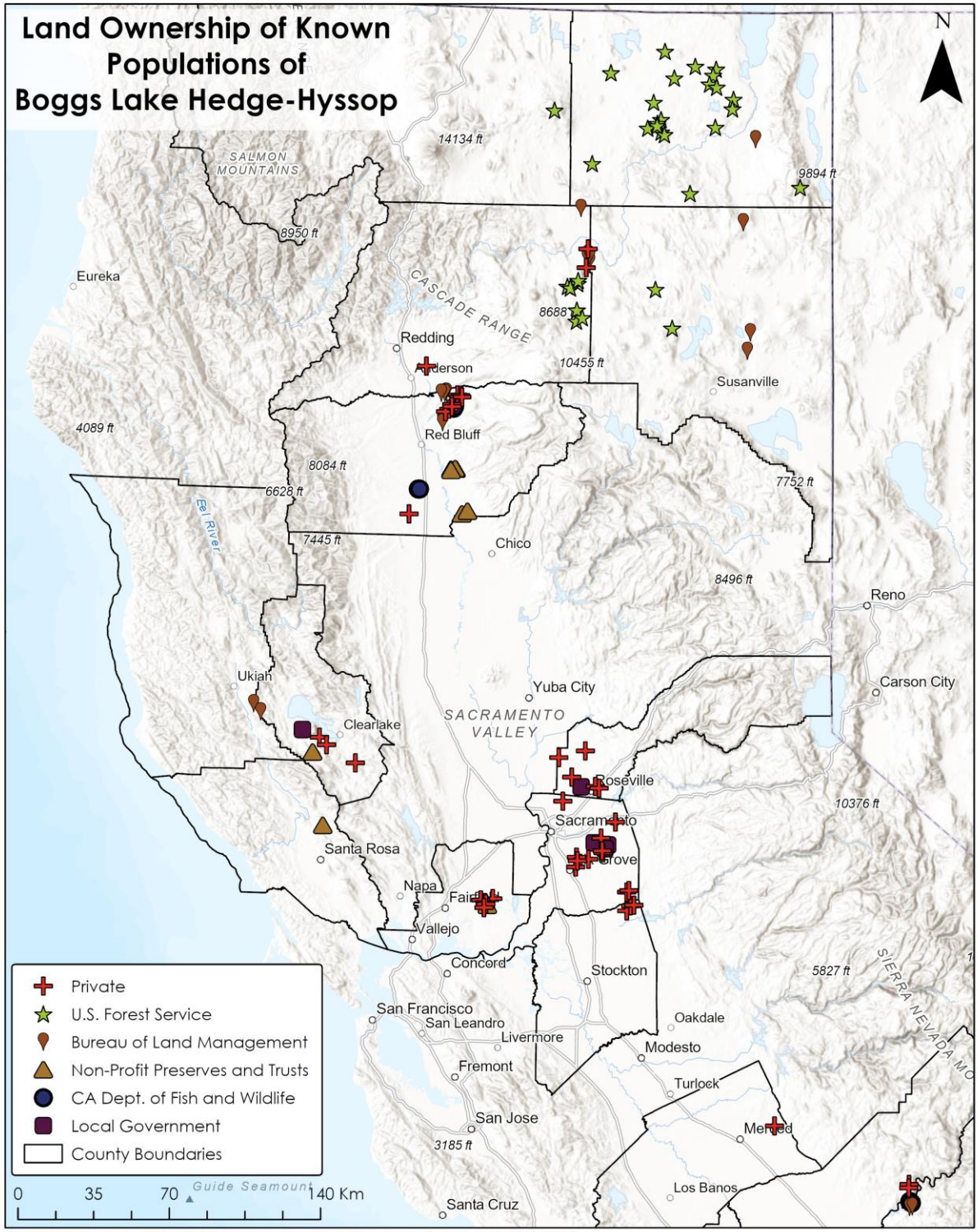


Figure 1. Distribution and range map of Boggs Lake hedge-hyssop. Populations (Element Occurrences (EOs)) described throughout this review are labeled on the map.



California Department of Fish and Wildlife. Habitat Conservation Planning Branch. M. Boldis 20250123
Basemap Source: ESRI USGS Topo. California Natural Diversity Database (CNDDB) population features are generalized on this map and are not representative of the actual population boundaries (CNDDB version 11/2024).

Figure 2. Land ownership of populations of Boggs Lake hedge-hyssop.

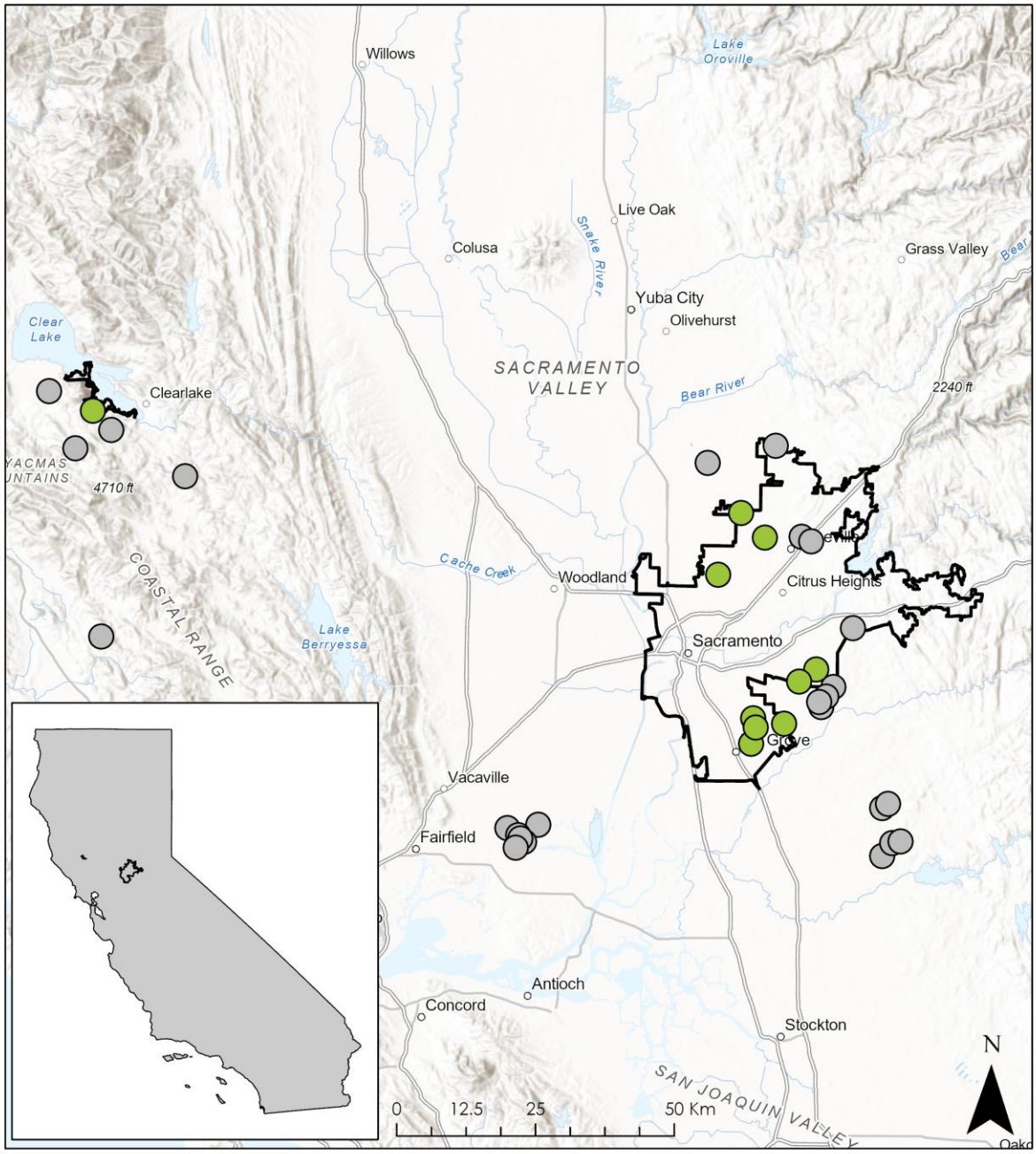


Figure 3. Populations of Boggs Lake hedge-hyssop in relation to Urban Area Boundaries (UAB). The UABs are classified based on human populations of more than 5,000 people in an area (Caltrans 2024).

B. Population Trend and Abundance

This section considers the species' abundance and population trends (Fish & G. Code, § 2072.3; Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)).

The population abundance of Boggs Lake hedge-hyssop is highly variable each year. Some populations have been monitored for ten years to document this variability (Barrows 1984; Barrows pers. comm. 1985a; Barrows 1985b; Bingham et al. 1987; Baldwin and Baldwin 1988, 1990, 1991), and some populations for 17 years and counting (Sacramento Valley Conservancy 2023, 2024). In Spring 2024, the Department surveyed for the species at Mather Field Vernal Pools (EO 84; Figure 1) in Sacramento County (not seen since 2001) and on a privately owned marsh called Ely Flat (EO 97; Figure 1) in Lake County (not seen since 1989); however, no plants were found at either population. The BLM and Department regional staff also surveyed populations 19 km (12 mi) north of Hog Lake (Figure 1) and counted 500-700 plants at Coleman Pond (EO 41), 100-200 plants in two patches at Spring Branch Road (EO 19), and about 10 plants at North Spring Branch Road (EO 70) (Schaefer pers. comm. 2024). Prior to 2023/24, these populations were last surveyed in the 1990s where plant counts at each population were between 50 and 5,000 individuals (CNDDB 2025). An estimated 60% (66/110 populations) have not had any plants observed since 1998 and 58% (64/110) have not been re-surveyed since 1998. Of those populations, 67% of them (43/64 populations) were never surveyed again after the initial discovery. During the 1980s and 90s, many new populations were documented because of the numerous survey efforts conducted by the BLM, USFS, and partners when Boggs Lake hedge-hyssop was still federally classified as a "sensitive" species (Corbin et al. 1994; USFWS 2005). Although there is long-term monitoring in place at two populations, and numerous populations documented since listing, there is still not enough information to understand population trends across the species' range. Some of the better or more recently documented Boggs Lake hedge-hyssop population data are described in more detail below.

a. Boggs Lake Preserve (EO 2)

The population at Boggs Lake Preserve was described in a 1953 herbarium specimen collection as "scattered individuals among a sea of bractless hedge-hyssop" (Mason 1953). In 1981, more than 1,000 plants were observed at Boggs Lake, which is the highest recorded abundance at this location. From 1981 to 1991, annual surveys were conducted between May and July as part of a long-term plant monitoring project (Barrows 1984, 1985a, b; Baldwin et al. 1986; Baldwin 1987; Bingham et al. 1987; Baldwin and Baldwin 1988, 1990, 1991). Boggs Lake hedge-hyssop was not found during the 1981 to 1991 survey period, except for when only a few plants were observed from 1986 to 1988 (Mansfield 1981; Barrows 1984, 1985b; Baldwin et al. 1986; Baldwin 1987; Baldwin and Baldwin 1988, 1991). Since the monitoring project concluded in 1991, there have

only been periodic surveys. No plants were found in 1992, five plants were counted in 1997, and an unspecified number of plants were observed in 2002 and 2010. The last time the population was observed was in 2016 when three plants were found. Based on this information, the population has been in decline.

b. Kiefer Landfill Wetland Preserve (EO 18)

In 1990, Kiefer Landfill Wetland Preserve an estimated 2,500 individual plants were counted, before long-term annual monitoring commenced from 2005 to 2023 (Figure 4) across 14 vernal pools (Witham 2016, 2023b). Four of these pools have had zero plants since monitoring started. The highest abundance was in 2018 with over 870,000 plants. The greatest amount of precipitation in 2018 came in January and temperatures were below average in February-May, which may have contributed to the high abundance of the species (Sacramento Valley Conservancy 2018). Abundance was low in 2019, and late spring algal blooms may have impacted the population. There were zero plants in 2020, likely due to below average temperatures and precipitation during the growing season, and drought followed in 2021-2022 where there were also zero plants counted (Sacramento Valley Conservancy 2019, 2020, 2021, 2022). Overall, the extreme fluctuations in population size may coincide with local rainfall and temperature and do not seem to represent a trend over time (Sacramento Valley Conservancy 2023).

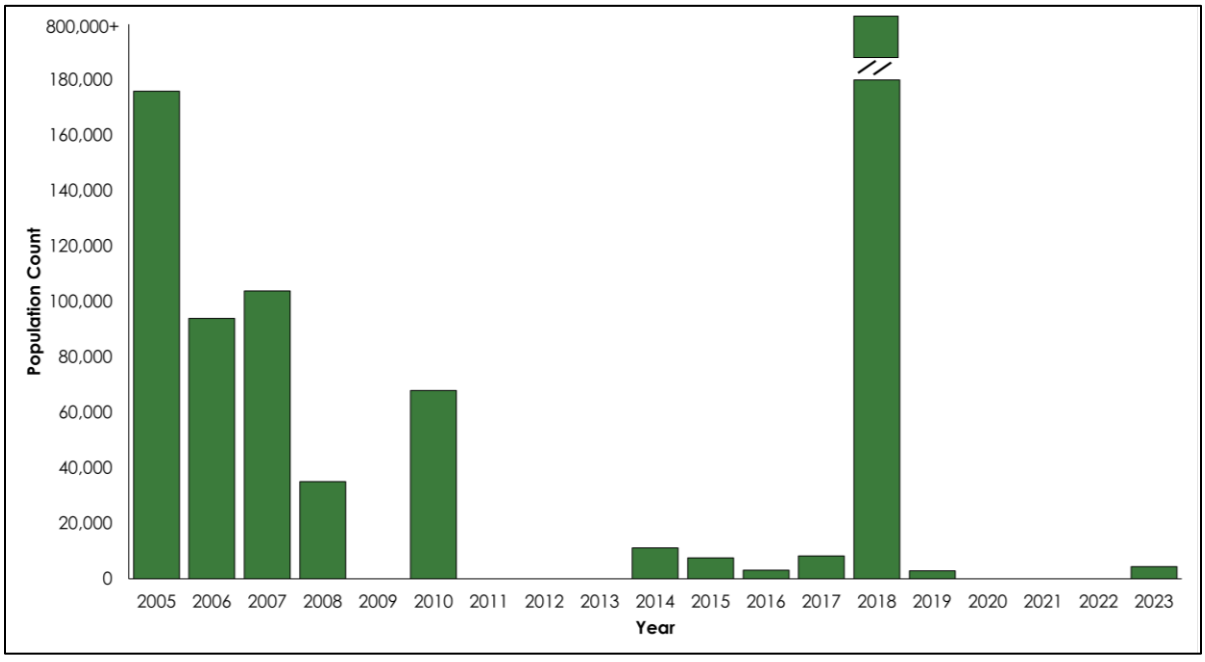


Figure 4. Cumulative abundance of Boggs Lake hedge-hyssop in 14 vernal pools at Kiefer Wetland Preserve from 2005 to 2023. Sources (Sacramento Valley Conservancy 2007; Witham 2016; Sacramento Valley Conservancy 2018, 2019, 2020, 2021, 2022, 2023; Witham 2023b).

c. Hog Lake (EO 27)

The BLM first documented Boggs Lake hedge-hyssop in 1991, where approximately 1,000 plants were found, followed by another survey in 1996 when counts were in the low hundreds (CNDDB 2025). There are no known surveys for the species from 1997-2022. The BLM surveyed for Boggs Lake hedge-hyssop in 2023 and estimated about 190 plants in the large vernal pool and zero plants in the smaller pool (i.e., Little Hog Lake) as part of a recently completed grazing assessment (Freund 2023; BLM 2024b). The Department conducted a survey with the BLM at Hog Lake in May 2024 and about 20 plants were estimated in one patch and about 50 plants in another. Based on this information, the population appears to persist but is overall likely in decline.

d. Montelena Wetland Preserve (EO 57)

A population consisting of a single occupied pool at Montelena Preserve was monitored from 2006 to 2023 (Table 3; Witham 2023a). Boggs Lake hedge-hyssop was detected in another pool in 2024, where it had never been recorded before despite almost two decades of monitoring the nearby pool (Sacramento Valley Conservancy 2024; pers. comm. Witham 2024). The population appears to be in decline, but there is not enough data to identify a trend.

Table 3. Population counts of Boggs Lake hedge-hyssop from a single vernal pool at Montelena Wetland Preserve from the monitoring period 2006-2023. Data by Witham (2023a) and Sacramento Valley Conservancy (2024).

Year	Plant Count
2006	No Survey Data
2007	No Survey Data
2008	2,000
2009	0
2010	1,500
2011	325
2012	0
2013	0
2014	100
2015	No Survey Data
2016	1,000
2017	900
2018	0
2019	0
2020	0
2021	0
2022	0
2023	0

e. Dye Creek Preserve (EOs 115 – 118)

Dye Creek Preserve has 30 artificial duck ponds, and Boggs Lake hedge-hyssop was first observed in 2001 in two of the ponds with about 500 plants. In 2002, several other ponds contained an estimated 13,000 plants in total, but only "very few" were found in 2003. Few plants were observed in 2023. In 2024, about 8,000 plants were counted across six duck ponds, one of which the species was observed in for the very first time (Kramer pers. comm. 2024). Overall, patches of the species may be especially dense during years of high abundance (Craig pers. comm. 2024; Kramer pers. comm. 2024), and the populations appear to persist, but there is not enough information to identify a trend.

VIII. HABITAT NECESSARY FOR SPECIES SURVIVAL

This section considers the best available scientific information regarding the kind of habitat necessary for the species survival (Fish & G. Code, § 2072.3; Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)), and a review of the identification of the habitat that may be essential to the continued existence of the species (Fish & G. Code, § 2077, subd. (a)).

Boggs Lake hedge-hyssop is typically found in bare areas (Figure 5) with sparse vegetation (Figure 6) along the edges of natural vernal pools (e.g., Hog Lake, Tehama County) or man-made water bodies (e.g., Moon Springs Reservoir, Shasta County. The species is found in moist soil or in up to 10 cm (4 in) of water (Barbour et al. 2003; Witham pers. comm. 2024). Pools the species is found average 24 cm (9 in) deep and range from 5-70 cm (2-28 in) deep, at 10-2,375 m (33-7792 ft) in elevation (Barbour et al. 2007).

Figure 5. Boggs Lake hedge-hyssop found flowering on sparsely vegetated, moist soil. Photo Credit: BLM, Hog Lake, Redding, March 2024.

Figure 6. Habitat conditions typical of where Boggs Lake hedge-hyssop is found. The species is marked by the pink flags at the edges of Hog Lake which is southest of Redding, California. Photo credit: BLM, Redding, 2024.

A. Vegetation Communities

Boggs Lake hedge-hyssop is associated with seven different vernal pool regions (Modoc Plateau, Northwest Sacramento Valley, Northeast Sacramento Valley, Lake-Napa, Solano-Colusa, Southeast Sacramento Valley, and South Sierra Foothill) as described by Keeler-Wolf et al. (1998). Within these regions, the species is related to four vegetation alliances (*Lasthenia fremontii - Distichlis spicata*, *Lasthenia glaberrima - Eleocharis macrostachya*, *Montia fontana - Sidalcea calycosa*, *Navarretia leucocephala ssp. miima - Plagiobothrys cusickii*) and various vegetation associations, as described in the Manual of California Vegetation (VegCAMP 2016; CNPS 2024; Ratchford pers. comm. 2024). Alliances and associations are lower-level units of the classification hierarchy that provide greater floristic details at smaller geographic scales than a higher level (e.g., macrogroup) and are often preferred for species reviews to support conservation and management decisions. Data collected over a 5-year period in the Central Valley found the species in six different vegetation associations (Barbour et al. 2007). These associations are listed below, along with the frequency at which the species is found in each association:

- *Pogogyne douglasii - Lasthenia glaberrima*; commonly
- *Downingia bicornuta - Lasthenia fremontii*; occasionally
- *Downingia bicornuta - Lasthenia glaberrima*; rarely
- *Downingia cuspidata - Lasthenia fremontii*; rarely

- *Pleuropogon californicus - Lasthenia glaberrima*; rarely
- *Montia fontana - Sidalcea calycosa*; rarely

Plant species that are most commonly associated with Boggs Lake hedge-hyssop across its range include one state-listed endangered plant (bold) and the following species in order of frequency:

- Bractless hedge-hyssop (*Gratiola ebracteata*)
- Stalked popcornflower (*Plagiobothrys stipitatus*)
- Two-horned downingia (*Downingia bicornuta*)
- **Slender Orcutt grass (*Orcuttia tenuis*)**
- Common spikerush (*Eleocharis macrostachya*)

B. Geology and Soils

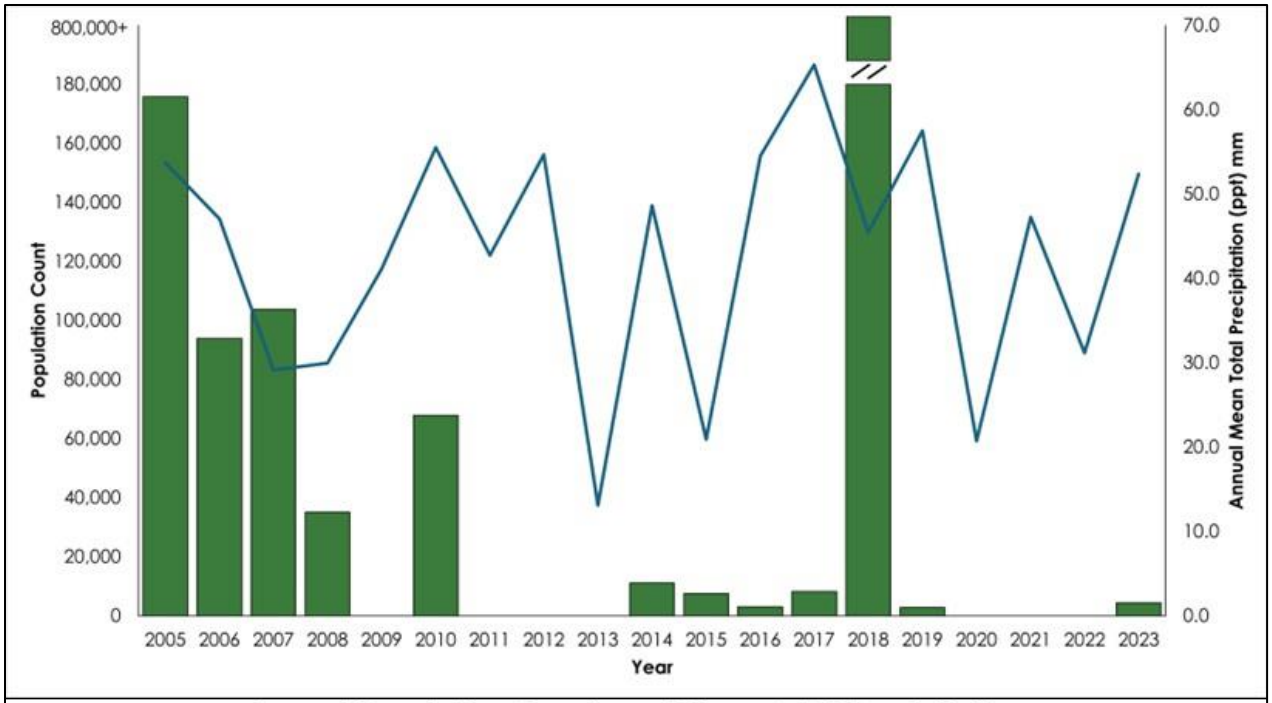
One of the most important soil characteristics associated with Boggs Lake hedge-hyssop are the thin, rocky, clay soils that form a hardpan when dry. This hardpan is crucial for water retention in vernal pools and stock ponds in springtime. In northern California, some populations grow on slightly acidic soils (USFWS Corbin et al. 1994; 2005). The populations in Lassen and Modoc National Forests occur on numerous soil families that include poorly draining soils that are important for the species (Corbin et al. 1994). Some populations in the Central Valley are associated with volcanic mudflows, basin rims, and high terraces on numerous geomorphic surfaces including Lovejoy, Modesto, Red Bluff, and Laguna (Barbour et al. 2007). In the Central Valley, the species is associated with several series (Barbour et al. 2007).

C. Climate and Hydrology

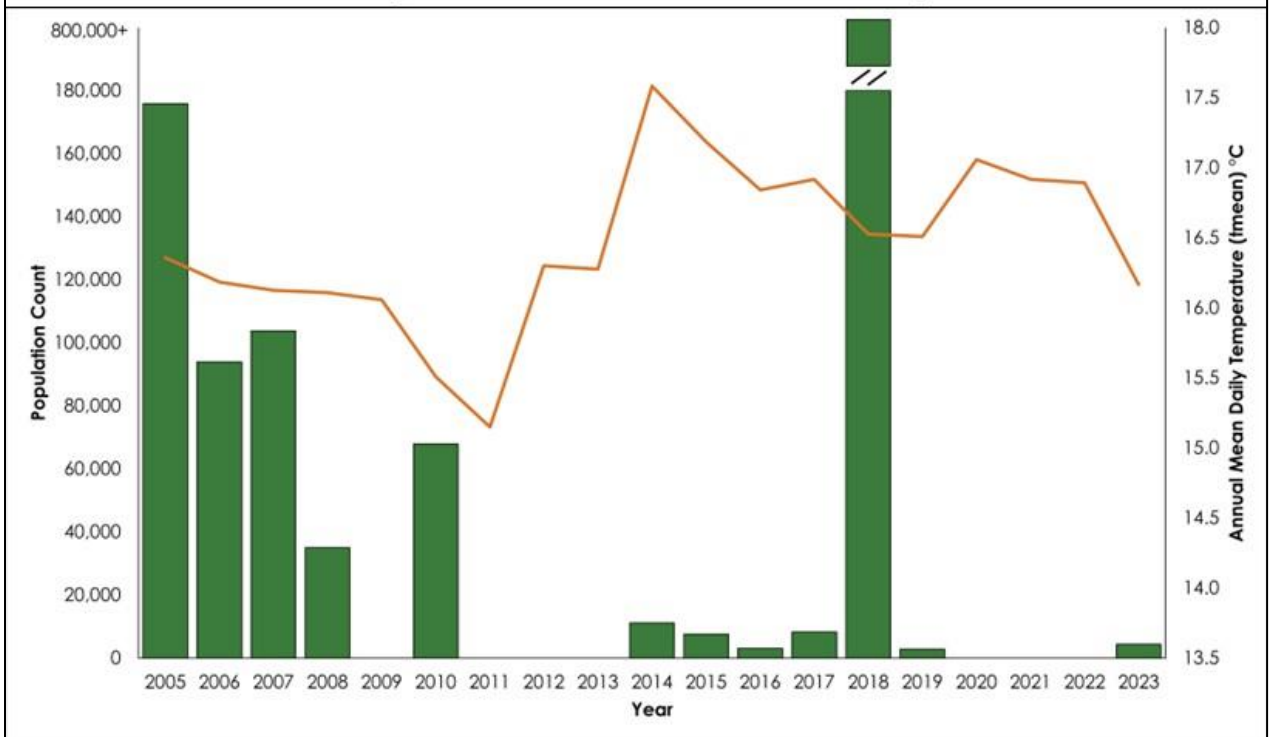
The timing and amount of precipitation and temperature at the peak of flower and/or seed production may impact successful reproduction of Boggs Lake hedge-hyssop. The species typically emerges in warmer ambient temperatures and in pools with short inundation periods (Bingham et al. 1987; Baldwin and Baldwin 1990, 1991; Sacramento Valley Conservancy 2023; Kramer pers. comm. 2024; Sacramento Valley Conservancy 2024; Witham pers. comm. 2024), which is typical of many rare annual plants (Levine et al. 2008). At Boggs Lake, for example, only a few Boggs Lake hedge-hyssop plants were observed for three years (1986-1988) out of the 10-year monitoring period (1981-1991). It was thought the species was declining due to drought, considering 1987 and 1988 were especially dry years. However, the monitoring data shows the species appeared during some of the driest years— following high rainfall and high water level years (1982-1984) with a more moderate winter (1984) that lead to a completely dry lakebed (1985) since 1982, followed by a period of drought (1987-1988) (Mansfield 1981; Barrows 1984, 1985b; Baldwin et al. 1986; Baldwin 1987; Baldwin and Baldwin 1988, 1991).

In another example, the Department used PRISM's long-term monthly time series dataset (Prism Climate Group 2024a) to plot the annual mean total precipitation and annual mean daily temperature during the same time period as population monitoring occurred at Kiefer Landfill Wetland Preserve 2005-2023 (Figure 7). The average total precipitation during the germinating and growing period (December-March) was 90.0 mm (+/- 70.5 mm), which was much more variable than the average total precipitation during the flowering and senescing period (April -August), which had a mean of 14.3 mm (+/- 14.1 mm). The average daily temperature during these same periods (December to March) was 10.0 °C (+/- 1.3 °C). The extreme fluctuation in populations appears to be unrelated to local rainfall and temperature patterns and does not show a directional trend over time. Population abundance over the course of 18 years has no significant correlation with mean total annual precipitation from January to December ($r = 0.077$) and has no correlation with mean daily temperature ($r = -0.034$). However, it is important to note that although Boggs Lake hedge-hyssop abundance is not correlated with weather patterns in this case, the relationship between various plant traits (e.g., lifespan, plant height) and mean annual temperature or mean annual precipitation are correlated more strongly than with abundance alone (Moles et al. 2014).

The Department also assessed PRISM's 30-year normal (1991-2020) dataset of monthly averages of total precipitation and monthly averages of daily temperature across the species' entire range (Figure 8) to estimate extents in weather that the species may commonly occur in (Prism Climate Group 2024b). The average annual total precipitation (September to August) is 49.9 mm (+/- 20.6 mm). The annual average daily temperature is 13.4 °C (+/- 3.9 °C). It is interesting to note that May (which is when the species first starts flowering in many localities), is the first month after a major part of the rainy season (Nov-Mar). The average precipitation in May (37.4 mm, SD +/- 14.5 mm, SE +/- 1.4 mm) drops below the annual average, and the average monthly temperature (15.4 °C, SD +/- 4.0 °C, SE +/- 0.4 °C) rises above the annual average (Figure 8). If the species is already entering its flowering phase and temperatures are too high for too long and drawdown occurs too quickly, or the temperature drops and late precipitation floods the pool again, the species may not reproduce that year, which is devastating for an annual species long-term.



Annual Population Counts and Mean Total Precipitation



Annual Population Counts and Mean Daily Temperature

Figure 7. Cumulative annual abundance of Boggs Lake hedge-hyssop and annual mean total precipitation (top) and mean daily temperature (bottom) for the monitoring period (2005-2023) at Kiefer Wetland Preserve.

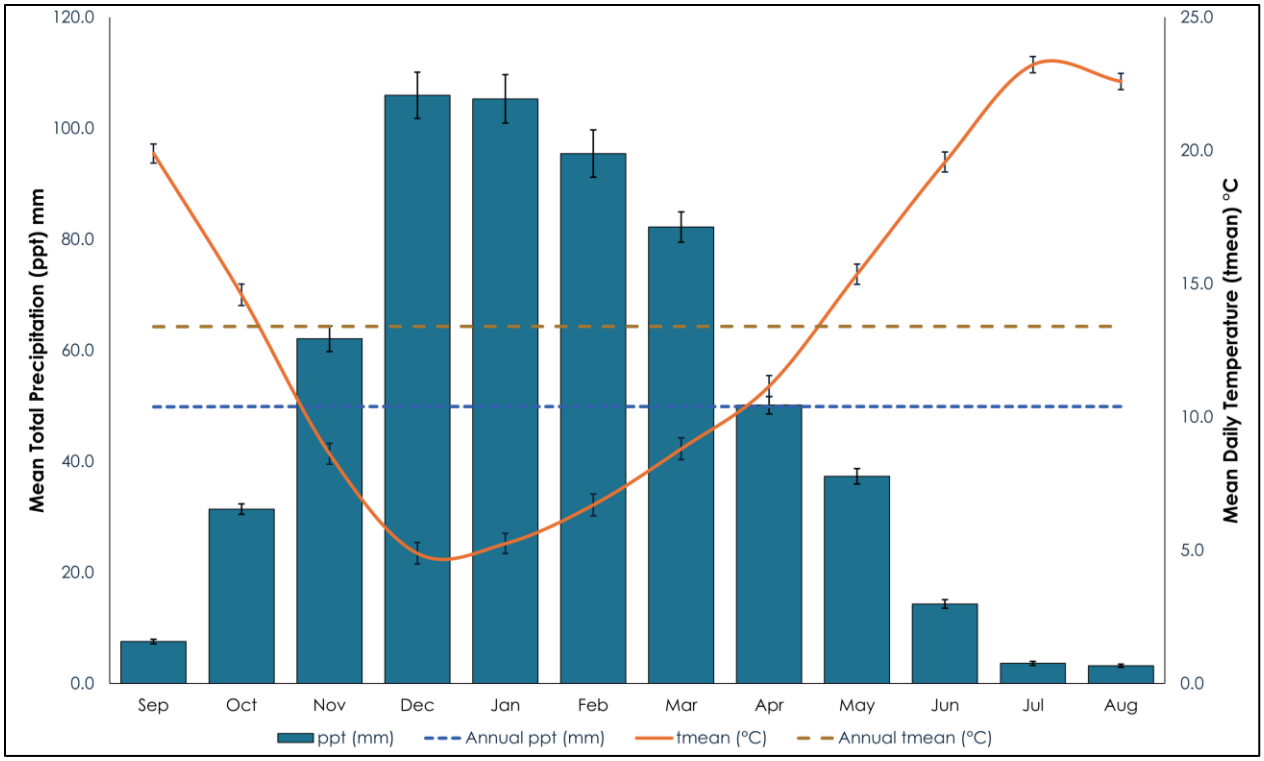


Figure 8. PRISM 30-year normals (1991-2020) of the monthly mean total precipitation and monthly mean daily temperatures with standard error bars. The mean annual total precipitation (Annual ppt (mm)) and annual mean daily temperatures (Annual tmean °C)) are denoted by the dashed lines.

IX. THREATS AND SURVIVAL FACTORS

This section considers the factors affecting the ability of the species to survive and reproduce, and the degree and immediacy of threat (Fish & G. Code, § 2072.3; Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)). In addition, this section addresses the six listing factors identified in title 14 of the California Code of Regulations section 670.1, subdivision (i)(1)(A): Present or threatened modification or destruction of habitat, overexploitation, predation, competition, disease, or other natural occurrences or human-related activities. This section reviews the best scientific information available, and assesses the degree of threat, for each factor. The sixth listing factor, "other natural occurrences or human-related activities", is addressed under the following subsections: Climate change and nutrient pollution.

A. Factors Affecting Ability to Survive and Reproduce

Boggs Lake hedge-hyssop's survival and reproduction depend entirely on the existence of pools that reliably fill and dry down. Most populations are vulnerable to disturbance or destruction from grazing, trampling, activities associated with logging, recreation,

hydrological alterations, road construction, fire suppression, competition, and herbicide drift (USFWS 2005; CNDDB 2025). Seventy populations indicate grazing or trampling as a threat, and 16 populations are currently on grazing allotments (VegCAMP 2016; BLM 2024a; CNDDB 2025). Any top soil disturbance between germination and seed setting would result in the species being unable to complete its lifecycle, which may reduce the number of seeds and viable plants in the following years (Corbin et al. 1994). The factors that threaten the species' ability to survive and reproduce also threaten the species' habitat and the seasonal precipitation cycles that many vernal pools rely on.

a. Present or Threatened Habitat Modification or Destruction of Habitat

Habitat modification and destruction is a great threat to the biodiversity of vernal pools, altering the hydrology and soils of vernal pools which shift the regional distribution of plant species and endemic plant assemblages (Barbour et al. 2003; Barbour et al. 2007; Vollmar et al. 2023). An estimated 87% of the Central Valley's vernal pools have been lost over the last 200 years, with an estimated 13% lost between 1997 and 2005 alone (Holland and Hollander 2007). Land conversions related to urban growth have accounted for at least 19% of total vernal pool habitat loss between 1976 and 2005 (Holland and Hollander 2007; Vollmar et al. 2023), which includes the known extirpation of one population of Boggs Lake hedge-hyssop in Sacramento County from residential development (CNDDB 2025), and 10 vulnerable populations located within urban area boundaries (Figure 3), which are considered densely developed areas (Caltrans 2024), in Lake and Sacramento counties (USFWS 2005; Sacramento Valley Conservancy 2024).

Boggs Lake hedge-hyssop occurs on land under various levels of ownership (Figure 2). Most populations are on federal lands (45%) and private property (37%; Table 2), which puts the species' habitat at particularly high risk to grazing impacts and development (CNDDB 2025). Any future development can have major impacts on the hydrology of the species' habitat in neighboring areas. Altered hydrology can contribute to declining species abundance due to increased exposure to change in environmental conditions. Competition or human-related activities identified in this species review can further exacerbate declines in species abundance. For example, the Mather Field Vernal Pools contain a population of Boggs Lake hedge-hyssop on the southeastern border of protected land which is adjacent to the designated land use "Urban Development Area" (Figure 9) (County of Sacramento 2016a). There are plans to convert over 323 ha (800 ac) of vernal pool grassland to mixed-use residential, commercial, and educational development, and set aside 21 ha (53 ac) as a part of the Mather Preserve (County of Sacramento 2020); however, development has been delayed. Another population currently surrounded by land being developed for residential housing is the Montelena Wetland Preserve. Roads, sidewalks, and street

lighting were built in late 2021. Landscaping was installed in 2022, followed by residential homes (Sacramento Valley Conservancy 2024).

About 42 populations (38%) of Boggs Lake hedge-hyssop are on lands that have experienced fire since 1910 (Figure 10), including wildfire and prescribed burns (CALFIRE 2024b; CNDDB 2024). For example, the Kiefer Landfill Wetland Preserve in Sacramento County contains vernal pools with Boggs Lake hedge-hyssop that are subject to indirect impacts due to its location within the 76 m (250 ft) zone of the proposed landfill expansion area and proximity to a wildfire that broke out in July 2023 (Sacramento Valley Conservancy 2023). The wildfire impacted approximately 3.6 ha (9 ac) on the northern portion of the Preserve (Figure 11) which overlapped with habitat that had one previous observation of Boggs Lake hedge-hyssop in 1990 (none during the 19-year monitoring period) (Sacramento Valley Conservancy 2023). While it is unknown how fire impacts the species, studies have shown that fire can be detrimental (Gerhardt and Collinge 2003) or beneficial (Marty pers. comm. 2007; Gantenbein and Little pers. comm. 2024) to vernal pool plant species. However, implementation of prescribed fire can be challenging because of limited funding and capacity, especially in habitat near urban areas where air quality and liability are major concerns (Marty 2015).

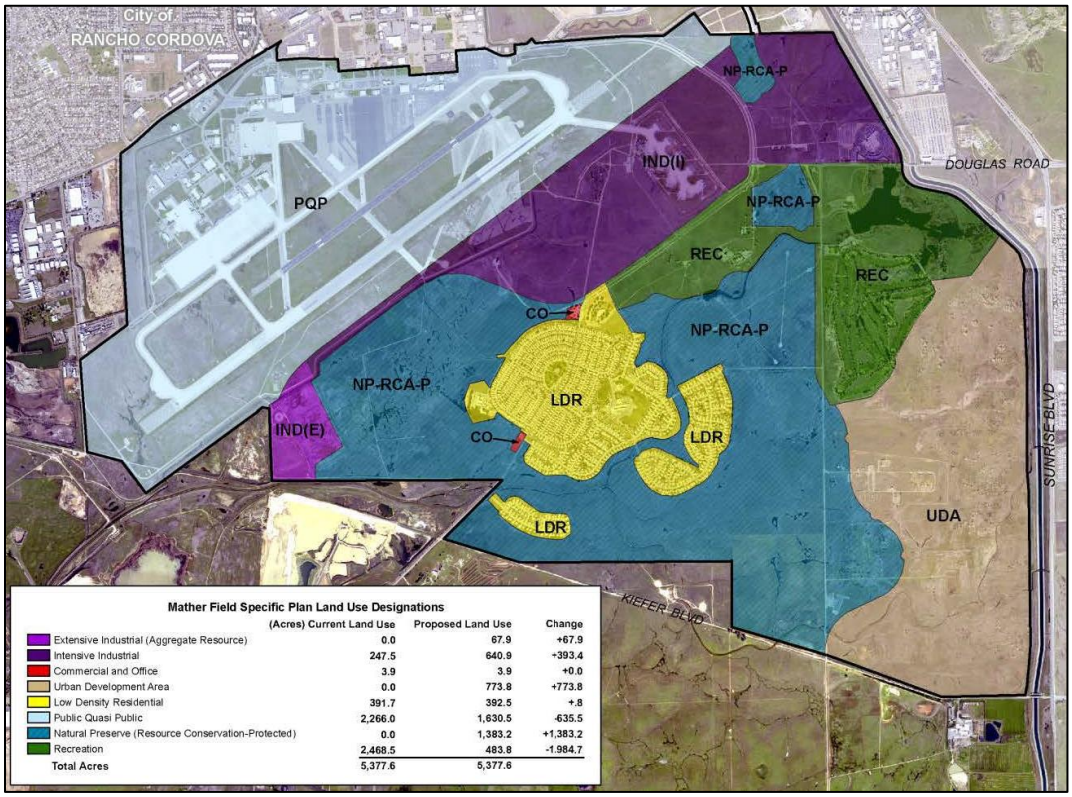


Figure 9. Mather Field Specific Land Use Designations. Boggs Lake hedge-hyssop occurs on land designated as "Natural Preserve (Resource Conservation-Protected)" which is blue on the map (County of Sacramento 2016a).

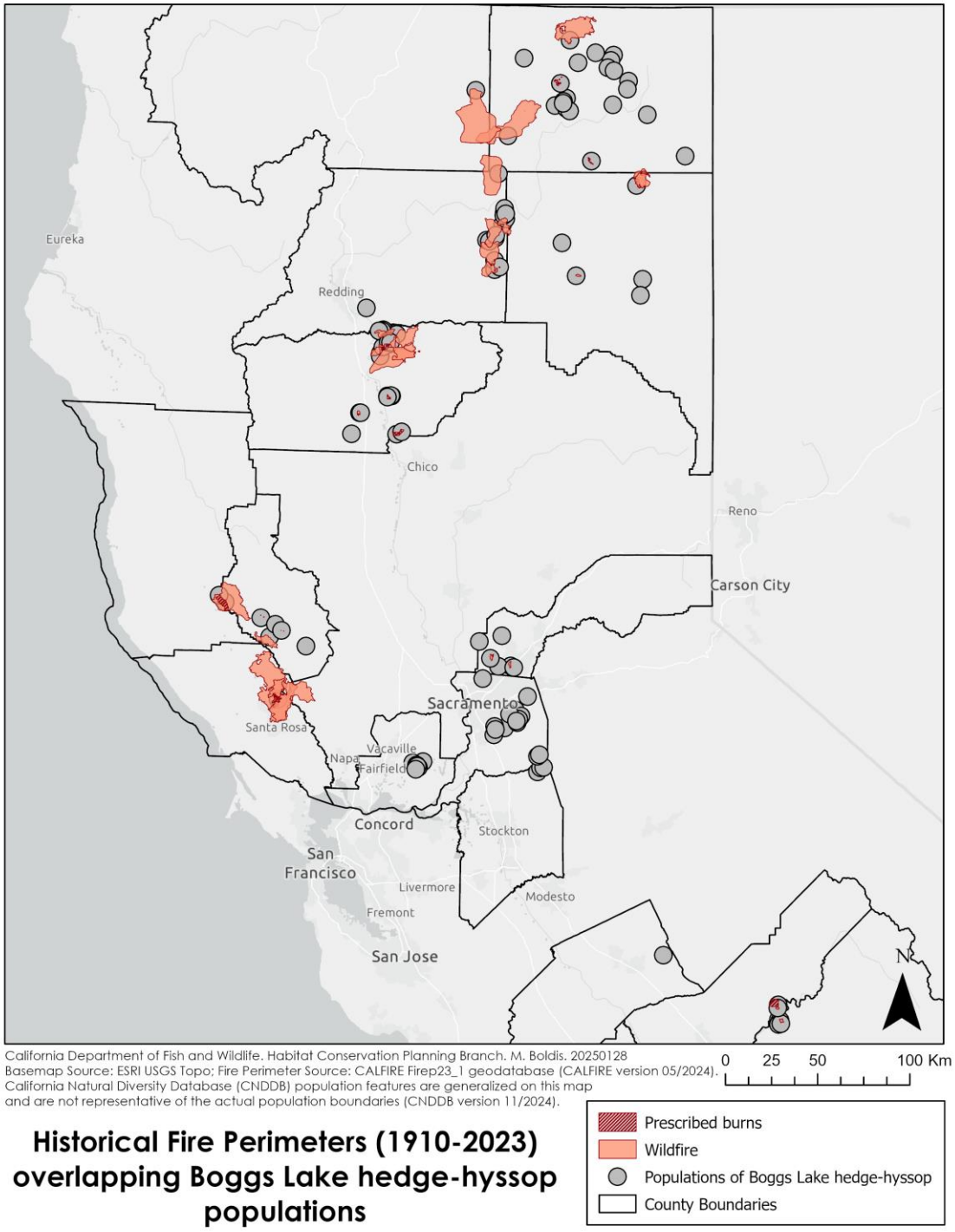


Figure 10. Historic fire perimeters for prescribed burns and wildfire overlapping 42 populations of Boggs Lake hedge-hyssop (CALFIRE 2024a).

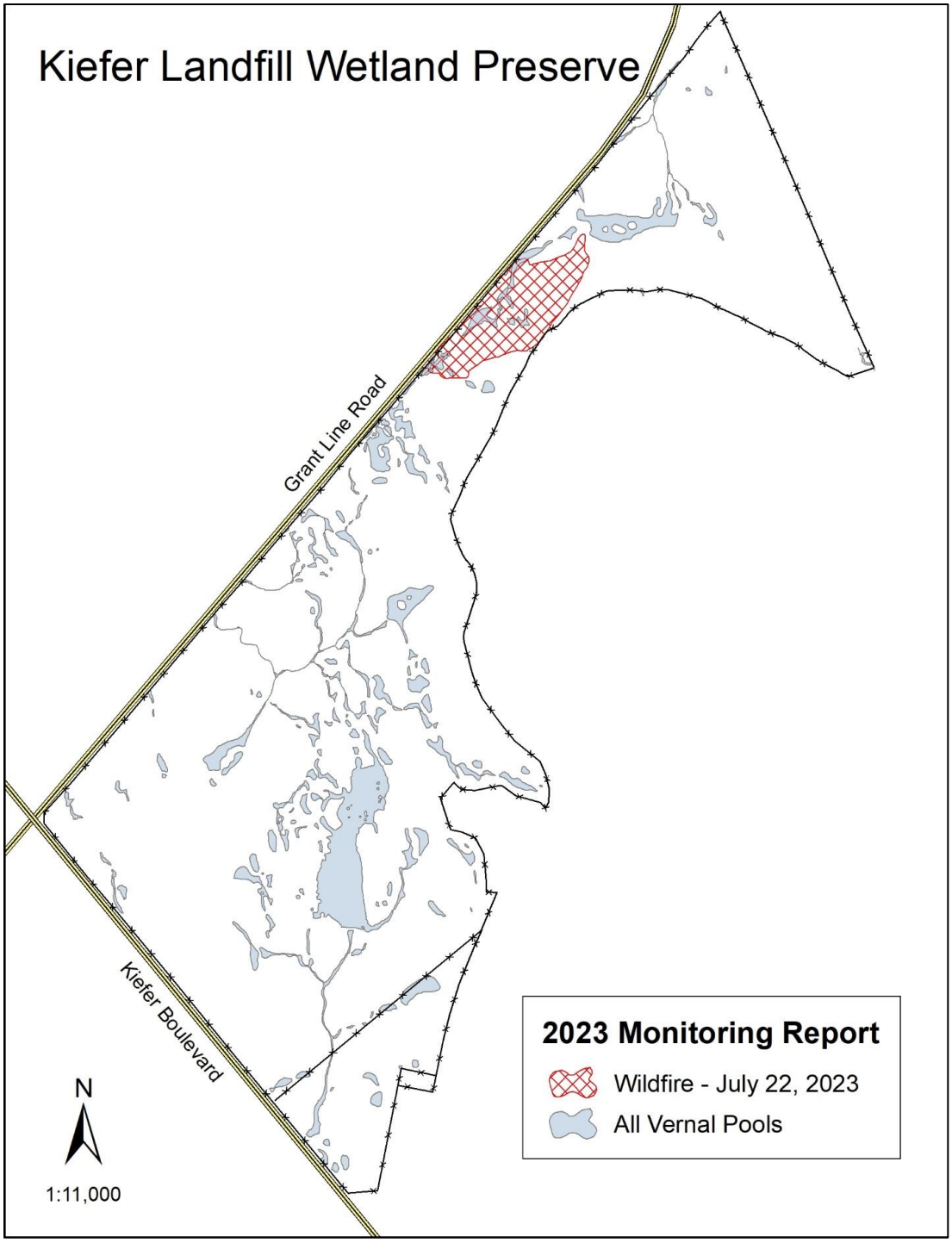


Figure 11. Wildfire in 2023, that burned on the northern end of Kiefer Landfill Wetland Preserve. Figure sourced from the 2023 Biological Monitoring Report (Sacramento Valley Conservancy 2023).

b. Overexploitation

There is no available evidence of overexploitation threatening the existence or persistence of Boggs Lake hedge-hyssop.

c. Predation

There is currently no evidence of direct predation on Boggs Lake hedge-hyssop; however, there is evidence of impacts from grazing or browsing Boggs Lake hedge-hyssop habitat. Approximately 70 Boggs Lake hedge-hyssop populations are located on lands that have previously experienced or currently experience some form of grazing by cattle, sheep, pigs, or wild horses (VegCAMP 2016; BLM 2024a; CNDDB 2024), with 16 of those populations currently located on grazing allotments (BLM 2024a). Livestock grazing in vernal pools has prompted research and discussion on the impacts of hoof prints and trampling which have led to polarizing results (Robins and Vollmar 2002). At Dales Lake Ecological Reserve, where a population of Boggs Lake hedge-hyssop occurs, grazing has been excluded for a number of years which subsequently increased the growth of competing plants that reduced the amount of bare ground available—ultimately creating habitat conditions that do not support the species (Sater pers. comm. 2024). A population at Devils Garden, located in Modoc National Forest, has previously experienced extensive trampling by cattle and wild horses at the pool edges while the species were seen growing (Corbin et al. 1994). While grazers can remove other plant species encroaching into new areas, ill-timed grazing can crush small plants (e.g., Boggs Lake hedge-hyssop) and increase invasive plant cover overall (Robins and Vollmar 2002; Butterfield et al. 2022). A USFS Biological Assessment indicated that cow trails cut across vernal pool plant habitat that included Boggs Lake hedge-hyssop, trampling individuals and degrading site conditions (USFS 2006b). The following provides more detailed information on grazing impacts at two sites with the species:

<u>Boggs Lake Preserve</u> – Deer browsing was noted as severe in the wet strip where Boggs Lake hedge-hyssop was usually found germinating (Baldwin and Baldwin 1988, 1991). In 1988, an area where the plants were observed was subject to daily browsing by deer; and several days after data collections, young equestrians were seen stopping at the site which caused inadvertent trampling of the species (Baldwin and Baldwin 1988). Both deer browsing and equestrian activity during this time may have contributed to lower plant counts or no observations of the species in subsequent years. It is currently unknown whether deer browsing and recreation still occur and how they impact the species.

<u>Hog Lake</u> – Cattle grazing occurs at Hog Lake between December 15 and April 30 (BLM 2024b). Minimal trampling and hoofprints have been documented on the thin soils

where the species occurs on the north end of Hog Lake (BLM 2024b). However, there are currently no barriers in place to avoid grazing on the species' occupied habitat. Boggs Lake hedge-hyssop has not been observed at the smaller vernal pool nearby (i.e., Little Hog Lake) since 1991. Little Hog Lake is entirely accessible to cattle and there have been cattle hoofprints throughout the entire pool (BLM 2024b), which may likely indicate local extirpation of Boggs Lake hedge-hyssop if the species continues to remain undetected in future survey efforts. Any increased cattle use of Hog Lake would intensify the impacts of trampling, which can be detrimental to the species (BLM 2024b). In contrast, removing grazing completely at Hog Lake could make the margins of Hog Lake more susceptible to invasive species encroachment, and subsequently more impacted by early season grazing targeting invasive species (BLM 2024b).

d. Competition

The edges of vernal pools, especially where Boggs Lake hedge-hyssop occurs in up to 10 cm (4 in) of water, are vulnerable to competition by non-native plants (e.g., waxy manna grass (*Glyceria declinata*)), and encroachment by other vegetation such as cattails (*Typha* spp.), tules (*Schoenoplectus* spp.), or bulrushes (*Scirpus* spp.). The mixed conditions of wet and dry make it ideal for a wider array of species (Robins and Vollmar 2002; CDFW 2024d; Witham 2024 pers. comm. 2024). Competitive plants that are prolific seeders or with long-lived seed banks may become more abundant and encroach habitat following especially dry years or during periods of extended drought (Robins and Vollmar 2002), which may impact the ability for Boggs Lake hedge-hyssop to successfully germinate and recruit. The following provides more detailed information on competition at four sites with Boggs Lake hedge-hyssop:

Boggs Lake Preserve – There is one non-native species, yellow star-thistle (*Centaurea solstitialis*), that was conspicuously dominant across various monitoring years (Baldwin and Baldwin 1990, 1991), and is still considered a species to watch and manage for at the Preserve. Yellow star-thistle is rated as a highly invasive plant (Cal-IPC 2024), which means it has severe ecological impacts to biological communities, establishes easily, and is responsible for complete shifts in community structure.

Hog Lake – Annual non-native grasses represent about 50% of total herbaceous cover according to a 2023 Rangeland Health Assessment (BLM 2024b) which includes wild oat (*Avena fatua*), slender wild oat (*Avena barbata*), ripgut brome (*Bromus diandrus*), yellow star-thistle, medusahead (*Elymus caput-medusae*), Italian ryegrass (*Festuca perennis*), and rough cat's-ear (*Hypochaeris radicata*). Medusahead covers most of the upland at Hog Lake that surrounds the vernal pool. This species creates heavy thatch (BLM 2024b), and is rated as a highly invasive plant (Cal-IPC 2024).

Montelena Wetland Preserve – The uplands at Montelena Wetland Preserve are dominated by non-native species (wild oats, soft chess brome (*Bromus hordeaceaus*), filaree (*Erodium* spp.), and annual fescue (*Festuca octoglora*)), and to a lesser extent, the invasive medusahead and barbed goatgrass (*Aegilops triuncialis*). Since Montelena Wetland Preserve is surrounded by residential development and landscaping, the vernal pools may become more vulnerable to invasive species spreading from landscaped plants and recreational use around the perimeter of the Preserve (Sacramento Valley Conservancy 2024).

Kiefer Landfill Wetland Preserve – The uplands at Kiefer Landfill Wetland Preserve are dominated by non-native species, and the invasive medusahead and barbed goatgrass. Yellow starthistle, rattlesnake grass (*Briza maxima*), yellow glandweed (*Bellardia viscosa*), and stinkwort (*Dittrichia graveolens*) are monitored and treated as necessary (Sacramento Valley Conservancy 2023). A significant amount of waxy manna grass cover has also been reported within the vernal pools at Kiefer Landfill Wetland Preserve (Sacramento Valley Conservancy 2023). Waxy manna grass is also rated as a highly invasive plant (Cal-IPC 2024) and is extremely difficult to control. Dense populations of waxy manna grass can significantly reduce available habitat and native plant populations (including Boggs Lake hedge-hyssop) if left unmitigated (Gerlach et al. 2009; DiTomaso et al. 2013; Helm 2019; CDFW unpublished data).

e. Disease

There is no available evidence of disease threatening the existence or persistence of Boggs Lake hedge-hyssop.

f. Climate Change

Boggs Lake hedge-hyssop is highly dependent on the timing and amount of precipitation and timing of when water draw-down of pools occurs to survive and reproduce (Kramer pers. comm. 2024; Witham pers. comm. 2024). The species is susceptible to extended periods of drought or ill-timed precipitation, such as late spring rains, which negatively impacts the species (Witham pers. comm. 2024), causing the species to not flower, desiccate prematurely, and fail to produce seeds. In response to unfavorable conditions, there may be less viable individuals germinating, which can increase the likelihood of local extirpation or further isolate individuals and populations from one another. Since the species can self-fertilize, which is a reproductive strategy that can stabilize isolated populations, this can cause inbreeding, which can limit the genetic diversity of Boggs Lake hedge-hyssop important to its survival for when poor habitat conditions do not improve (Corbin et al. 1994; USFWS 2005; Barbour et al. 2007; Wright et al. 2013). If the species' habitat floods and dries too soon or the pools remain inundated for too long or re-inundate after the species germinates, the growth of other

vegetation adapted to those conditions may outcompete Boggs Lake hedge-hyssop for light and resources (Corbin et al. 1994; USFWS 2005). If for any reason the pools of water become deeper and max depth changes stochastically and multiple times from a shifting climate, the narrow band of habitat where Boggs Lake hedge-hyssop occurs may disappear (pers. comm. Kramer 2024) and the species may not have enough time to complete its life cycle and produce viable seeds to replenish the seed bank. Additional research is needed to better understand if and for how long seeds of the species are adapted to survive as the edges of the water line shifts between years with abrupt changes and fluctuating weather patterns that may be intensified by the extreme conditions predicted under climate change (Levine et al. 2008).

In 2011, Department staff assessed the vulnerability of Boggs Lake hedge-hyssop's southern edge of its range to climate change using the NatureServe Climate Change Vulnerability Index (CCVI) Version 2.01 (NatureServe 2010). The CCVI is used as a way to estimate a plant or animal species' relative vulnerability to climate change (NatureServe 2024). The results of the CCVI in 2011 indicated that Boggs Lake hedge-hyssop within the geographical area assessed was moderately vulnerable, showing that the abundance and/or range extent was likely to decrease by 2050 (CDFW 2011).

An updated CCVI assessment was completed for the species' entire range in 2024 using the latest CCVI version 4.0 which includes new metrics for assessing climate vulnerability and provides three categories of results (adaptive capacity, climate exposure, overall CCVI) under two carbon emission scenarios (Lyons et al. 2024). These included the moderate (RCP4.5) and high (RCP8.5) emissions scenarios from the Intergovernmental Panel on Climate Change Coupled Model Intercomparison Project Phase 5. The 2024 CCVI results indicated that the species' adaptive capacity is low, which was derived from climate exposure and vulnerability scores based on 37 population- or species-level metrics adapted from the framework in Thurman et al. (2020). Under both climate emission scenarios, Boggs lake hedge-hyssop ranked high on climate exposure and was overall considered highly vulnerable to climate change (CDFW 2024b) on a qualitative scale from less vulnerable to extremely vulnerable (Lyons et al. 2024). While the species' extent spans across central and northern California and appears to tolerate a level of disturbance (e.g., grazing), the species is highly specialized, occupying localized areas under specific habitat conditions within its vegetative community. The species may exhibit low to moderate adaptive capacity for dispersal (i.e., splash seed dispersal by raindrops) and move short distances within its habitat (e.g., flooded pools carrying dehisced seeds); however, the species' short window to germinate, flower, and produce seeds is very dependent on the timing of weather.

Overall, the information available indicates that climate change may threaten the long-term persistence of the species. However, there is not enough information, even from existing long-term monitoring data (Baldwin and Baldwin 1991; Sacramento Valley Conservancy 2023, 2024), to accurately predict the extent of its impacts to Boggs Lake hedge-hyssop populations.

g. Pollution

Many of the remaining vernal pools in California are surrounded by development and agriculture (Holland and Hollander 2007), putting them at high risk of polluted water or soils negatively impacting biodiversity (Kneitel and Lessin 2010; Helm 2019; Sinnathamby et al. 2020). While there haven't been any studies on the effects of nutrient pollution on Boggs Lake hedge-hyssop, many populations may be extremely vulnerable to pollutants such as herbicides, pesticides, or fertilizers from urban, pastoral, and agricultural runoff. Nutrient pollution and habitat modification are some of the main drivers of algae blooms (Kneitel and Lessin 2010; Smith et al. 2021), which may be exacerbated by the extreme dry and hot conditions predicted under climate change (Gobler 2020). Big algal blooms may make the habitat unsuitable for Boggs Lake hedge-hyssop (Gantenbein and Little pers. comm. 2024; Little pers. comm. 2024) by blocking sunlight completely or producing toxins. Harmful algal bloom (HAB) data showed that at least 16 populations were within 5 km (3 mi) of 41 reported blooms since 2017 (SWRCB 2025), all located in Lake, Modoc, Placer, Sacramento, and Solano counties. These populations are in areas where there is evidence of development, grazing and other habitat modification (e.g., resource extraction, disking, erosion) threatening Boggs Lake hedge-hyssop (CNDDB 2025). An influx of algae was observed at Kiefer Landfill Wetland Preserve in all the pools that contain Boggs Lake hedge-hyssop in 2022. The algae shaded the soil surface and the data indicated lower than average total plant cover that year (Sacramento Valley Conservancy 2022). Montelena Wetland Preserve is surrounded by residential development and may be at risk of increased algal growth from surface runoff from adjacent landscaping (Sacramento Valley Conservancy 2024). Algae is critical to aquatic food webs; however, an overabundance of algae can create harmful algal blooms that reduce the plant species' access to sunlight, further alters soil pH and nutrient levels, and overall initiates a negative, cascading effect on native species' composition and ecological functions.

Herbicide and pesticides are known to impact vernal pool biodiversity by contaminating water, soil, and wind that enters habitat (USFWS 2005; Sinnathamby et al. 2020). While their impacts to Boggs Lake hedge-hyssop specifically are unknown, it is important to note that some areas near the species' habitat have been treated with herbicides or pesticides. Table Mountain in Fresno County has been subject to targeted

herbicide treatment for Italian thistle (*Carduus pycnocephalus*) in the uplands of the vernal pools where a known population of Boggs Lake hedge-hyssop occurs (Currier pers. comm. 2024). The USFS applied herbicide in a targeted way to treat Scotch thistle (*Onopordum acanthium*) in areas that were known to exist within 15 m (50 ft) and 90 m (300 ft) of two Boggs Lake hedge-hyssop populations at Emigrant Springs in Modoc National Forest (USFS 2006a, b). No known impacts to the species have been reported. Overall, additional research is needed to better understand if and how pollution impacts Boggs Lake hedge-hyssop, especially since the species' habitat is often adjacent to areas that receive treatments like herbicide or fertilizers.

B. Degree and Immediacy of Threats

The most immediate threats at the time of listing were few populations and habitat modification and destruction from development, grazing, and off-road vehicles (CDFG 1978). Since listing, many more populations have been documented, so the threat of too few populations is no longer the most immediate threat to the species. At present, the most immediate threat of extinction is present or threatened habitat modification or destruction of habitat. This is a serious and immediate threat since most populations are on federal lands (45%) impacted by grazing and on private lands (37%; Table 2) that are not protected or they occur in or adjacent to heavily modified areas with proposed development.

The degree (intensity) of the most immediate threats of extinction, in order of highest to lowest intensity, are as follows:

1. Present or threatened habitat modification or destruction of habitat,
2. Direct impacts from grazing,
3. Pollution and runoff,
4. Competition, and
5. Climate change.

Any form of soil disturbance between the time that the species germinates and sets seed (which is often a few weeks), would result in the plants not completing its lifecycle and presumably reducing the number of individuals that grow and set more seed in the following years. Any use of the habitat (e.g., livestock grazing) when soil conditions are not dry may significantly alter hydrologic conditions of the pool, especially at the edges where the species would be trampled. Excessive trampling is often relatively high in the species' habitat since livestock use vernal pools and stock ponds as a watering source. Increased nutrient loads from livestock use or polluted runoff from adjacent development or agricultural sources promote algal bloom growth, which outcompetes Boggs Lake hedge-hyssop for light, space, and resources. Highly competitive plants may encroach into the species' habitat more readily during periods of prolonged

inundation or drought. Climate change may alter the timing, frequency, and amount of precipitation needed to fill vernal pools, and increased temperatures can alter the timing of water drawdown, ultimately affecting the species' ability to thrive in its habitat.

The cumulative interaction of one or more threats amplifies the species' vulnerability to the most immediate threats and its habitat. For example, land-use changes (e.g., urbanization, agriculture, mining expansion, road construction) can exacerbate the species' ability to survive through changes in pool hydrology (e.g., inundation periods), grazing regimes (e.g., excessive trampling), and competition (e.g., algal blooms) (CDFW 2024b; Lyons et al. 2024). Climate change may create conditions more favorable to highly competitive plants that can encroach into the species' habitat. Algal blooms are more prolific with polluted runoff, and increased temperatures and less precipitation, which is expected to continue with climate change (Smith et al. 2021).While grazing is used to manage competitive plants, ill-timed and excess grazing could intensify the magnitude of altering pool hydrology in space and time, which may decrease annual recruitment of Boggs Lake hedge-hyssop in the long-term.

X. EXISTING MANAGEMENT

This section considers the impact of existing management efforts on the species (Fish & G. Code, § 2072.3; Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)).

Populations of Boggs Lake hedge-hyssop occur on lands under various ownership (Table 2), which exposes populations to different land uses and management. Of 110 populations, 18 populations of Boggs Lake hedge-hyssop are located on lands that are owned by CDFW (fee title), operated by CDFW (wildlife areas, ecological reserves, public access properties that are leased or with agreement), held in agreement between CDFW and a private landowner as conservation easements (permanently protected lands), or are on preserves owned and managed by private non-profit conservation organizations (Figure 2; CDFW 2024a; CNDDB 2024). Approximately 21 populations (18 under BLM ownership, 2 under The Nature Conservancy) occur on land where adaptive grazing is implemented to mitigate wildfire risk and promote native plant biodiversity (Robins and Vollmar 2002; Marty 2005; Butterfield et al. 2022; BLM 2024a; BLM 2024b; Craig pers. comm. 2024; Gantenbein and Little pers. comm. 2024; Schaefer pers. comm. 2024; Thompson pers. comm. 2024; Witham pers. comm. 2024). If done properly, while minimizing impacts to non-target species, grazing can be successful in removing encroaching, invasive plants, promoting native plant biodiversity, and prolonging inundation periods (e.g., at Dye Creek Preserve, Vina Plains Preserve, Mather Field Vernal Pools, Big Table Mountain, Jepson Prairie Preserve) (Robins and Vollmar 2002; Marty 2005; Butterfield et al. 2022). In September 2024, the

Department provided a letter of support to The Nature Conservancy recommending long-term monitoring for Bogg's Lake hedge-hyssop at Dye Creek and Vina Plains Preserves (CDFW 2024c). Due to the preserves' unique habitats (i.e., vernal pools and man-made stock ponds) and management conditions (i.e., grazing and recreation), these locations may prove to be important and provide valuable information for understanding the species' population dynamics, understanding the species' ability to use artificially created habitats (stock ponds), and for assessing the effectiveness and risks of using grazing as a management tool in its habitat (CDFW 2024c).

A. Federal Plans

Forty-five percent of Boggs Lake hedge-hyssop populations occur on federally owned land (Table 2), with 16% of populations on BLM land and 28% on USFS land. Some of these populations occur in areas with restricted uses, but many more could implement protections from future disturbance (USFWS 2005; CNDDB 2025). The USFWS developed a recovery plan for vernal pool ecosystems of California and southern Oregon in 2005 as part of a requirement for conserving threatened and endangered species under the federal ESA (USFWS 2005). In response to the recovery plan, the BLM and USFS developed a conservation strategy in 1994 to protect the species over a 10-year period in northeastern California (Corbin et al. 1994); however, monitoring was largely discontinued because it was not listed under the federal ESA (USFWS 2005). The USFWS Sacramento field office coordinates with the project partners on the Markham Ravine restoration project in Placer County where sowing Boggs Lake hedge-hyssop seed has shown to be successful in several vernal pools (Snow 2022). There has not been any active management for the species on USFS-managed lands other than occasional surveys to check the status of the populations (Decker pers. comm. 2025). The USFS implemented a five-year noxious weed treatment for Scotch thistle at Emigrant Springs in Modoc National Forest (USFS 2006a), which included herbicide and manual removal. The Environmental Impact Statement's Biological Assessment indicated that populations of Boggs Lake hedge-hyssop occurred within 15 m (50 ft) and 90 m (300 ft) of two treatment sites (USFS 2006b). Project design standards were outlined to avoid and minimize impacts on the species; however, it is unknown whether the species was ultimately affected.

B. Habitat Conservation Plans

Boggs Lake hedge-hyssop occurs on lands with multiple interests, which highlights the need to develop partnerships to effectively mitigate any risks the species might face. As part of the ESA and in coordination with USFWS, Habitat Conservation Plans (HCPs) provide an avenue to do just that. HCPs are planning documents that enable long-term conservation of special status species and their habitat while also streamlining

permitting needs for projects within the specified area of an HCP. Boggs Lake hedge-hyssop is part of three separate HCPs which are the South Sacramento HCP, PG&E San Joaquin Valley Operations and Maintenance HCP, and the Natomas Basin Revised HCP. Mitigation and protection measures for Boggs Lake hedge-hyssop are outlined within these HCPs (USFWS, CDFG 2003; PG&E 2007; County of Sacramento et al. 2018).

C. Mather Field Specific Plan

The Mather Field Specific Plan outlines land use planning for Mather Field including protections and enhancements for the Natural Preserve (County of Sacramento 2016a). The Mather Field Vernal Pools, which contain a population of Boggs Lake hedge-hyssop (EO 84), were once owned and used by the military up until 1918 before being designated as open space and becoming part of Mather Regional Park in 1995 (County of Sacramento 2016a). The Mather Field Vernal Pools were likely grazed in the late 19th and early 20th centuries (Williamson et al. 2005). The Mather Field Specific Plan was developed and adopted in 1997 to guide the transition from military to multi-use, which included protecting vernal pools. The Mather Field Specific Plan was last updated in 2016 to update land-use designations (Figure 9) in response to a project proposal that included building a regional sports park and university on the southern end of Mather Field in an area designated as the Urban Development Area (County of Sacramento 2016b). Subsequently, approximately 50 sq km (1,272 ac) were also designated as a Natural Preserve for mitigation, which contains various habitat including the addition of two vernal pools with the potential to support special status species (County of Sacramento 2016a). The Natural Preserve land designation provides additional opportunities for conservation and protection for the species and improves habitat connectivity for the vernal pools. Ultimately, the plans to build a regional sports park and university in the Urban Development Area were rejected and in 2018 a modified version of the project was proposed—the Mather South Community Master Plan (County of Sacramento 2016b, 2018). The final EIR was posted in 2020 for the Mather South Community Master Plan which includes plans to convert 343 ha (848 ac) of vernal pool grassland to mixed-use residential, commercial, and educational development, and set aside 21 ha (53 ac) as a part of the Mather Preserve (County of Sacramento 2020); however, concerns over the project's impacts have likely delayed development.

D. Long-Term Monitoring

The species has been monitored long-term at three sites including Boggs Lake Preserve (10 yrs), Montelena Wetland Preserve (17 yrs and ongoing), and Kiefer Landfill Wetland Preserve (19 yrs and ongoing). While these efforts provide valuable insight on variation in the species' annual population size, additional research is needed to discern a

pattern or relationship with other biological or environmental variables. Monitoring efforts at Montelena Wetland and Kiefer Landfill Preserves are ongoing to meet the conditions in the federal Biological Opinions for the sites, which are documents related to the Section 7 consultation process of the Endangered Species Act. No recommendations for management of the species have been made.

The 1991 long-term monitoring report for Boggs Lake Preserve included recommendations to protect Boggs Lake hedge-hyssop from deer browsing (if it germinated), and included recommendations to use low wire mesh fencing around the groups of plants that would be closed off with chicken-wire cover (Baldwin and Baldwin 1991). The enclosures would then be left in place until the species set seed. It is unknown if these recommended actions were ever implemented.

E. Kiefer Landfill Wetland Preserve Operations and Management Plan

The Kiefer Landfill Wetland Preserve is owned by the County of Sacramento as a permanent conservation easement and is managed and monitored by the Sacramento Valley Conservancy (Sacramento Valley Conservancy 2023). Management and monitoring goals at Kiefer Landfill Wetland Preserve are guided by their Operations and Management Plan which ensures that the habitat under their care is maintained in good condition and in perpetuity. Management actions for the Preserve are designed to protect, repair, restore, and maintain targeted species (including Boggs Lake hedge-hyssop) and their habitat (Sacramento Valley Conservancy 2007). Grazing was reintroduced at Kiefer Landfill Wetland Preserve during the 2006-2007 growing season as a management tool to reduce the relative cover of invasive species in the upland areas, especially medusahead, barbed goat grass, and rattlesnake grass (Sacramento Valley Conservancy 2023). Winter grazing has reduced thatch and invasive plant cover, which has promoted the overall persistence of native plants at the preserve. Waxy manna grass has also been tracked since 2006 since it can be especially pervasive within the vernal pools; however, no actions have been recommended to manage for that species (Sacramento Valley Conservancy 2022, 2023). In the past 10 years, the Kiefer Landfill Wetland Preserve implemented additional actions for targeted invasive species control of stinkwort, tumbleweed (*Salsola tragus*), and skeleton weed (*Chondrilla juncea*) which helped reduce further spread (Sacramento Valley Conservancy 2023).

F. Hog Lake Management

The BLM currently allows grazing at Hog Lake between its eastern edge and Highway 36 (BLM 2024b; pers. comm. Schaefer 2024). The population of Boggs Lake hedge-hyssop is on the northern edge of Hog Lake, which does not currently appear to experience grazing; however, access by grazers is unrestricted. The BLM indicated that if cattle

remain on the southern end of the lake, there could be benefits like controlling the non-native invasive flora (e.g., cheatgrass, medusahead) and promote vernal pool plant biodiversity (Butterfield et al. 2022; BLM 2024b). The BLM provided to the Department a draft of their monitoring protocols for Boggs Lake hedge-hyssop as part of the long-term monitoring they are establishing for federally-threatened and state-endangered slender Orcutt grass (Thompson pers. comm. 2024; Bureau of Land Managemen (BLM) pers. comm. 2024). Estimated population counts and photographs will be documented. The goals outlined in the monitoring plan for Boggs Lake hedge-hyssop are summarized as follows:

- Monitor population health on all sites managed by the area field office.
- Gather and analyze population data in coordination with staff and researchers.
- Repeat qualitative assessments for annual variation in the species' population

G. Montelena Wetland Preserve Operations and Management Plan

The Sacramento Valley Conservancy owns the Montelena Wetland Preserve as a permanent conservation easement that is held by the Wildlife Heritage Foundation. Management and monitoring at Montelena Wetland Preserve are guided by their Operations and Management Plan which includes that all rare plant populations be monitored each year. The Montelena Wetland Preserve assesses vegetation and residual dry matter annually, but due to lack of water sources for cattle, grazing has often been abbreviated over the years. There was a period of drought between 2018 and 2022, and by 2022, many of the pools contained a large proportion of species that are more typical of upland plant communities (Sacramento Valley Conservancy 2022). These upland plants may compete for space, light, and resources with Boggs Lake hedge-hyssop, especially considering there were no observations of Boggs Lake hedge-hyssop in 2018-2022 (Table 3). A more permanent water source for cattle may be installed in 2025 if coordination between the appropriate parties is successful or if funding can be secured, such as through the USFWS Partners Program (Sacramento Valley Conservancy 2024).

H. Dye Creek Preserve Management

Dye Creek Preserve is a working cattle ranch owned by the State of California and managed under a long-term lease agreement by The Nature Conservancy. The Nature Conservancy removed all livestock grazing in the 1980s before re-introducing it experimentally, which has benefited overall ecosystem function (Butterfield et al. 2022). Their management focus is implementing conservation priorities while preserving public recreation and hunting opportunities. The property is under a long-term lease agreement and all grazing and hunting revenue is reinvested in land improvements, conservation, and restoration needs. Dye Creek Preserve is regularly grazed, and

prescribed burns are also used to maintain natural disturbance regimes to mitigate invasive species and promote biodiversity. The ponds at Dye Creek Preserve, where Boggs Lake hedge-hyssop occurs, do experience grazing with care outside of the species' growing season (Craig pers. comm. 2024). Although not on a yearly basis, these ponds are regularly surveyed by contracted botanists, and the Preserve Manager adapts any management recommendations based on survey results (Craig pers. comm. 2024). While this approach is not ideal for better understanding the long-term population dynamics of Boggs Lake hedge-hyssop, it does provide a snapshot of site conditions, periodic confirmation of species presence or absence, and general understanding of its persistence under current management practices.

I. Vina Plains Preserve Management

Vina Plains Preserve is owned and actively managed by The Nature Conservancy with seasonal cattle grazing and prescribed burns. Similar to the livestock removal at Dye Creek Preserve, The Nature Conservancy removed all livestock grazing in the 1980s for several years before re-introducing it experimentally (Schlising and Castro 2019). In recent years, the Preserve Manager has integrated both grazing and rotational prescribed burning in coordination with CAL FIRE. Boggs Lake hedge-hyssop was last observed here in 2002 and surveys have not been conducted since to search for the species; however, the Preserve Manager expressed interest in adding this species to future monitoring and survey efforts (CDFW 2024c; Craig pers. comm. 2024).

XI. FUTURE MANAGEMENT

This section considers suggestions and recommendations for future management activities and other recommendations for recovery of the species (Fish & G. Code, §§ 2072.3 & 2077; Cal. Code Regs., tit. 14, § 670.1, subd. (d)(1)). The following actions, generated by the Department, are not a detailed conservation strategy; however, they outline the major steps needed to prevent the extinction of the species. The Department recommends that the following actions be conducted in coordination with partners and interested parties, consistent with California's goals of preventing the extinction of rare, threatened, and endangered species.

The goal of management and recovery for Boggs Lake hedge-hyssop is to reach an adequate size and number of self-sustaining populations so that ongoing CESA-listing is no longer necessary. Since listing, the number of populations documented has increased from three to 110 in California (CDFG 1978; CNDDB 2025). Boggs Lake hedge-hyssop has the potential to remain undetected and estimates of its abundance may be low due to its small stature, short window of detection (Witham pers. comm. 2024), and propensity for having "boom-and-bust" years typical of annual plants, where plant

abundance is high in some years and plants remain as dormant seed in other years (Crawley et al. 1990). It is important to implement consistent, well-timed surveys for the species to accurately gauge the magnitude of threats across its full range. Although our understanding is limited on how fire impacts Boggs Lake hedge hyssop, both grazing or fire can be important management tools for maintaining vernal pool function and biodiversity at sites that also contain Boggs Lake hedge-hyssop (Marty 2015). With that said, the Department recognizes the challenge to align management objectives for ecosystem function and for rare species persistence that are cost effective and beneficial in the long-term. Although many more populations have been documented since listing, there is currently not enough data for over half the populations to indicate the species is no longer at risk of extinction. The Department recommends the following actions, which include some overlapping recovery actions of the federal Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005). If actions are implemented, it will better inform the species' abundance across its range, on its recovery potential, and provide for a possible CESA downlist or delist recommendation in the future.

A. Land Protection and Conservation

a. Identify priority lands important for permanent protection.

b. Collect seeds for long-term seed banking in at least two Center for Plant Conservation certified facilities, from at least one population from each core area identified in the USFWS Recovery Plan for vernal pools (USFWS 2005).

c. Work with landowners to discuss opportunities for permanent land protection (e.g., land acquisition, conservation easement).

d. Collaborate with partners (landowners, federal, state, local agencies, tribes) to identify measurable goal for protecting remaining suitable species habitat (Keeler-Wolf et al. 1998; USFWS 2005)

e. Coordinate with partners to identify opportunities and funds for managing the species in perpetuity.

B. Botanical Surveys

a. Re-survey known populations, especially those that have not been observed since 2014.

b. Survey for undiscovered populations in vernal pools or artificial water bodies with similar habitat and associated plant species that Boggs Lake hedge-hyssop would typically be found in.

C. Long-Term Monitoring

a. Establish range-wide monitoring of the species with a representative sample of populations (at least two populations from each vernal pool region).

b. Target monitoring efforts to better understand population trends and factors that influence inter-annual variation in species' abundance.

    - Implement long-term monitoring to ensure that information on the species is collected through multiple years of various precipitation patterns and periods of drought.
    - Continue monitoring at Kiefer Landfill Preserve (EO 18) and Montelena Wetland Preserve (EO 57).
    - Establish or re-stablish long-term monitoring at, including but not limited to, Boggs Lake Preserve (EO 2), Hog Lake (EO 27), Dye Creek Preserve (EOs 115-118), and Vina Plains Preserve (EO 99).
    - Collect information on factors such as:
        - Air and water temperature
        - Hydrology (e.g., precipitation, vernal pool draw-down, infiltration rates)
        - Surface disturbance
        - Plant community composition and cover,
        - Residual dry matter
        - Management (e.g., grazing, fire, invasive plant control techniques)

D. Land Management

a. Establish land management actions to support the persistence of Boggs Lake hedge-hyssop populations, focused on:

    - Minimizing excess disturbance
    - Supporting low to moderate disturbance
    - Reducing competition
    - Preventing algal blooms
    - Maintaining hydrological function of vernal pools

b. Coordinate with federal agencies to update the BLM Northwest California Integrated Resource Management Plan and USFS Northwest Forest Plan to include measures for monitoring and managing Boggs Lake hedge-hyssop.

c. Coordinate with local governments to update their urban conservation and development plans (e.g., Mather Field Specific Plan) to include measures for monitoring and managing Boggs Lake hedge-hyssop and its habitat.

E. Plant Encroachment Reduction

a. For non-native and invasive plant species or non-vernal pool plant species that are encroaching into vernal pools with Boggs Lake hedge-hyssop populations, consider the following actions for removal if appropriate:

- Remove non-native, invasive, or non-vernal pool plant species that are encroaching along the edges of Boggs Lake hedge-hyssop habitat by hand or by using a method that is low impact to the soil surface. If using grazing as a management tool, see the "Grazing practices" recommendation below.
- Control thistles (*Cirsium* spp.) known to produce abundant seed crops and expand into Boggs Lake. Pull the seedlings early in spring, and in later spring, remove buds, flowers, and seeds and dispose them in black plastic bags (Baldwin and Baldwin 1988).
- Eradicate or reduce invasive medusahead where present (e.g., Hog Lake, Kiefer Landfill Wetland Preserve, Montelena Wetland Preserve) by interrupting the species' seed cycle to prevent further encroachment (Gantenbein and Little pers. comm. 2024).
- Eradicate waxy manna grass within the vernal pools at Kiefer Landfill Wetland Preserve by implementing annual removal actions (e.g., hand pulling prior to seed set) (DiTomaso et al. 2013; CDFW unpublished data).
    i. If eradication is not feasible, mitigate the spread of waxy manna grass.
        1. In the Preserve's Operations and Management Plan, identify a threshold for the allowable area occupied by waxy manna grass before management must be applied.

F. Appropriate Grazing Practices

b. Where grazing is allowed, implement an adaptive management approach to ensure species' persistence. Consider the following actions to meet this goal:

- Exclude grazing during the species' growing season, especially at the pool margins, during vernal pool dry-down, or where residual dry matter does not warrant grazing for that season. The population at Coleman Pond, which is managed by the BLM, is fenced to exclude cattle (Corbin

et al. 1994), and the species was last observed in 2024 (Schaefer pers. comm. 2024), which indicates some form of grazing exclusion does help the species persist long-term.

- Install enclosures (e.g., mesh fencing) around patches of Boggs Lake hedge-hyssop plants to avoid accidental trampling, topsoil disturbance, or browsing. The population at Hog Lake (EO 27) would likely benefit from enclosures, especially by the smaller vernal pool (i.e., Little Hog Lake) where cattle hoofprints have been seen throughout the pool.

c. If periodic exclusion from particular areas is not possible, the following actions may help reduce dependency and grazing pressure on the species' vernal pool habitat:

- Adjust stocking rates to a lower threshold.
- Alleviate trampling pressure by removing grazers early (e.g., April 1st instead of April 15th).
- Minimize access to areas where plants are growing.
- Allow for only early season grazing prior to the species' first growth or late season grazing after the species sets seeds or before first rain.
- Provide an alternative water source at an appropriate distance away from the species' habitat to lessen the reliance of vernal pools as a source of drinking water.
- Provide a strategically placed salt block at an appropriate distance away from the species' habitat to draw cattle away from the species' habitat.

G. Algae Bloom Mitigation

a. In populations growing next to bodies of water that are highly susceptible to algal blooms, identify and remove or mitigate possible sources of nutrient input or other conditions that promote excessive algal growth.

b. Coordinate with relevant partners (e.g., State Water Resources Control Board's Freshwater and Estuarine Harmful Algal Bloom Program) to develop and implement actions to prevent and mitigate algal blooms where they are known to occur (e.g., Mather Field Vernal Pools) that can be integrated into land use management plans (e.g., Mather Field Specific Plan). Preventative measures to consider include:

- Reducing the amount of fertilizer used in surrounding landscaping to reduce the amount entering urban runoff, especially at locations where

populations are surrounded by development (e.g., Montelena Wetland Preserve).

- Where practical, establish and maintain wetland buffers (e.g., swales, floating islands, filter strips of vegetated channels) that are approximately 3-6 m (10-20 ft), between urban areas and vernal pool habitat to help filter excess nutrient and polluted urban runoff (Sink et al. 2014).
- Reduce excess, previous year's overgrown vegetation around the edges of pools to deprive algae of nutrients needed for growth.
- If feasible and as needed, provide temporary shade structures at strategic points around the pool to help reduce water temperatures and filter sunlight that algae needs to photosynthesize (Fery 2009; Sink et al. 2014).
- Years with warm late spring/early summer rainfall, consider implementing one or more preventative measures above, and if an algal bloom occurs, take actions to remove excessive algal growth (see below).

Actions to control excessive algae growth for consideration may include:

- Use pond rakes, skimmers, seine, wire screens, or other similar device recommended to remove algae at an appropriate distance from pool edges to prevent trampling (Fery 2009; Sink et al. 2014).
- The application of non-chemical dye to limit light penetration for algae, with consideration that impacts to vernal pool plants are minimized to the maximum extent practicable.

H. Research

a. Conduct studies to better understand the impacts of grazing and the role of fire on Boggs Lake hedge-hyssop' ability to survive and reproduce, its seed bank, and its habitat.

b. Investigate the effects of toxins (e.g., herbicides), algal blooms, and drought on Boggs Lake hedge-hyssop, and how they may influence the species' ability to persist long-term.

c. Conduct population genetic studies to assess genetic diversity within and among populations.

d. Conduct genetic studies to determine if the species' ability to self-fertilize may be causing inbreeding depression and/or genetic drift.

e. Conduct pollinator-species interaction studies to identify pollinator needs of the species.

f. Investigate the extent of area occupied of the species' soil seedbank.

g. Assess how resilient Boggs Lake hedge-hyssop may be to changes in the position of the water's edge year to year.

XII. RECOMMENDATION TO THE COMMISSION

CESA requires the Department to prepare this 5-year species review to 1) assess the status of Boggs Lake hedge-hyssop in California based on the best scientific information available to the Department 2) determine if the conditions that led to the original listing are still present, and 3) indicate to the Commission the results of its 5-year species review (Fish & G. Code, § 2077).

Under CESA, an endangered species is defined as "a native species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, overexploitation, predation, competition, or disease" (Fish & G. Code, § 2062). A threatened species is defined as "a native species or subspecies…that although not presently threatened with extinction, is likely to become an endangered species in the foreseeable future in the absence of the special protection and management efforts required by [CESA]" (Fish and G. Code § 2067).

Based on the criteria described above and the best scientific information available, the Department submits the following recommendation to the Commission:

NO CHANGE IN STATUS FROM ENDANGERED

In completing this 5-year species review for Boggs Lake hedge-hyssop, the Department has determined that the precise nature of the threats to this species has changed but that the species still faces multiple serious and immediate threats. The Department thus finds there is sufficient scientific information to indicate that the conditions that led to the listing of Boggs Lake hedge-hyssop as endangered—i.e., the presence of serious and immediate threats and the need for management activities and other actions to recover the species—are still present and put the species in danger of becoming extinct. For these reasons, the Department recommends no change to the endangered status of Boggs Lake hedge-hyssop at this time.

XIII. PROTECTION AFFORDED BY ENDANGERED STATUS

It is the policy of the state to conserve, protect, restore, and enhance any endangered or any threatened species and its habitat (Fish & G. Code, § 2052). The species is listed as an endangered species, and unauthorized "take" of Boggs Lake hedge-hyssop is

prohibited, and the conservation, protection, and enhancement of the species and its habitat is a statewide concern. As noted earlier, "take" is defined under CESA as "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill" (Fish & G. Code, § 86). Any violation of the take prohibition would be punishable under state law. The Fish and Game Code provides the Department with related authority to permit "take" under certain circumstances (Fish & G. Code, §§ 2081, 2081.1, 2086, 2087, 2089.6, 2089.10, & 2835).

Listed species receive additional considerations during environmental review under the California Environmental Quality Act (CEQA). CEQA requires public agencies to analyze and disclose project-related environmental effects before discretionary approval of a project. CEQA requires adoption of mitigation measures to reduce or eliminate any significant environmental impacts.

The species' CESA status may prompt increased interagency coordination specific to Boggs Lake hedge-hyssop's conservation and protection. The species' CESA status may also increase the likelihood that state and federal land and resource management agencies will allocate additional funds toward monitoring, research, protection, and recovery actions.

XIV. ACKNOWLEDGEMENTS

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

XV. LITERATURE SOURCES AND PERSONAL COMMUNICATIONS (PERS. COMM.) CITED

Literature sources

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