23. STATUS REVIEWS FOR THREATENED AND ENDANGERED SPECIES

Today's Item **Information ☒** **Action ☐**

Receive status reviews from DFW for Baker's larkspur (*Delphinium bakeri*) and Clara Hunt's milkvetch (*Astralgus claranus*), which are listed as threatened or endangered under the California Endangered Species Act (CESA).

Summary of Previous/Future Actions

• Determined listing of Clara Hunt milkvetch as threatened was warranted	Jan 7, 1991; Palm Springs
• Determined listing of Baker's larkspur as endangered was warranted	Apr 4, 2006; Monterey
• **Today's receipt of status reviews**	**Dec 11-12, 2019; Sacramento**
• Determine if the action may be warranted	Feb 5-6. 2020; Sacramento

Background DFW

Clara Hunt's milkvetch has been listed as a threatened species since 1991, and Baker's larkspur has been listed as an endangered species since 2006. Both species are currently included in FGC's list of endangered and threatened plants found in Section 670.2.

California Fish and Game Code Section 2077 mandates that the status of species listed by FGC as threatened or endangered under CESA be reviewed every five years, if funding is available. New DFW funding was authorized in 2018 for purposes of completing reviews; the reviews scheduled for receipt at this meeting are the first two to be conducted under the authorized funding. Additional status reviews are expected at future FGC meetings.

DFW has prepared status reviews of Baker's larkspur (exhibits 1-2) and Clara Hunt's milkvetch (exhibits 3-4) to evaluate whether the conditions that led to the original listings are still present, or if conditions have changed to warrant a different listing status.

- Baker's larkspur: DFW finds there is sufficient scientific information to indicate that the conditions that led to the listing of Baker's larkspur as endangered in 2006 are still present. The scientific information available to DFW indicates that Baker's larkspur remains in serious danger of extinction in all of its range due to one or more causes. Therefore, DFW recommends no change to the status of Baker's larkspur.
- Clara Hunt's milkvetch: DFW finds there is sufficient scientific information to indicate that the conditions that led to the listing of Clara Hunt's milkvetch as threatened in 1991 have changed. The scientific information available to DFW indicates that Clara Hunt's milkvetch is in serious danger of extinction in all or a significant portion of its range due to one or more causes. Therefore, DFW recommends a change in the status of Clara Hunt's milkvetch from threatened to endangered.

The DFW report regarding Clara Hunt's milkvetch is the equivalent of a listing petition with a DFW recommendation to accept, which should be considered by FGC as described in subdivision (b) of Section 2073.5, and is subject to sections 2074 to 2079, inclusive (Fish and Game Code sections 2072.7 and 2077(e)).

At this meeting, DFW will provide an overview on the process set forth in Fish and Game Code Section 2077 for reviews of species listed under CESA.

Significant Public Comments (N/A)

Recommendation

FGC staff: Accept DFW's evaluation report to allow staff to provide notice that consideration of DFW's candidacy recommendation for Clara Hunt's milkvetch will be scheduled for Feb.

DFW: Change the status of Clara Hunt's milkvetch from threatened to endangered. No change to the status of Baker's larkspur is recommended.

Exhibits

1. DFW memo transmitting Baker's larkspur status review, received Nov 18, 2019
2. DFW five-year status review of Baker's larkspur, dated Dec 2019
3. DFW memo transmitting Clara Hunt's milkvetch status review, received Nov 18, 2019
4. DFW five-year status review of Clara Hunt's milkvetch, dated Sep 2019
5. DFW presentation

Motion/Direction (N/A)

State of California
Department of Fish and Wildlife

Signed copy on file, received Nov 18, 2019, 11:30 a.m.

M e m o r a n d u m

Date: November 15, 2019

To: Melissa Miller-Henson
Executive Director
Fish and Game Commission

From: Charlton H. Bonham
Director

Subject: **Five-Year Status Review of Baker's Larkspur**

The California Department of Fish and Wildlife (Department) has prepared the attached Five-Year Status Review of Baker's Larkspur for the Fish and Game Commission (Commission) pursuant to the California Endangered Species Act (CESA). Pursuant to Fish and Game Code, section 2077, subdivision (a), the Department has prepared this Five-Year Status Review to evaluate whether conditions that led to the original listing of Baker's larkspur are still present.

In completing this Five-Year Status Review, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Baker's larkspur as endangered in April of 2006 are still present. The scientific information available to the Department indicates that Baker's larkspur remains in serious danger of extinction in all of its range due to one or more causes. Therefore, the Department recommends no change to the status of Baker's larkspur.

If you have questions or need additional information, please contact Richard Macedo, Branch Chief, Habitat Conservation Planning Branch at (916) 653-3861, or by e-mail at Richard.Macedo@wildlife.ca.gov.

Enclosure

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State of California
Natural Resources Agency
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION

FIVE-YEAR STATUS REVIEW OF BAKER'S LARKSPUR (*Delphinium bakeri*)

December 2019

Baker's larkspur, CDFW photo by Doreen Smith

Charlton H. Bonham, Director
Department of Fish and Wildlife

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I. EXECUTIVE SUMMARY

Baker's larkspur (*Delphinium bakeri* Ewan) is currently listed as an endangered plant under the California Endangered Species Act. Pursuant to Fish and Game Code section 2077, subdivision (a), the California Department of Fish and Wildlife (Department) has prepared this Five-Year Status Review to evaluate whether conditions that led to the original listing of Baker's larkspur are still present. This review is based on the best scientific information currently available to the Department regarding each of the components listed under section 2072.3 of the Fish and Game Code and Section 670.1, subdivisions (d) and (i)(1)(A), of Title 14 of the California Code of Regulations. In addition, this document includes 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)).

Baker's larkspur is a perennial herb in the buttercup family (Ranunculaceae) and is about 50-100 cm (20-40 in) tall with showy deep blue and white flowers. Its historical range was in Marin and Sonoma counties, but has been reduced to a single naturally occurring roadside population in Marin County. Due to its location and very small population size, Baker's larkspur is highly vulnerable to several threats and at extreme risk of extinction.

At the time of listing in 2006, there were four major threats to the survival and reproduction of Baker's larkspur: (1) modification of habitat through conversion to agricultural land, including pasture; (2) possible overexploitation from seed collection for horticultural trade; (3) human-related activities such as road maintenance (e.g., mowing and emergency flood response); and (4) other natural occurrences that stem from bottleneck events that reduce population size and result in low genetic variation, inbreeding depression, and high vulnerability to random events. Baker's larkspur continues to encounter these threats, but is also at risk of extinction from two additional threats: (5) competition from other plant species, and (6) predation (herbivory). Between 2005 and 2019, the single natural population has maintained an average population size of nine plants, with only two to three plants flowering per year. However, with such a small population size, it would only take a single major event to extirpate this population, driving the species to extinction.

The survival of Baker's larkspur can be attributed to management efforts by the University of California Botanical Gardens (UCBG), the U.S. Fish and Wildlife Service, and the California Native Plant Society, with coordination from the Department. UCBG and collaborators have monitored the natural population annually and conducted studies to assess the genetic variation of the natural and nursery-grown populations. Recovery efforts have included introducing Baker's larkspur into three new locations within 6 km (3.7 mi) of the natural population, but these introduced populations have thus far failed to establish. The Department recommends the continuation of these introduction efforts, with additional research goals. It will be beneficial to: (1) understand more about the ecology of Baker's larkspur to identify new introduction sites; (2) identify the stage at which the plants are most vulnerable to natural threats, to focus intervention activities; and (3) quantify the genetic diversity of the remaining natural population and the cultivated plants that the introductions are drawn from.

In completing this Five-Year Status Review for Baker's larkspur, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Baker's larkspur as endangered are still present, and recommends no change to its status on the list of endangered species at this time.

II. INTRODUCTION

A. Five-Year Status Review

This Five-Year Status Review addresses Baker's larkspur (*Delphinium bakeri* Ewan), 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)(27)(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)). Baker's larkspur is also listed as endangered under the Federal Endangered Species Act. Pursuant to Fish and Game Code section 2077, subdivision (b), the U.S. Department of the Interior, U.S. Fish and Wildlife Service (USFWS) was contacted in an effort to coordinate this status review with their five-year review process (under review in 2019) (Prevost, pers. comm. 2019).

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

B. Listing and Status Review History

On October 5, 1979, Baker's larkspur was listed as rare and protected under the Native Plant Protection Act (NPPA) of 1977 (Fish and G. Code, § 1900 et seq.).

On January 26, 2000, USFWS, under the authority of the Endangered Species Act of 1973, listed Baker's larkspur as federally endangered.

In 2005, the Department petitioned the California Fish and Game Commission (Commission) to change the status of Baker's larkspur from rare to endangered, the Commission adopted the proposal, and Baker's larkspur was added to the CESA list of endangered plants on April 7, 2006 (Cal. Code Regs., tit. 14, § 670.2, subd. (a)(27)(A)). The main identified threats to the species at the time of listing included modification and/or destruction of habitat, overexploitation, human-related activities, and other natural occurrences that pose a threat to its extremely small population.

This Five-Year Status Review was prepared by Dr. Raffica La Rosa, in the Department's Habitat Conservation Planning Branch, Native Plant Program.

III. BIOLOGY

A. Taxonomic and Physical Description

Baker's larkspur is a perennial herb in the buttercup family (Ranunculaceae). Plants generally produce one stem that is 50-100 cm (20-40 in) tall, smooth, and is loosely attached to a thickened root (Figure 1). The leaves are simple, palmately lobed, have toothed edges, and grow at the base of the plant (basal leaves) and along the stem (cauline leaves). Leaves often have a distinctive light green center where the stalk of the leaf (petiole) is attached, which has been used as a diagnostic trait, but can be found in other species as well (CDFG 2005; Koontz 2005). Baker's larkspur sometimes retains its upper leaves when in flower and fruit (CNPS 1977). It can be distinguished from other larkspurs with overlapping ranges based on stem and leaf traits, and plant height. For example, *Delphinium californicum* is more than 1 m (40 in) tall, and *D. decorum, D. hesperium,* and *D. patens* have hairy stems and deeply lobed leaves (CNPS 1988).

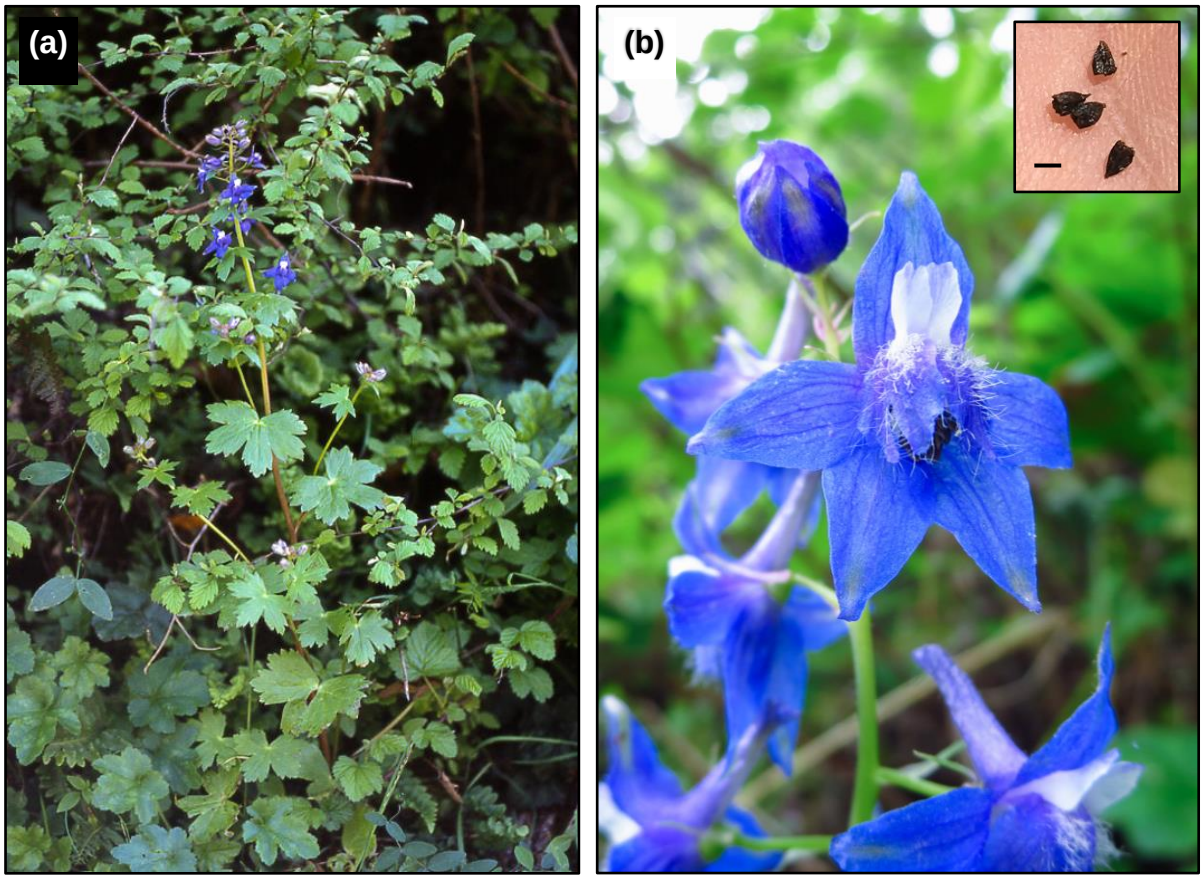

FIGURE 1. Photos of Baker's larkspur (*Delphinium bakeri*). (a) A mature plant in bloom, and (b) the flowers of Baker's larkspur, with a close-up of the seeds shown in the inset (scale bar = 1 mm). Photos (a) and (b) by Holly Forbes (inset by Raffica La Rosa).

A single stem of Baker's larkspur can have one or more flowering stalks (inflorescences). The inflorescence is a terminal raceme, meaning the flowers grow along the upper end of the stem (Figure 1a). The flowers are showy with bilateral symmetry common to larkspurs (Figure 1).

Each flower consists of five dark blue sepals, about 1 cm (0.4 in) long; the uppermost sepal forms a nectar spur, which is a long, tapered tube where nectar collects. The four petals are in the center of the flower and are smaller than the sepals. The upper two petals are typically white and the lower two petals are blue with hairs on the upper surface; the lower petals are larger than the upper white petals. Each flower can produce a fruit consisting of three to four small, dry segments called follicles that are 18-20 mm (7.1-7.9 in) long. Each follicle, once ripe, splits lengthwise and contains about 20 seeds (Forbes, pers. comm. 2019b). Seeds are small, black, smooth, shiny, and have a pyramidal shape (Figure 1b).

Baker's larkspur is distinct from other larkspur (*Delphinium*) species (CDFG 2005), and closely related to the more common red larkspur (*Delphinium nudicaule*) (Koontz et al. 2004). Larkspurs tend to have high genetic diversity, and it was found that even the rare species with small populations tend to have relatively high genetic diversity (Koontz and Forbes 2011). This assessment of the genetic diversity of the naturally occurring population (natural population) of Baker's larkspur was determined from samples taken prior to 2005. In 2005, the population was drastically reduced from approximately 50 plants to just nine after emergency maintenance crews excavated a large area of the roadside where most of the plants were growing. The very small population size makes it risky to remove any leaf tissue for additional genetic studies as tissue removal can stress the plant or make it more susceptible to disease. Consequently, the current level of genetic diversity of the population is not known; however, it is likely that the genetic diversity is significantly lower than it was prior to 2005.

B. Life History and Ecology

Baker's larkspur is a long-lived perennial, with some plants living at least 13 years or more (Forbes, pers. comm. 2019b). Seeds germinate and dormant roots produce new shoots in response to winter rains. Plants bloom between March and May and release seeds between May and July. In a nursery, plants can reproduce in their third year, but it can take at least seven years for plants in the wild to first produce flowers (Forbes, pers. comm. 2019b). At the end of the growing season, the aboveground vegetation dies back, and the plants can survive the hot, dry summer underground as small tuber-like roots.

Baker's larkspur generally reproduces by outcrossing, so it relies on animal pollinators such as hummingbirds and bees to move pollen between individual plants. Pollinators may also transfer pollen within a plant, and because Baker's larkspur is self-compatible (CPC 2017), it can reproduce even when there is only one flowering plant, or if the timing of flowering is too offset between individuals. Selfing can be detrimental, however, because it can contribute to inbreeding depression and a loss of genetic diversity, a common threat to most rare species with small population sizes.

Throughout a growing season, the number of Baker's larkspur plants can decrease substantially due to generalist herbivores like slugs and snails (e.g., banana slugs (*Ariolimax* sp.)) (UCGB 2012; USFWS 2015). Baker's larkspur is also subject to disturbances such as digging by wildlife and trampling by cattle, where cattle are present (Forbes, pers. comm. 2019a); herbivory from insects and other animals (USFWS 2015); seed predation of unripened fruits (R. La Rosa, pers. obs.); and possible fungal infection of the flowers (Forbes, pers. comm. 2019a).

C. Habitat Necessary for Species Survival

Baker's larkspur has been found growing on steep rocky slopes made of decomposing shale that are frequently disturbed. It has also been historically seen along grassy fencerows (CNDDB

2019). The immediate area surrounding individual larkspurs is moderately moist with partial shade. Small Baker's larkspur populations have been introduced into three new locations within the species' range (USFWS 2015). Outplanting sites are within a 6 km (3.7 mi) radius of the natural population. Specific sites were chosen to mimic the north-facing aspect, level of direct sunlight, community diversity, and close proximity to a water source (e.g., stream) of the only remaining natural population.

i. Vegetation Communities

Baker's larkspur grows north of San Francisco along the central coast of California (Koontz and Warnock 2012). It has also been introduced into nearby areas supporting a California Bay-Coast Live Oak Alliance (Sawyer et al. 2009; MMWD 2014). When Baker's larkspur was first discovered in 1942, it was growing alongside California honeydew (*Horkelia californica* ssp. *dissita*) and straightbeak buttercup (*Ranunculus orthorhynchus*). The only known naturally occurring population grows under an overstory that includes California bay (*Umbellularia californica*), California buckeye (*Aesculus californica*), and coast live oak (*Quercus agrifolia*). Other native plants associated with Baker's larkspur include: California blackberry (*Rubus ursinus*), sword fern (*Polystichum munitum*), goldback fern (*Pentagramma triangularis*), licorice fern (*Polypodium glycyrrhiza*), maidenhair fern (*Adiantum jordanii*), woodland star (*Lithophragma affine*), grand hound's tongue (*Cynoglossum grande*), alumroot (*Heuchera* sp.), oceanspray (*Holodiscus discolor*), sanicle (*Sanicula* sp.), western poison oak (*Toxicodendron diversilobum*), giant trillium (*Trillium chloropetalum*), bedstraw (*Galium* sp.), and red ribbons *(Clarkia concinna)* (Koontz and Forbes 2003; CNDDB 2019; R. La Rosa pers. obs.). CNPS (2019) further identifies broadleaved upland forest, coastal scrub, and valley and foothill grasslands as habitats associated with Baker's larkspur.

ii. Geology and Soils

Baker's larkspur occurs on decomposing shale or limestone slopes at low elevations below 300 m (985 ft) (Koontz and Warnock 2012; CNDDB 2019). The only known extant natural population exists in an area that spans approximately 35 m (115 ft) along a road and rises about 3 m (9 ft) up a sheer slope. The soil layer is very shallow and unstable, with solid rock beneath it. Activities by county road crews have reduced the soil layer even further over the past 10-20 years. The three introduced populations, like the natural population, are on steep, north-facing slopes about 2 m (6.5 ft) high, with moist soil. The soils in the immediate vicinity of these populations have not been examined for type, substrate, pH, or minerality, so little is known about the soil chemistry at these sites.

The soil series that best represent the soils that are found at the one extant and two presumed extirpated natural sites are: Blucher, Kneeland, McMullin, and Tocaloma (Appendix A) (Soil Survey Staff 2019). Based on the descriptions of these soil series, the characteristics that are associated with Baker's larkspur are fine grained and loamy, with well mixed, superactive topsoil in the "Haploxerolls" soil great group. Haploxerolls are part of the Mollisol soil order and are common to California grasslands with thick topsoil and lots of soil organic carbon. This soil type is associated with areas of weathered shale and limestone (O'Geen and Arroues 2016), consistent with soil types that were reported with the early collections of Baker's larkspur (CNDDB 2019).

iii. Climate and Hydrology

The remaining natural population of Baker's larkspur experiences a Mediterranean climate that is characterized by hot, dry summers and cool, wet winters. Based on 30 years of temperature and precipitation data between 1981-2010 gathered from local weather stations near the natural population, the estimated annual rainfall total is about 112 cm (44 in) (PRISM Climate Group 2004). The estimated monthly average high/low temperatures range from 12.8°/4.4°C (55°/40°F) in January to 27.8°/11.7°C (82°/53°F) in July (PRISM Climate Group 2004). In April, when rainfall tapers off and the plants are in bloom, the average temperature is 20.0°/7.2°C (68°/45°F). Baker's larkspur populations (natural and introduced) grow in mesic (moist) soil, and in close proximity to water sources (e.g., streams, rivers, or reservoirs); humidity from the water sources may help delay drying of the soil during the growing season.

IV. DISTRIBUTION AND ABUNDANCE

A. Range and Distribution

Baker's larkspur is native and restricted (endemic) to the central coast and San Francisco Bay Area of California (Koontz and Warnock 2012). Historically, its range included Sonoma and Marin counties (Figure 2). Its first known collection was in the 1930s, and it has only been found naturally occurring in a few locations between 90 and 205 m (295-672 ft) in elevation. When Baker's larkspur was first described by Joseph Ewan (1942), he recognized that its range was highly restricted, and he described it as a "fast disappearing larkspur [that he hoped could be] saved from extinction." There is a total of six documented occurrences (CNDDB 2019) of Baker's larkspur, including historical, contemporary, natural, and introduced locations (Figure 2; Table 1).

Extirpated populations: two populations were no longer present when Baker's larkspur became State-listed as endangered. They are presumed extirpated as no one has seen Baker's larkspur at either location in over 80 years, but the exact locations of the original collections are unknown.

- *Camp Meeker* – this is the northernmost population on record, and the only one from Sonoma County. There are several herbarium collections from this population, with the last collection taken in 1946. The original location of the population is likely still on private property (Table 1). B. Guggolz reported that the population was extirpated after surveying the area in 1986 (CNDDB 2019).
- *Tomales* – this population of Baker's larkspur is in the northwest region of Marin County, and is likely on private property. It was last seen in 1923, but the exact location of that sighting is unknown. Grazing is very common in the area, and Baker's larkspur has not been reported in this area since, so it is presumed to be extirpated.

Extant population: when Baker's larkspur was added to the NPPA list of rare species, and later when it was added to the CESA list of endangered species, there was only one naturally occurring extant population on record.

- *Marshall Petaluma Road* – This population occurs in the Point Reyes U. S. Geological Survey 7.5-minute topographic quadrangle on the south side of Marshall Petaluma Road near mile marker "C112, 5.32 mi, 8.561 km" between Marshall and Petaluma in Marin

County. This population remains the only known natural population of Baker's larkspur in 2019. It occurs on private property within the county road right-of-way on a very steep ungrazed slope that abuts the road.

FIGURE 2. Range and distribution of Baker's larkspur (*Delphinium bakeri*). The range of *Delphinium bakeri* is restricted to the rectangle marked on the California inset. Introduced sites are collectively marked with one circle per location. The current extant distribution consists of the four southernmost populations. The upper two populations, Camp Meeker and Tomales, are historical sites and have not been seen since 1946 and 1923, respectively (CNDDB 2019).

TABLE 1. Populations of Baker's larkspur (Delphinium bakeri).

EO[1]	Population	Population origin	Status	County	Ownership	Parcel[2]	Land use category[3]
1	Marshall Petaluma Road	Natural	Extant, but low numbers	Marin	County/Private	125-010-12	Farmland-improved
3	Tomales[4]	Natural	Extirpated (presumed)	Marin	Unknown, but likely private	Unknown	Residential or Vacant land
4	Camp Meeker[4]	Natural	Extirpated	Sonoma	Unknown, but likely private	Unknown	Residential/Agricultural/ or Industrial
5	Stubbs Vineyard	Introduced	Declining; population not yet established	Marin	Private	125-010-08	Agriculture-improved
6	Chileno Valley Ranch	Introduced	Declining; population not yet established	Marin	Private	106-120-07	Farmland-unimproved
7	Soulajule Reservoir	Introduced	Unsuccessful establishment	Marin	Marin Municipal Water District	106-241-09	Rural-improved

[1]Element Occurrence, CNDDB
[2]Assessor's Parcel Number
[3]Taken from county parcel ownership data
[4]Exact location unknown

Introduced populations: in winter 2009/2010, three outplantings were planned through cooperative agreements with each of the three landowners and USFWS and CDFW (formerly California Department of Fish and Game) and outlined in a USFWS Recovery Plan (USFWS 2015). The outplanting was primarily executed by the University of California Botanical Garden (UCBG). UCBG grew nursery plants from seed collected from the Marshall Petaluma Road population, then collected seed from the nursery-grown plants each year between 2008 and 2012. UCBG also collected seed from the Marshall Petaluma Road population each year between 2001 and 2005 (excluding 2002).

- *Chileno Valley Ranch* – outplanted sites at this location are approximately 6 km (3.7 mi) north of the natural Marshall Petaluma Road population. In the winter of 2019, UCBG expanded its outplanting efforts into a new site about 1.2 km (0.75 mi) south of the original sites.
- *Soulajule Reservoir* – three outplanted sites at this location are approximately 3 km (1.9 mi) southwest of the natural population. The sites are spaced along the southern edge of the reservoir. No new plants were added in 2019.
- *Stubbs Vineyard* – the single outplanted site at this location is approximately 3.3 km (2 mi) northeast of the natural population. In the winter of 2019, UCBG outplanted mature plants into a new site adjacent to the original site.

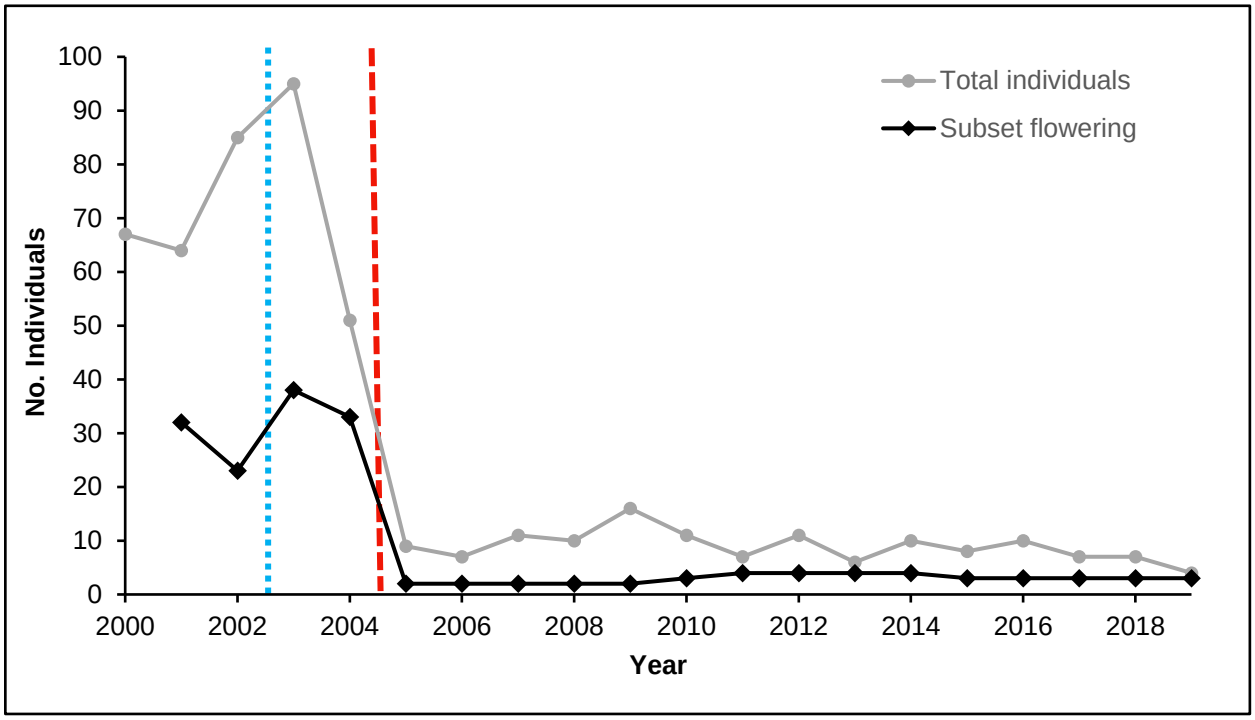

FIGURE 3. Population trend of Baker's larkspur (*Delphinium bakeri*). Population size (gray) and the subset of individuals that were flowering (black) at the naturally occurring Marshall Petaluma Road population (CNDDB EO #1) between 2000-2019. The dotted blue line indicates when the population was mowed while setting seed (late spring, 2002), and the dashed red line indicates when road crews excavated the road cut above the mud-filled culvert.

(a) 2001

(b) post-mowing in 2002

(c) post-fire in 2004

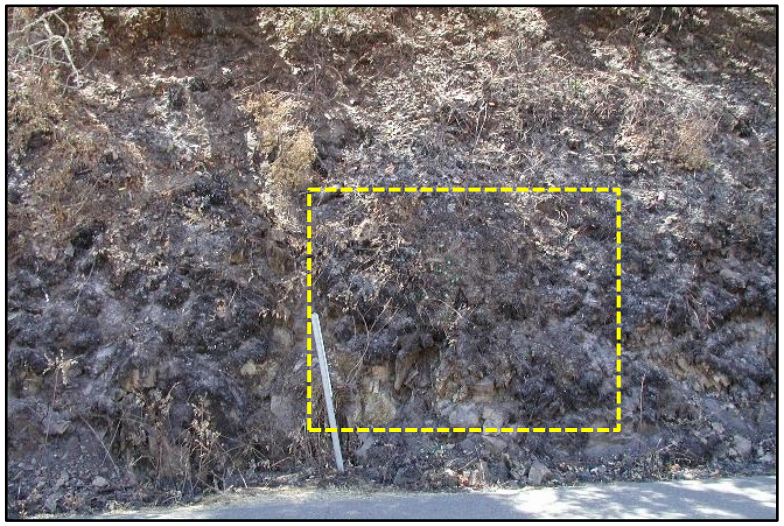

FIGURE 4. Threats to Baker's larkspur (*Delphinium bakeri*) on Marshall Petaluma Road. Photos of the Marshall Petaluma Road population (CNDDB EO #1) between 2001 and 2004 when the population was severely reduced by natural and human causes. Photos show the population (a) in 2001, (b) after mowing in 2002, (3) after a fire in 2004, and (d) after excavation above the culvert in 2004. The yellow dashed box approximates the same area of hillside in all four photos which contained about two-thirds of the total natural population in 2003. Photos by Holly Forbes.

TABLE 2. Population trends of outplanted sites. Outplanting began in the winter of 2009/2010 at three locations. Each location consisted of 1-4 sites. Numbers in parentheses are the number of individuals planted into the location in a given year. In 2019, two new sites were added, one at Chileno Valley Ranch and one at Stubbs Vineyard. (UCBG 2012, 2015, 2019; USFWS 2015; Forbes, pers. comm. 2019)

	Chileno Valley Ranch			**Soulajule Reservoir**			**Stubbs Vineyard**		
Year	*# Adult plants*	*# Flowered*	*# Young recruits*	*# Adult plants*	*# Flowered*	*# Young recruits*	*# Adult plants*	*# Flowered*	*# Young recruits*
2009	-	-	-	40	-	-	11	-	-
2010	45	-	-	26 (70)	-	-	-	-	-
2011	-	10	30	89	-	-	5	-	-
2012	-	4	-	-	0	1	1 (7)	8	-
2013	26	5	98	18	1	28	3	3	1
2014	14	2	32	20	0	13	3	1	6
2015	14	-	65	14	0	1	3	0	6
2016	2	1	0	9	0	0	0	0	0
2017	14	3	0	4	0	0	0	0	0
2018	7	2	0	25	0	0	0	0	0
2019	13 (28)	16	0	18	1*	0	0 (24)	18	0

*This flowering plant is the first Baker's larkspur recruit (offspring of outplanted individuals) to reach maturity and flower at any of the three introduced locations.

B. Population Trend and Abundance

The one extant population on Marshall Petaluma Road has maintained an average population size of nine plants, ranging from 6-16 plants annually since 2004 (Figure 3). The population size is so low that it is at high risk of extinction. UCBG has introduced Baker's larkspur into three locations near the Marshall Petaluma Road population. These plants have been monitored annually and throughout their growing seasons for growth, flowering, and seed set. To date, these outplanted sites have not become established populations (Table 2). Trends and abundances of the individual populations are discussed below.

- *Marshall Petaluma Road* – Data on population size show a population that fluctuated between 0-50 plants in the 1980s (CNDDB 2019). Population information was not collected in the 1990s, but starting in 2000, UCBG began monitoring the population and recording the number of mature plants, as well as the number of plants that were reproductive (i.e., producing flowers) (Figure 3).

  Between 2000 and 2002, the population of Baker's larkspur was between 64-85 plants, with approximately 30-50% of them flowering. While seeds were developing in late May 2002, the population was mowed by a Marin County road crew (Figure 4b; Figure 3, blue dotted line). Due to the timing of this mowing, the plants were unable to contribute to the next generation of Baker's larkspur. The ground was also gouged by mowing equipment, disturbing root stocks of the long-lived perennial species. Signs were erected to protect approximately 30 m (98 ft) of roadside from future mowing. In the following year, 2003, the population size was 97 plants with about 40% of those individuals in flower. In the short-term, mowing did not seem to harm the population; however, the missing deposit of seeds to the seed bank may have affected the long-term recruitment into the population.

  In the winter of 2004, a fire created conditions that led to a mudslide that filled the culvert below the roadcut on which the plants were growing (Figure 4c). The road subsequently flooded, and a Marin County emergency road crew cleared the culvert to recover proper drainage. In addition, several meters above the culvert was also excavated down to bedrock, which reduced the population of Baker's larkspur to just nine individuals (Figure 4d; Figure 3, red dashed line). The population has not recovered from these events (Figure 3). After these events, the population has consistently had between 6-16 plants, with 2-4 reproductive individuals annually. Consequently, any seeds produced by this population have a greater likelihood of being inbred, which will reduce the genetic variation of the population.
- *Chileno Valley Ranch* – In December 2009, a total of 45 mature Baker's larkspur plants were outplanted into three introduction sites at this location. The sites were in close proximity and fenced to exclude cattle. In January 2011, 30 additional plants were added to the same three sites. As of 2018, these three sites had failed to become established populations (Table 2). In winter 2018/2019, 28 individuals were outplanted into a new site on the property. It will be several years before the success of this introduction can be determined.
- *Soulajule Reservoir* – In January 2010, 40 mature Baker's larkspur plants were outplanted into one introduction site near the southwest edge of the reservoir. In January 2011, 70 mature plants were outplanted in two additional nearby introduction sites (35 plants each). These two sites were abandoned after they stopped producing flowers and seeds in 2014. Plants in the three sites flowered well initially, but only the first site near

the southwest edge of the reservoir supported mature plants into 2019, although none flowered since 2013 (Table 2). In 2019, for the first time, a recruit (i.e., offspring of the outplanted individuals) reached maturity and flowered. It failed to produce any seeds.

- *Stubbs Vineyard* – In March 2009, 11 three-year-old Baker's larkspur plants were outplanted into a fenced site that was wooded, sloped, and near a stream that crossed a gravel road. In February 2012, seven additional plants were added to the one remaining plant at this site. Three adult plants survived through 2015, but no plants remained by 2016. Initially, plants did well and flowered each year, but eventually they all appeared to die off with no recruitment from the seeds of previous years. In 2019, 24 new mature individuals were outplanted into an adjacent site just outside the fence. It will be several years before the success of this new site can be determined.

V. THREATS AND SURVIVAL FACTORS

A. Factors Affecting Ability to Survive and Reproduce

At the time of listing, threats to Baker's larkspur included: modification and/or destruction of habitat, overexploitation, human-related activities, and other natural occurrences that pose a threat to its extremely small population. Explanations of how these factors affect the species are described below, followed by two additional factors that currently threaten the species' survival.

- *Present or threatened modification or destruction of its habitat* – Conversion of land to "grainfields" (Ewan 1942), along with conversion to grazing land and the encroachment of non-native grasslands, led to the extirpation of the two historical populations. Similar land conversions are ongoing and have reduced possible habitat across the historical range of Baker's larkspur (Forbes, in litt. 2004). Lack of adequate habitat also diminishes the chances of the Marshall Petaluma Road population expanding beyond its current restricted habitat. If not collected, most seeds produced by the Marshall Petaluma Road population currently fall into the culvert or fall onto the paved road. Furthermore, habitat of the natural population could be reduced by future road maintenance or efforts to upgrade or widen the county road.

- *Overexploitation* – In 1992, all seeds that were produced by the Marshall Petaluma Road population were taken illegally, possibly for horticultural purposes (USFWS 2000; CDFG 2005). The poacher was never identified, and the seeds were not recovered. Removing the yearly reproductive output for an entire population can negatively impact the species. There has not been any evidence of this type of activity since, however it remains a threat as larkspurs produce showy flowers, and horticultural trade markets for rare plants could shift, making rare larkspurs highly desirable.

- *Human-related activities* – At the time of listing, the only remaining natural population had suffered several setbacks that reduced its population size to just nine plants. The most impactful activities were associated with roadside maintenance. There were two poorly timed mowing events that destroyed plants before they could fully set seed. The most damaging event occurred in October 2004 after a fire burned the area, resulting in a mudslide that filled the culvert below the population. Road crews used a backhoe to clear the culvert, and in the process excavated the entire slope above the culvert down to bedrock; this was where most of the population was located, and the natural population has not recovered from this event.

Baker's larkspur is susceptible to environmental changes associated with climate change. The Climate Change Vulnerability Index (CCVI) (NatureServe 2016) quantifies the vulnerability of a species under current climate change models, using information on the needs of a species, its range, life history, and ecology (CDFW 2019). Baker's larkspur is rated as "Highly Vulnerable," meaning its abundance and range are likely to decrease significantly by 2050. Factors that most determined this rating were the bottleneck (severe reduction in population size and genetic variation), its narrow temperature tolerance (experiencing a range of temperatures of spanning 42°F), somewhat specialized pollination, short dispersal distance, and anthropogenic barriers to dispersal (roads and agricultural fields).

- *Other natural occurrences* – With such small population sizes confined to very small areas, Baker's larkspur is highly vulnerable to random events. Documented random events that have negatively affected the natural population include vehicle collisions, fire, mudslides, and small mammal digging or movement over the population. Small populations are also susceptible to inbreeding depression, which results in low genetic variation and the potential inability to adapt to environmental changes (Ellstrand and Elam 1993). The ability to adapt is especially important in the face of climate change.

In addition to these threats that contributed to the near extinction of Baker's larkspur, this species is further at risk due to competition from encroaching woody vegetation, and predation (herbivory) by slugs and cattle (USFWS 2015; Forbes, pers. comm. 2019).

- *Competition* – Baker's larkspur competes with surrounding vegetation for resources such as sunlight. At the Marshall Petaluma Road population, the ecological succession of the roadside (i.e., the change of the plant community over time) has been ongoing since the backhoe removed all soil down to bedrock. Since then, detritus has collected, new soil has been deposited, and Marin County has refrained from mowing the area where Baker's larkspur grows, so the surrounding vegetation has rebounded and Baker's larkspur faces increased competition from encroaching woody shrubs.

- *Predation* – Baker's larkspur faces predation from animals that eat its leaves, stems, or seeds. Loss of individuals throughout the season due to herbivory has been identified through monthly censuses (UCBG). Herbivory by slugs has been the primary threat to the populations that have been introduced into sites near Marshall Petaluma Road, and is partially responsible for their inability to become established populations that do not require consistent human intervention. For plants that can successfully reproduce and set seed, seed predation is another event that hinders success of the introduced populations and survival of the natural population.

B. Degree and Immediacy of Threats

Threats that are faced by Baker's larkspur have increased since this species was placed on the list of endangered species in 2006. This species remains in extreme danger of extinction. Without continued protection of the natural population, and management through recovery projects, the risk of this species being lost is very high and Baker's larkspur could go extinct at any time. Loss of genetic diversity due to population reductions, along with random events, are likely the greatest threats to the Marshall Petaluma Road population. Timing and outcome of

these types of threats are, by nature, unpredictable and require diligent monitoring of the natural and introduced populations.

MANAGEMENT AND RECOVERY

A. Impact of Existing Management Efforts

Current management efforts consist of the collection and long-term storage of seeds from the Marshall Petaluma Road population, and the introduction of cultivated plants grown from seeds collected from the natural population, into new sites nearby.

i. Marshall Petaluma Road Population Monitoring

Management efforts at the natural population has consisted of identifying and mapping all individuals, then monitoring them throughout the growing season to census the number of seedlings, mature plants, plants that survive to flower, plants that survive to produce seeds, and the number of seeds produced. Since 2003, the California Native Plant Society (CNPS) and UCBG has coordinated with Marin County to stop maintenance crews from mowing the roadside where Baker's larkspur grows, which has allowed the natural population to complete its reproductive cycle annually.

Because seeds from this roadside population tend to fall into the culvert and onto the road, which is not suitable habitat for Baker's larkspur, UCBG has collected all of the seeds produced by the natural population (typically from only two to three plants) since 2009. Seeds are kept frozen at UCBG to be used for future plantings and/or genetic studies.

ii. USFWS-led Recovery Efforts (2009-Present)

UCBG has managed concerted efforts towards establishing new populations of Baker's larkspur. Beginning in 2009, staff at USFWS secured USFWS Recovery funds to support seed collection, propagation, outplanting, and monitoring by UCBG (Symonds, pers. comm. 2019b). Additional funding through the USFWS Partners for Fish and Wildlife Program funded site preparation and the installation of fences to exclude cattle on private and Marin County property where new outplanting sites within the historic range of Baker's larkspur would be established (Symonds, pers. comm. 2019a). Plans for introduction sites and the results of the first six years of the project are described in the USFWS Recovery Plan (USFWS 2015).

USFWS signed cooperative agreements with each of the private landowners, as well as the Marin Municipal Water District to allow cultivated plants to be outplanted into seven new sites at the three locations. These agreements state that the outplanting sites will be managed cooperatively through 2030, 2030, and 2020, respectively; however, the landowners retain full ownership of the sites and may terminate their agreement, with notice, at any time. Termination of any of the agreements is highly unlikely, but the future of the sites once the agreements expire or if a property is sold is uncertain. Each landowner also has a memorandum of understanding with the Department and USFWS to permit the recovery efforts for Baker's larkspur on their land.

The introduction sites are within 6 km (3.7 mi) of the Marshall Petaluma Road population. Outplanting sites were chosen based on their apparent similarity to the natural population (i.e., moist, steep slopes with diverse plant communities near a stream). To maximize

genetic diversity, cultivated Baker's larkspur plants grown for outplanting were descendants of the natural population, and grown at the Regional Parks Botanic Garden in Berkeley, CA, or were grown from wild-collected seeds and grown by maternal line at UCBG in Berkeley, CA. Cultivated plants had relatively large root stocks that could initially support vegetative growth while they became established. Initially, these outplanted populations did very well, with many plants flowering in the first few years. Subsequently, plants ceased flowering and herbivory from slugs significantly reduced the population size (Table 2; Forbes, pers. comm. 2019a). In the winter of 2018/2019, UCBG introduced additional plants into two new sites, one at Chileno Valley Ranch, and one at Stubbs Vineyard. These two new populations did well in the first year (spring 2019), flowering and setting seed. When possible, seeds were counted and dispersed back into the site by UCBG staff to germinate next winter.

Thus far, this recovery project has not established new populations of Baker's larkspur that are reliably sustainable without human intervention. Establishing new plant populations can be very challenging and generally has a low rate of success (Fiedler 1991). However, in the case of Baker's larkspur, it is the only possible way to increase the number of populations, thereby lowering the risk of extinction. UCBG will continue trying to establish new Baker's larkspur populations, and with long-term data collection, may identify the sites that will support Baker's larkspur for the long-term.

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

The Department's recommendations for management and recovery of Baker's larkspur begin with the continued preservation of the current natural population through monitoring activities and promotion of recruitment of plants into the population. Recovery of Baker's larkspur is dependent on introductions into the historical range of the species to boost the number of individuals and occurrences. Recommendations include:

- Collaborate with Marin County to ensure there are no new impacts to the natural population from road maintenance or mowing. Mowing should only be done with permission from the scientists at CDFW, CNPS, UCBG, and/or USFWS who are familiar with the phenology (i.e., the timing of growth, flowering, and seed production) of Baker's larkspur.
- Consider planting seedlings that have been cultivated from wild-collected seeds into the natural population. However, all proposals should strongly weigh the risk of unintended introductions of pathogens or other factors that may negatively affect the current highly vulnerable population.
- Monitor all introduction populations several times throughout the growing season to collect demographic data (e.g., numbers of seedlings, adults, flowering plants, fruits, and seeds). This will identify the vulnerability of each life stage, so interventions can be chosen that will mitigate the most risk to each introduced population.
- Facilitate research that expands our knowledge of the ecology of Baker's larkspur to help identify suitable habitat (1) to narrow searches for additional natural populations and (2) that could act as introduction sites. Much remains unknown about the soil chemistry, moisture, and species interactions (e.g., pollination, competition) that define the natural population.

- Foster relationships with private landowners in Baker's larkspur's historical range and employ tools such as Safe Harbor Agreements (Fish and G. Code, § 2089.2 et seq.) to incentivize recovery and conservation of the species.
- Develop microsatellite markers (a tool for quantifying population genetics) for Baker's larkspur. This research is currently underway, but is time intensive (Koontz, pers. comm. 2019).
- Describe the genetic diversity of the natural population and the cultivated plants currently growing at the two botanical gardens. Before the devastating population reduction in 2005, genetic studies showed that Baker's larkspur, like other larkspurs, had higher diversity than expected for its small population size (Koontz 2011). The population reduction down to just nine plants was likely a major genetic bottleneck; however, without further genetic studies, the genetic diversity of the current population cannot be known. Care should be taken when collecting tissue for such genetic studies, seeking techniques that minimize impacts to the natural population. Additionally, any new introduced populations should be genetically diverse, so understanding the genetics of the cultivated stock will facilitate recovery efforts.
- Collect seeds following protocols that consider genetic diversity and rarity (e.g., RSABG 2009) and place them in long-term conservation storage at Department-approved facilities.
- Coordinate with other resource agencies and organizations to establish a formal recovery team to support recovery efforts beyond 2020 when the USFWS recovery period ends (USFWS 2015).

VI. RECOMMENDATION TO THE COMMISSION

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

In completing this Five-Year Status Review for Baker's larkspur (*Delphinium bakeri*), the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing Baker's larkspur as endangered are still present, and recommends no change to the status of Baker's larkspur on the list of endangered species at this time.

VII. Sources

A. Literature Cited

CDFG (CALIFORNIA DEPARTMENT OF FISH AND GAME). 2005. Report to the Fish and Game Commission on the status of Baker's larkspur (*Delphinium bakeri* Ewan). The Resources Agency, Sacramento.

CDFW (CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE). 2019. Climate change vulnerability assessment for Baker's larkspur (*Delphinium bakeri*) using the NatureServe Climate Change Vulnerability Index. Release 3.02.

CNDDB (CALIFORNIA NATURAL DIVERSITY DATABASE). 2019. Rarefind 5 [Internet]. California Department of Fish and Wildlife. [Accessed: 5 July 2019].

CNPS (CALIFORNIA NATIVE PLANT SOCIETY). 1977. Rare plant status report for *Delphinium bakeri* Ewan, Baker's delphinium.

CNPS (CALIFORNIA NATIVE PLANT SOCIETY). 1988. California native plant status report for *Delphinium bakeri*, Baker's delphinium (revised).

CNPS (CALIFORNIA NATIVE PLANT SOCIETY). 2019. Inventory of Rare and Endangered Plants of California (online edition, v8-03 0.39). Rare Plant Program. http://www.rareplants.cnps.org [accessed: 24 June 2019].

CPC (CENTER FOR PLANT CONSERVATION). 2017. CPC national plant collection plant profile, *Delphinium bakeri*. https://saveplants.org/national-collection/plant-search/plant-profile/?CPCNum=1375. Site updated: 2018-03-08 [Accessed: 17 July 2019].

ELLSTRAND N. C. AND D. R. ELAM. 1993. Population genetic consequences of small population size: implications for plant conservation. Annual Review of Ecology and Systematics 24: 217-242.

EWAN, J. 1942. The genus *Delphinium* in North America: series Echinatae of subsection Subscaposa, and miscellaneous noteworthy species. Bulletin of the Torrey Botanical Club 69: 137-150.

FIEDLER, P. L. 1991. Mitigation-related transplantation, relocation and reintroduction projects involving endangered and threatened, and rare plant species in California. Final Report. California Department of Fish and Game. Endangered Plant Program.

KOONTZ, J. A. AND H. FORBES. 2003. Demography and conservation genetics of the endangered Baker's larkspur (*Delphinium bakeri*, Ranunculaceae). Progress report submitted to the Habitat Conservation Planning Branch, California Department of Fish and Game, Sacramento. Permit 2081(a)-01-01-RP.

KOONTZ, J. A. AND H. FORBES. 2011. Conservation genetics of Baker's larkspur (*Delphinium bakeri*). Final report submitted to the Habitat Conservation Planning Branch, California Department of Fish and Game, Sacramento. Permit 2081(a)-01-01-RP.

KOONTZ, J. A., P. S. SOLTIS, AND D. E. SOLTIS. 2004. Using phylogeny reconstruction to test hypotheses of hybrid origin in *Delphinium* Section Diedropetala (Ranunculaceae). Systematic Botany 29(2): 345-357.

KOONTZ J. A. AND M. J. WARNOCK. 2012. *Delphinium bakeri*, in The Jepson Manual: Vascular Plants of California, 2nd edition. University of California Press. Berkeley, California.

MMWD (MARIN MUNICIPAL WATER DISTRICT). 2014. Vegetation - Marin Municipal Water District (MMWD) [ds996]. California Department of Fish and Wildlife. Biogeographic Information and Observation System (BIOS). Retrieved 1 July 2019 from http://bios.dfg.ca.gov.

NATURESERVE. 2016. Climate Change Vulnerability Index. Release 3.02. Available online at http://www.natureserve.org/conservation-tools/climate-change-vulnerability-index. [Accessed: 26 June 2019].

O'GEEN, A. AND K. ARROUES. 2016. Soils. In: M.R> George (ed.). Ecology and management of annual rangelands. Davis, CA: Department of Plant Science. Pgs. 30-59.

PRISM CLIMATE GROUP. 2004. Oregon State University. http://prism.oregonstate.edu. [Accessed: 24 June 2019].

RSABG (RANCHO SANTA ANA BOTANIC GARDEN). 2009. Seed collection guidelines. https://uploads-ssl.webflow.com/59613419dcbd9b40dceb57a6/5acd728da1daf8feb5427a0c_Seed%20Collecting%20and%20Storage%20Guidelines.pdf [Accessed: 5 August 2019]

SAWYER, J. O., T. KEELER-WOLF, AND J. M. EVENS. 2009. A Manual of California Vegetation, Second Edition. California Native Plant Society, Sacramento, CA.

SOIL SURVEY STAFF. 2019. Web Soil Survey. Natural Resources Conservation Service, U. S. Department of Agriculture. http://websoilsurvey.nrcs.usda.gov [Accessed: 27 February 2019].

UCBG (UNIVERSITY OF CALIFORNIA BOTANICAL GARDEN). 2012. Recovery actions to benefit State-listed plants, report for 2009-2012 activities. Progress report submitted to the Habitat Conservation Planning Branch, California Department of Fish and Game, Sacramento. Permit 2081(a)-09-02-RP.

UCBG (UNIVERSITY OF CALIFORNIA BOTANICAL GARDEN). 2015. Recovery actions to benefit State-listed plants, report for 2015 activities. Progress report submitted to the Habitat Conservation Planning Branch, California Department of Fish and Wildlife, Sacramento. Permit 2081(a)-09-02-RP.

UCBG (UNIVERSITY OF CALIFORNIA BOTANICAL GARDEN). 2019. Progress Report. Recovery actions to benefit State-listed plants, report for 2016-2018 activities. Progress report submitted to the Habitat Conservation Planning Branch, California Department of Fish and Wildlife, Sacramento. Permit 2081(a)-09-02-RP.

USFWS (U. S. FISH AND WILDLIFE SERVICE). 2015. Recovery plan for Baker's larkspur (*Delphinium bakeri*). U. S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vi + 37 pp.

USFWS (U. S. FISH AND WILDLIFE SERVICE). 2019. 5-Year Review, Baker's larkspur (*Delphinium bakeri*). https://ecos.fws.gov/docs/five_year_review/doc6003.pdf

B. In Litteris

FORBES, H. 2004. E-mail update on ongoing research by the University of California Botanical Garden on Baker's larkspur. Sent to MA Showers in the Habitat Conservation Planning Branch [Received: 3 December 2004].

KOONTZ, J. 2005. A letter accompanying the review of the report recommending the status change of Baker's larkspur. Sent to K Hunting, Chief, Habitat Conservation Planning Branch [Received: 30 November 2005].

C. Personal Communication

FORBES, H. 2019a. Conversation with R. La Rosa during a site visit to the introduced populations [7 June 2019].

FORBES, H. 2019b. E-mail message to R. La Rosa answering several questions on seed and fruit number per plant, and clarification of outplanting activities and seed collection [28 June 2019].

KOONTZ, J. A. 2019. E-mail message to R. La Rosa discussing the current status of microsatellite marker development for Baker's larkspur [10 July 2019].

PROVOST, S. 2019. E-mail message to R. La Rosa regarding the USFWS 5-year review. S Provost included a draft of that document [Received: 20 February 2019]

SYMONDS, K. 2019a. Conversation with R. La Rosa during a site visit to the introduced populations [7 June 2019].

SYMONDS, K. 2019b. E-mail message to R. La Rosa discussing funding sources for the outplanting project [Received: 19 July 2019].

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X. LIST OF APPENDICES

APPENDIX A. Soil composition of natural and introduced sites. Each soil series is described independently, but can exist alone, or as a soil complex with another series (Soil Survey Staff 2019). Most of the soil series share a similar soil profile: loamy texture, mixed topsoil, superactive cation activity, and a haploxerolls soil group. There are three soil series that do not share this common profile: Barnabe, Cole, and Los Osos.

Series	Site(s)[1]	Population type[2]	Texture	Topsoil	Cation activity	Soil group
Barnabe[3]	T	N	loamy-skeletal	mixed	active	isomesic lithic haplustolls
Blucher	CM, T	N	fine-loamy	mixed	superactive	thermic fluvaquentic haploxerolls
Bonnydoon	CVR, SR	I	loamy	mixed	superactive	thermic shallow entic haploxerolls
Cole[4]	T	N	fine	mixed	superactive	thermic pachic argixerolls
Kneeland	CM	N	fine-loamy	mixed	superactive	isomesic ultic haploxerolls
Los Osos[5]	CVR	I	fine	smectitic	none	thermic typic argixerolls
McMullin	MPR, SR	N, I	loamy	mixed	superactive	mesic lithic ultic haploxerolls
Saurin	SV	I	fine-loamy	mixed	superactive	thermic typic haploxerolls
Tocaloma	MPR, SR, SV	N, I	fine-loamy	mixed	superactive	mesic typic haploxerolls

[1]Sites are: CM (Camp Meeker), CVR (Chileno Valley Ranch), MPR (Marshall Petaluma Road), SR (Soulajule Reservoir), SV (Stubbs Vineyard), and T (Tomales)

[2]Associated Baker's larkspur population type: natural (N) or introduced (I)

[3]Exact site location unknown; this soil type may not be present at the actual site of the historic population

[4]Part of a soil complex with the Blucher series

[5]Part of a soil complex with the Bonnydoon series

State of California
Department of Fish and Wildlife

Signed copy on file, received Nov 18, 2019, 11:30 a.m.

M e m o r a n d u m

Date: November 18, 2019

To: Melissa Miller-Henson
Executive Director
Fish and Game Commission

From: Charlton H. Bonham
Director

Subject: **Five-Year Status Review of Clara Hunt's Milk-Vetch**

The California Department of Fish and Wildlife (Department) has prepared the attached Five-Year Status Review of Clara Hunt's Milk-Vetch for the Fish and Game Commission (Commission) pursuant to the California Endangered Species Act (CESA). Pursuant to Fish and Game Code section 2077, subdivision (a), the Department has prepared this Five-Year Status Review to evaluate whether conditions that led to the original listing of Clara Hunt's milkvetch are still present.

In completing this Five-Year Status Review, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Clara Hunt's milkvetch as threatened in January of 1991 have changed. The scientific information available to the Department indicates that Clara Hunt's milkvetch is in serious danger of extinction in all or a significant portion of its range due to one or more causes. Therefore, the Department recommends a change in the status of Clara Hunt's milkvetch from threatened to endangered. This Five-Year Status Review shall be considered by the Commission as a petition with a Department recommendation to accept and consider the petition (Fish and G. Code §§ 2072.7 and 2077).

If you have questions or need additional information, please contact Richard Macedo, Branch Chief, Habitat Conservation Planning Branch at (916) 653-3861, or by e-mail at Richard.Macedo@wildlife.ca.gov.

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State of California
Natural Resources Agency
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION
FIVE-YEAR STATUS REVIEW OF CLARA HUNT'S MILKVETCH (*Astragalus claranus*)

September 2019

Clara Hunt's milkvetch photo by Jeb Bjerke

Charlton H. Bonham, Director
Department of Fish and Wildlife

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I. EXECUTIVE SUMMARY

Clara Hunt's milkvetch (*Astragalus claranus* Jeps.) is currently listed as threatened under the California Endangered Species Act (CESA). Pursuant to Fish and Game Code section 2077, subdivision (a), the California Department of Fish and Wildlife (Department) has prepared this Five-Year Status Review to evaluate whether conditions that led to the original listing of Clara Hunt's milkvetch are still present. This review is based on the best scientific information currently available to the Department regarding each of the components listed under section 2072.3 of the Fish and Game Code, and Section 670.1, subdivisions (d) and (i)(1)(A), of Title 14 of the California Code of Regulations. In addition, this document reviews 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).)

Clara Hunt's milkvetch is a short annual herb of the legume family that has white petals with bright purple tips. There are six small populations of Clara Hunt's milkvetch, all located in Napa and Sonoma Counties within ten miles of St. Helena. The species is generally found in oak woodlands, in sparsely-vegetated openings without significant shrub or tree overstory, and appears to be adapted to poor quality, acidic soils that may limit competition from other plants.

Despite a lack of consistent monitoring and limitations in available data, sufficient information is available to suggest that of the six known populations of Clara Hunt's milkvetch, one population is declining and another population may be extirpated or only exist in the soil seed bank. The August 1989 "Report to the Fish and Game Commission on the Status of Clara Hunt's Milkvetch (*Astragalus clarianus*)" identified several factors affecting the ability of Clara Hunt's milkvetch to survive and reproduce that the Commission considered in listing Clara Hunt's milkvetch under CESA. Factors identified in the 1989 report were: present or threatened modification or destruction of habitat, predation, and stochastic (chance) extinction events due to small population size. These factors continue to threaten Clara Hunt's milkvetch with extinction. In addition to the factors identified in 1989, the Department has identified invasive plants, vegetation community succession, climate change, and possibly herbivory as additional factors affecting the ability of Clara Hunt's milkvetch to survive and reproduce. The scientific information available to the Department indicates that Clara Hunt's milkvetch is in serious danger of extinction in all or a significant portion of its range due to one or more causes.

n completing this Five-Year Status Review for Clara Hunt's milkvetch, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Clara Hunt's milkvetch as threatened have changed. Therefore, the Department recommends a change in the status of Clara Hunt's milkvetch from threatened to endangered. This Five-Year Status Review shall be considered by the Commission as a petition with a Department recommendation to accept and consider the petition (Fish and G. Code §§ 2072.7 and 2077).

II. INTRODUCTION

A. Five-Year Status Review

This Five-Year Status Review addresses Clara Hunt's milkvetch (*Astragalus claranus* Jeps.), which is designated as a threatened species under the California Endangered Species Act (CESA) (Fish and G. Code § 2050 et seq.; Cal. Code Regs. tit. 14 § 670.2, subd. (b)(6)(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)). Clara Hunt's milkvetch is also listed as endangered under the federal Endangered Species Act. Pursuant to Fish and Game Code section 2077, subdivision (b), this Five-Year Status Review was conducted in conjunction with the 5-year Review for Clara Hunt's milkvetch completed by the U.S. Fish and Wildlife Service on May 2, 2019. The U.S. Fish and Wildlife Service concluded that Clara Hunt's milkvetch remains an endangered species under the federal Endangered Species Act (USFWS 2009, 2019).

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

B. Listing and Status Review History

On July 1, 1988, Mr. Joe Callizo of the California Native Plant Society submitted a petition to the California Fish and Game Commission (Commission) requesting that Clara Hunt's milkvetch be listed as an endangered species under CESA. On August 26, 1988, the Commission accepted a Department recommendation to accept the petition and designated Clara Hunt's milkvetch a candidate species. In August of 1989 the Department completed a report to the Commission on the status of Clara Hunt's milkvetch which included a recommendation that the Commission find that the petitioned action to list Clara Hunt's milkvetch as endangered was warranted. After considering the petition, the Department's recommendation and report, and public comments, the Commission decided at a public meeting to designate Clara Hunt's milkvetch as a threatened species under CESA. In January of 1991, Clara Hunt's milkvetch was designated a threatened species under CESA. Clara Hunt's milkvetch was listed as endangered under the federal Endangered Species Act on October 22, 1997.

This Five-Year Status Review was prepared by Jeb McKay Bjerke in the Department's Habitat Conservation Planning Branch, Native Plant Program.

III. BIOLOGY

A. Taxonomic and Physical Description

Clara Hunt's milkvetch is a slender annual herb of the legume family (Fabaceae), with mature plants growing to heights of approximately 7 to 23 centimeters (3 to 9 inches) (Ruygt 1994). Stems of Clara Hunt's milkvetch branch from near the base of the plant and curve or angle upwards, and plants are sparsely covered with small appressed hairs (Jepson 1925, Wojciechowski and Spellenberg 2012). Like most other species of the genus *Astragalus*, the leaves of Clara Hunt's milkvetch are composed of smaller segments called leaflets that are arranged in pairs with one terminal leaflet centered at the end of the leaf. Clara Hunt's milkvetch leaves have two to four pairs of leaflets that have deeply notched tips (cover photo). The root zone of Clara Hunt's milkvetch is approximately 10 centimeters (4 inches) deep, and swelling observed along the primary roots suggests that the species may have a symbiotic relationship with a fungus that is referred to as a mycorrhizal association (Ruygt 1994).

Like most plants in the legume family, the flowers of Clara Hunt's milkvetch are bisexual, and are pea-like, which means that they have one large upper petal called a banner, two smaller side petals called wings, and two fused lower petals called a keel (Figure 1). The petals of Clara Hunt's milkvetch are more or less white, and the banner and keel petals have bright purple tips. Clara Hunt's milkvetch flowers are arranged into groups called inflorescences, and vegetative parts of the inflorescences are covered in short black hairs.

A Clara Hunt's milkvetch flower can develop into a 17 to 25 millimeter (⅔ to 1 inch) long fruit called a legume that can split into two halves that may remain joined at the base. Clara Hunt's milkvetch fruits are two-chambered, crescent-shaped, tapered at the ends, and sparsely covered with small appressed hairs. Clara Hunt's milkvetch fruits have a unique stalk-like base that is attached to a peg-like, 1.5 to 2.5 mm (~1/16 inch) extension of the flower that is most evident after fruits have dropped from the plant. Clara Hunt's milkvetch fruits tend to split open only after becoming wet (Liston 1990a). Fruits generally have between six and twelve seeds (Barneby 1965, Ruygt 1994). Clara Hunt's milkvetch seeds are about 2.0 to 3.3 mm (~1/8 inch) long and do not have any specialized dispersal structures (Macdonald 2016). Data collected by Ruygt (1994) suggests that Clara Hunt's milkvetch may produce an average of 29 viable seeds per plant.

Clara Hunt's milkvetch has a chromosome count of 2n=22 (Liston 1990b).

B. Life History and Ecology

Like many plants in the legume family, Clara Hunt's milkvetch exhibits physical seed dormancy, which means there is a physical barrier (seed coat) that prevents moisture from entering seeds (Ruygt 1994, Baskin and Baskin 1998). This seed coat prevents seed germination, even if other environmental factors such as moisture and temperature are favorable, and allows Clara Hunt's milkvetch to form a persistent seed bank. Clara Hunt's milkvetch seeds are reported to require scarification to initiate germination in the lab, such as by nicking the seed coat with a razor blade (Ruygt 1994, CDFW 2010, Rancho Santa Ana Botanic Garden 2018). Rainfall, animal activity, or other natural forces are likely needed to agitate soil particles and naturally break the seed coat of Clara Hunt's milkvetch seeds.

Reports indicate that Clara Hunt's milkvetch seeds may germinate as early as October and as late as March, depending on rainfall patterns (Hunter 1989, Ruygt 1994). After germination,

(a)

(b)

(a) Group of Clara Hunt's milkvetch flowers. (b) Photo showing Clara Hunt's milkvetch with competing vegetation, including immature Mediterranean grasses.

Figure 1. Photographs of Clara Hunt's milkvetch (*Astragalus claranus*)

seedlings have been observed growing at a slow rate from November until late February or early March, followed by a period of accelerated growth and development until mid- or late-April (Ruygt 1994). Ruygt also observed that individuals that germinated in April and May failed to mature.

Clara Hunt's milkvetch flowers from March to early May. Flowering within individual populations has been observed to be somewhat synchronous; however, different populations may begin flowering and reach peak flowering at different times in the same year (Ruygt 1994).

Clara Hunt's milkvetch is likely insect pollinated but plants are also capable of self-fertilization (Ruygt 1994). Bee pollination is a common mode of pollination in the *Astragalus* genus and bees have been observed visiting Clara Hunt's milkvetch plants (Green and Bohart 1975; Karron 1987; Sugden 1985, Liston 1992). Ruygt (1994) did not observe any pollinators during multiple site visits to populations in 1993 and 1994 and suggested that Clara Hunt's milkvetch may be visited by pollinators that are active at night or twilight.

Based on data collected from the Lake Hennessey and Lewelling Lane populations in 1993, Ruygt estimated that 35 to 50 percent of Clara Hunt's milkvetch flowers developed into mature fruit. In one experiment, Ruygt also found that fruit production was 25 percent lower in plants that pollinators were prevented from visiting, indicating that while pollinators may increase fruit production, they are not a requirement. Fruits have been observed on plants as early as April 16. Fruits tend to split apart and release seeds only after becoming wet (Liston 1990a). With no obvious dispersal agents or mechanisms, the dispersal ability of Clara Hunt's milkvetch seeds appears to be low, which likely limits the potential for colonization of unoccupied habitat.

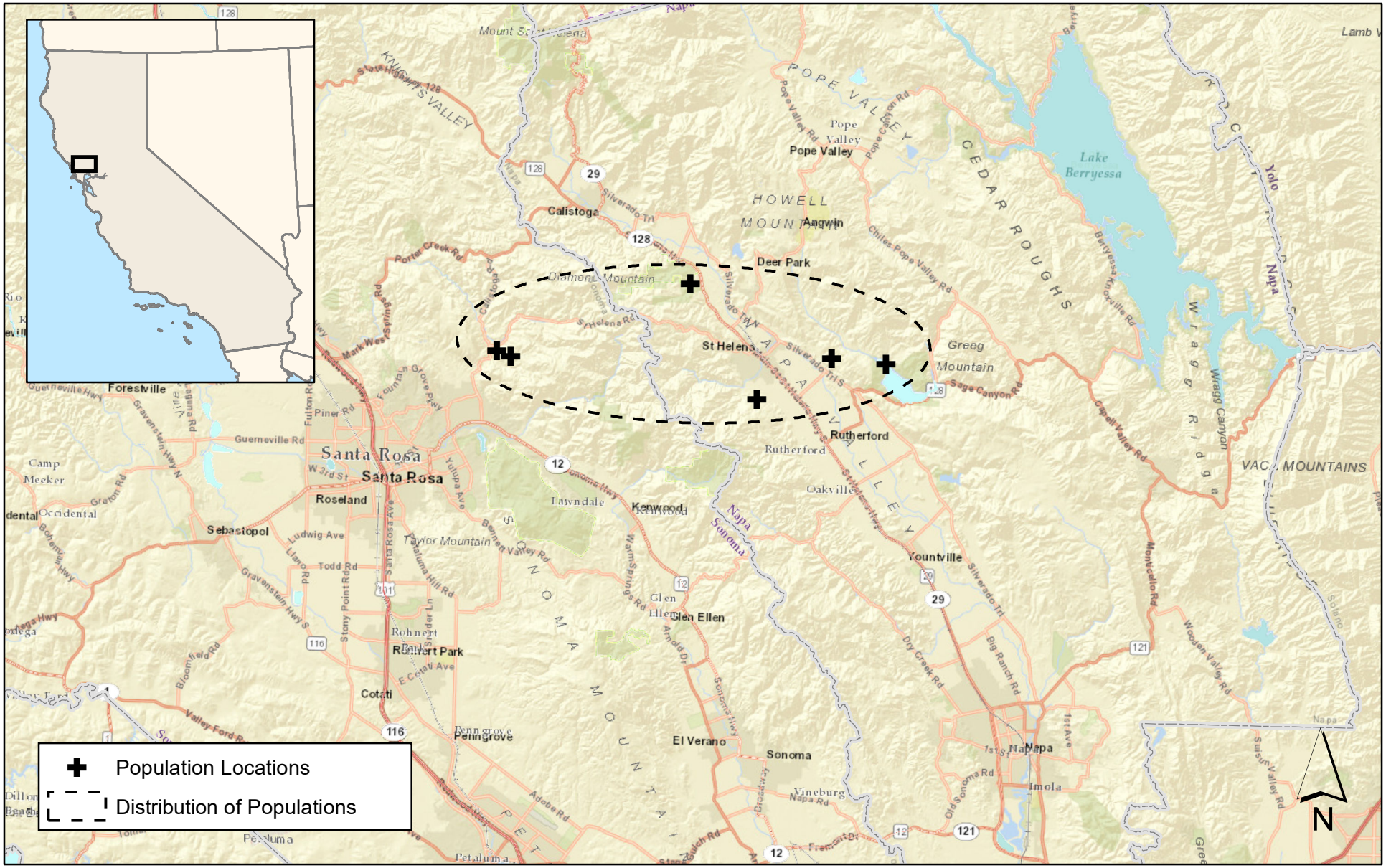
IV. DISTRIBUTION AND ABUNDANCE

A. Range and Distribution

Range is the general geographical area in which an organism occurs. For purposes of CESA and this Five-Year Status Review, the range is the species' California range (*Cal. Forestry Assn. v. Cal. Fish and Game Com.* (2007) 156 Cal.App.4th 1535, 1551). Distribution describes the actual sites where individuals and populations of the species occur within the species' range.

Clara Hunt's milkvetch only occurs in California, in the northern Coast Range of California. All known populations of Clara Hunt's milkvetch are near St. Helena in Napa County, and northeast of the city of Santa Rosa in Sonoma County, at elevations between approximately 95 and 360 meters (320 and 1175 feet) above sea level (Figure 2) (CNDDB 2019). The exact location that the type specimen of Clara Hunt's milkvetch was collected from is unknown. The type specimen was collected by Ms. Clara Adele Hunt and received by Willis Linn Jepson on April 8, 1909. The collection location was only described as "St. Helena". Another collection by Ms. Hunt from "Near St. Helena" was made in 1922. St. Helena has expanded since 1922, and therefore the habitat for the type locality may have been destroyed. Populations of Clara Hunt's milkvetch in Napa County are in the Napa River watershed that drains to San Pablo Bay. Populations of Clara Hunt's milkvetch in Sonoma County are in the Mark West Creek watershed that flows to the Russian River and the Pacific Ocean.

The distribution of Clara Hunt's milkvetch is documented within the California Natural Diversity Database (CNDDB). Plant taxa, animal taxa, and natural communities that are documented



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Sources: Esri, Garmin, USGS, NPS

Figure 2. Regional Vicinity of Clara Hunt's milkvetch (*Astragalus claranus*) Populations

within the CNDDB are of conservation concern within California and are referred to as "elements." An "element occurrence" (occurrence) is a location record for a site which contains an individual, population, nest site, den, or stand of a special status element. Populations, individuals, or colonies that are located within 0.40 kilometer (1/4 mile) of each other generally constitute a single occurrence, sometimes with multiple "parts" (Bittman 2001). The CNDDB occurrence records for Clara Hunt's milkvetch were updated in May 2019, in conjunction with the preparation of this Five-Year Status Review. There are currently six occurrences of Clara Hunt's milkvetch that are documented in the CNDDB. To make it easier to refer to these different occurrences in this Five-Year Status Review, each occurrence has been named as a separate "population" in Table 1, below. A detailed distribution map for Clara Hunt's milkvetch is included in this Five-Year Status Review as Figure 3. All documented Clara Hunt's milkvetch populations are located within an approximately 10-mile radius of St. Helena. The locations of known Clara Hunt's milkvetch populations are described as follows:

Alpine School: The Alpine School Population is one of two populations of Clara Hunt's milkvetch in Sonoma County. The Alpine School Population is approximately 15 kilometers (9.5 miles) west of St. Helena and approximately 10 kilometers (6 miles) northeast of downtown Santa Rosa. The Alpine School Population is located on private property and is southeast of the intersection of St. Helena and Calistoga Roads. The Alpine School Population has two separate parts in the CNDDB, based on surveys conducted intermittently since the late 1980s (Figure 4a). Historical collections suggest that Clara Hunt's milkvetch was also present across from the historic Alpine School, on the north side of St. Helena Road, but this area now has vineyards and a horse stable (McCarten 1985). The Alpine School Population is approximately 0.6 kilometer (0.4 mile) west of the Saddle/Hayfork Population, which is described in more detail below. The landowner of the property containing the Alpine School Population also owns a portion of the Saddle/Hayfork Population.

Bothe: The Bothe Population is one of four populations of Clara Hunt's milkvetch in Napa County. The Bothe Population is located within Bothe-Napa Valley State Park, approximately five kilometers (3.1 miles) northwest of St. Helena. The Bothe Population is mapped as one long population in the CNDDB that begins approximately 190 meters (620 feet) west of the Historic Bale Grist Mill building and extends approximately 0.8 kilometer (0.5 mile) to the west.

Lake Hennessey: The Lake Hennessey Population is one of four populations of Clara Hunt's milkvetch in Napa County. The Lake Hennessey Population is located north of Lake Hennessy, approximately seven kilometers (4.4 miles) east of St. Helena. The Lake Hennessey Population has two separate parts in the CNDDB, both adjacent to Conn Valley Road. The northern part of the Lake Hennessey Population is on the north side of Conn Valley Road on private property. The southern part of the Lake Hennessey Population is on the south side of Conn Valley Road, between the road and Lake Hennessey. The southern part is on land associated with the Lake Hennessey reservoir and is owned by the City of Napa (Figure 4b).

Lewelling Lane: The Lewelling Lane Population is one of four populations of Clara Hunt's milkvetch in Napa County. The Lewelling Lane Population is located on the west side of the Napa Valley, approximately two kilometers (1.4 miles) south of St. Helena, and southwest of the western terminus of Lewelling Lane. The Lewelling Lane Population has two separate parts. The western part of the population is mapped on three private parcels. The eastern part of the population is mapped on five private parcels.

Figure 3. Clara Hunt's milkvetch (*Astragalus claranus*) Distribution Map

(a)

(b)

(a) Alpine School Population of Clara Hunt's milkvetch on April 8, 2019, with pink pin flags marking locations of plants. Location of plants is outlined and view is approximately to the northeast; (b) Lake Hennessey Population of Clara Hunt's milkvetch on March 27, 2019, with pink pin flags marking locations of 27 plants; view is approximately to the southeast.

Figure 4. Photographs of Clara Hunt's milkvetch (*Astragalus claranus*) habitat

Table 1. Clara Hunt's Milkvetch Populations

Population Name	*Occurrence Number*	*County*	*Land Ownership*
Alpine School	3	Sonoma	Private with conservation easement
Bothe	7	Napa	State Park
Lake Hennessey	11	Napa	City of Napa, Private
Lewelling Lane	12	Napa	Private
Saddle/Hayfork	14	Sonoma	Private with conservation easement, Sonoma County
Taplin Road	13	Napa	Private

Saddle/Hayfork: The Saddle/Hayfork Population is one of two populations of Clara Hunt's milkvetch in Sonoma County. The Saddle/Hayfork Population is approximately 15 kilometers (9.5 miles) west of St. Helena and approximately ten kilometers (6 miles) northeast of downtown Santa Rosa. As currently mapped in the CNDDB the Saddle/Hayfork Population has two separate parts, but this mapping is based on observations from only 2019, and Clara Hunt's milkvetch plants have also been observed elsewhere in the immediate vicinity of the population (Evans pers. comm. 2019). The Saddle/Hayfork Population occurs on private property that is protected with a conservation easement, and on the adjacent Saddle Mountain Open Space Preserve owned by the Sonoma County Agricultural Preservation and Open Space District. The Saddle/Hayfork Population is approximately 0.6 kilometer (0.4 mile) east of the Alpine School Population, which is described in more detail above. The landowner of the property containing the Alpine School Population also owns a portion of the Saddle/Hayfork Population.

Taplin Road: The Taplin Road Population is one of four populations of Clara Hunt's milkvetch in Napa County. The population is located approximately four kilometers (2.5 miles) east of St. Helena, on the north side of Taplin Road. The Taplin Road Population occurs on one private parcel.

If undocumented populations of Clara Hunt's milkvetch existed in the past, urban development, agricultural development and/or the filling of Lake Hennessey may have eliminated them. There may also be additional, undocumented populations of Clara Hunt's milkvetch.

B. Population Trend and Abundance

Available data on the population trends and abundance of Clara Hunt's milkvetch populations have been compiled in Appendix A (Ruygt 1994, USFWS 2009, 2019, CNDDB 2019). Clara Hunt's milkvetch populations were monitored and visited regularly in the 1980s and 1990s. Beginning in 1999, visits to Clara Hunt's milkvetch populations occurred less frequently, and regular monitoring appears to have ceased. Because populations have only been visited intermittently since the early 1980s, and with inconsistent levels of comprehensiveness and survey effort, the direct comparison of population numbers between years and sites is limited, and Clara Hunt's milkvetch population trends are difficult to discern. Furthermore, the Department recognizes that populations of annual plants can have high annual variability

depending upon environmental conditions, making it difficult to detect population trends. Annual plant numbers can fluctuate wildly from year to year, depending on the seed production in previous years, germination of seedlings, and environmental conditions (e.g., timing and amount of rainfall) (Fischer and Matthies 1998; Harrison et al. 1999).

Since the beginning of monitoring efforts in the early 1980s, individual populations of at least one thousand Clara Hunt's milkvetch plants have only been observed in seven years: 1992, 1993, 1994, 1996, 1998, 2009, and 2011. It is not clear why Clara Hunt's milkvetch germination and survival was relatively high in these years. Populations of at least 1,000 Clara Hunt's milkvetch plants have only been observed at the Alpine School and Lewelling Lane populations, and these two populations are therefore considered to be the largest populations of Clara Hunt's milkvetch.

Despite a lack of consistent monitoring and limitations in available data, sufficient information is available to suggest that one population of Clara Hunt's milkvetch is declining, and another population may be extirpated or only exist in the soil seed bank. The population trends and abundance of each of the known Clara Hunt's milkvetch populations are discussed in more detail below.

Alpine School. The highest number of plants observed at this population was estimated at 4,500 in 1992, and the lowest number of plants observed at this population was zero in 2003 and 2008. Over 1,000 plants were observed at this population in six years (1992, 1993, 1996, 1998, 2009, and 2011), making this one of the two largest known populations of Clara Hunt's milkvetch. It does not appear that this population was surveyed for Clara Hunt's milkvetch between 2012 and 2018. Department staff observed approximately 50 plants at this population in 2019 (see Figure 4a) (CNDDB 2019). The trend of this population is unknown.

Bothe. The highest number of plants observed at this population was 200 in 1992, and the lowest number of plants observed at this population was zero in 2004, 2012, 2014, 2015, and 2019. The most recent observation of Clara Hunt's milkvetch at Bothe State Park was eight plants in 2009, and no plants have been found at the Bothe Population since 2009, despite surveys in 2012, 2014, 2015, and 2019 (CNDDB 2019). Although this population has only been visited intermittently, the available information suggests that this population may be extirpated or may only exist in the soil seed bank.

Lake Hennessey. The highest number of plants reported at this population was approximately 700 in the early 1980s, and the lowest number of plants observed at this population was one plant in 2011. Populations sizes of over 100 plants were observed several times between 1984 and 1994. The Lake Hennessey Population appears to have only been surveyed six times between 1994 and 2014, and never was the population observed to be over 100, as was observed between 1984 and 1994. Twenty-six Clara Hunt's milkvetch plants were observed at this population in 2015, 19 were observed in 2016, 22 were observed in 2017, 60 to 150 were observed in 2018, and 27 were observed at this population in 2019. Although this population has not been monitored regularly, the available information suggests that the Lake Hennessey Population may be declining.

Lewelling Lane. This population is one of the largest two known populations of Clara Hunt's milkvetch. In 1994, 6,192 plants were reported at this population, which is the highest number of plants ever reported for a population of Clara Hunt's milkvetch. The lowest number of plants observed at this population was 15 in 1991, which is the first year of CNDDB data recorded for this population. This population does not appear to have been surveyed since 2009, so the trend of this population is unknown, but the population is presumed to still be present.

Saddle/Hayfork. This population was first discovered in 2008. The highest number of plants reported at this population was 300 in 2009 and the lowest number of plants observed at this population was 0 in 2014. Monitoring efforts at this population may have been focused on the portion of the population that is on the Saddle Mountain Open Space Preserve. Forty Clara Hunt's milkvetch plants were observed at the Saddle/Hayfork Population in 2019 (Figure 5). The trend of this population is unknown.

Taplin Road. The Department only has data on this population from four years: 1997, 1998, 2009, and 2016. Sixty Clara Hunt's milkvetch plants were present in 1997, 290 were present in 1998, 60 were present in 2009, and 10 were present in 2016. The trend of this population is unknown.

The observed sharp rises and falls in Clara Hunt's milkvetch population sizes suggest that population size is highly dependent on climatic conditions, and a significant seed bank is present in the soil. Surveys also indicate that population levels of different Clara Hunt's milkvetch populations can vary independently from one another in the same year. For example, the Alpine School Population was ten times larger than the Lewelling Lane Population in 1992, and two years later the Lewelling Lane Population was six times larger than the Alpine School Population. Population size in a given year is therefore likely a function of both climate and prior years' contribution to the seed bank.

In a study of several species of *Astragalus*, Liston (1990a) investigated the genetic identity of three Clara Hunt's milkvetch populations (Alpine School, Bothe, and Lake Hennessey) and found them to share a high genetic identity value (mean I = .981), supporting the recognition of Clara Hunt's milkvetch as a distinct species. Liston also found that the Lake Hennessey and Alpine School populations have unique alleles for the species, and this genetic variation among populations is therefore important to conserve.

V. HABITAT NECESSARY FOR SPECIES SURVIVAL

Clara Hunt's milkvetch is generally found in oak woodlands, in sparsely vegetated openings without significant shrub or tree overstory. Clara Hunt's milkvetch appears to be adapted to poor quality, acidic soil conditions that retard the growth of other plant species. This tolerance of poor soil conditions allows Clara Hunt's milkvetch to occur in areas with reduced competition from plant species that thrive in richer soil.

A. Vegetation Communities

The Department uses A Manual of California Vegetation, Second Edition (Sawyer et al. 2009)

to classify natural communities within California. The vegetation of Sonoma County has been mapped consistent with A Manual of California Vegetation, Second Edition (Klein et al. 2015a and 2015b), and the vegetation of Napa County has been mapped consistent with the older first edition of A Manual of California Vegetation (Sawyer and Keeler-Wolf 1995, Thorne et al. 2004). Based on these vegetation maps, Clara Hunt's milkvetch appears to be commonly associated with California annual grasslands, and with various vegetation types that have oak trees as dominant species (Table 2).

Clara Hunt's milkvetch is generally found in openings, without significant shrub or tree overstory, however the native shrub and tree species found near Clara Hunt's milkvetch populations include common manzanita (*Arctostaphylos manzanita*), buckbrush (*Ceanothus cuneatus* var.

(a)

(b)

(a) Western part of the Saddle/Hayfork Population of Clara Hunt's milkvetch on April 8, 2019. View is approximately to the northeast; population is outlined. (b) Eastern part of the Saddle/Hayfork Population of Clara Hunt's milkvetch on April 8, 2019. View is approximately to the northwest; population is outlined.

Figure 5. Photographs of Clara Hunt's milkvetch (*Astragalus claranus*) habitat at the Saddle/Hayfork Population

Table 2. Vegetation Types Mapped at Clara Hunt's Milkvetch Populations

Vegetation Type/Population	*Alpine School*	*Bothe*	*Lake Hennessey*	*Lewelling Lane*	*Saddle/ Hayfork*	*Taplin Road*
Arctostaphylos (*canascens, manzanita, stanfordiana*); *A. glandulosa* Mapping Unit	X					
California Annual and Perennial Grassland Macrogroup or California Annual Grasslands Alliance	X		X	X	X	X
Coast Live Oak (*Quercus agrifolia*) Alliance					X	X
Coast Live Oak - Blue Oak (*Quercus douglasii*) - (Foothill Pine (*Pinus sabiniana*)) (no formal description (NFD)) Association			X			X
Foothill Pine Alliance				X		
Foothill Pine / Mesic Non-serpentine Chaparral NFD Association				X		
Mixed Oak Alliance (*Quercus agrifolia, Q. douglasii, Q. garryana, Q. kelloggii, Q. lobata, Q. wislizenii*)	X	X		X	X	X
Oregon White Oak (*Quercus garryana*) Alliance	X	X				
Serpentine Grasslands NFD Super Alliance				X		
Valley Oak (*Quercus lobata*) Alliance	X					

cuneatus), birch-leaf mountain-mahogany (*Cercocarpus betuloides* var. *betuloides*), toyon (*Heteromeles arbutifolia*), ponderosa pine (*Pinus ponderosa*), foothill pine (*Pinus sabiniana*), Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*), coast live oak (*Quercus agrifolia* var. *agrifolia*), blue oak (*Quercus douglasii*), leather oak (*Quercus durata* var. *durata*), Oregon oak (*Quercus garryana* var. *garryana*), and California black oak (*Quercus kelloggii*).

Ruygt (1994) observed the following six herbaceous plants in the immediate vicinity of Clara Hunt's milkvetch at all four populations that he studied (Alpine School, Bothe, Lake Henessey, and Lewelling Lane):

- common soaproot (*Chlorogalum pomeridianum*),
- blue dicks (*Dichelostemma capitatum* ssp. *capitatum*),
- fescue (*Festuca* sp.),
- true babystars (*Leptosiphon bicolor*),
- slender cottonweed (*Micropus californicus* var. *californicus*), and
- California plantain (*Plantago erecta*).

The following plant species were also associated with Clara Hunt's milkvetch at three of the four populations that Ruygt (1994) studied:

- Chilean trefoil (*Acmispon wrangelianus*),
- soft chess (*Bromus hordeaceus*),
- sticky mouse-ear chickweed (*Cerastium glomeratum*),
- California goldfields (*Lasthenia californica* ssp. *californica*),
- purple needle grass (*Stipa pulchra*),
- one-sided blue grass (*Poa secunda* ssp. *secunda*),
- purple sanicle (*Sanicula bipinnatifida*), and
- dwarf sack clover (*Trifolium depauperatum* var. *depauperatum*).

Sparse vegetation cover is a common trait of Clara Hunt's milkvetch habitat and may be a necessary condition for the species from the standpoint of competition for light and nutrients (Ruygt 1994). Ruygt also observed that the height of associated species ranged from 6 to 25 centimeters (2 to 10 inches), and did not overshadow Clara Hunt's milkvetch plants, even during late successional development.

B. Geology and Soils

Clara Hunt's milkvetch is found in the northern Coast Range of California in a region of the northern Coast Range that is dominated by north-northwest trending valleys and ridges of mountains that are mostly less than 800 meters (2600 feet) in elevation.

The geology of the northern Coast Range is broadly composed of two components: (1) older rocks that are generally highly mixed and deformed and have traveled great distances from the locations where they were formed; and (2) younger, less deformed rocks that are roughly in the same locations where they were formed (Graymer et al. 2007). The older rocks in Napa and eastern Sonoma Counties originated from ancient ocean crusts and deposits, and include: (1) the Great Valley sequence of sandstone, conglomerate and shale; (2) the Coast Range ophiolite of serpentinite, gabbro, and other rocks which rare plants are often associated with; and (3) the Franciscan Complex, which is a confusing mix of various kinds of thoroughly folded and sheared rocks (Bailey et al. 1964, Alt and Hyndman 1975, Graymer et al. 2007). The younger rocks in Napa and eastern Sonoma Counties include volcanic rocks from the eruption of the Sonoma Volcanic field, and even younger superficial deposits of sandstones and mudstones that often have many fossils.

All known populations of Clara Hunt's milkvetch are within or in close proximity to the northern part of the Sonoma Volcanic field. The rocks in the northern part of the Sonoma Volcanic field

surround and extend to the south of the Mount Saint Helena caldera, and are the youngest rocks of the Sonoma Volcanic field (Wagner et al. 2011). The Lake Hennessey Population and Lewelling Lane Populations are also associated with serpentinite rocks from the older Coast Range ophiolite.

There are a variety of different soil series mapped at populations of Clara Hunt's milkvetch by the Natural Resources Conservation Service (Soil Survey Staff 2019). Many of these soil series are noted as being loams, and are weathered from volcanic, metavolcanic, and sedimentary rock.

Ruygt (1994) excavated six soil pits within one meter of Clara Hunt's milkvetch plants at the Alpine School, Bothe, Lake Hennessey and Lewelling Lane populations to examine soil properties, and found soils from all pits to be rocky, shallow and well-drained. Ruygt found the Lake Hennessey Population to be in soil formed from serpentine bedrock, and the Lewelling Lane Population to be in soil formed from serpentine bedrock with volcanic or other metamorphic components. The Alpine School and Bothe populations were both found to occur on soils formed from basalt (volcanic) bedrock.

Based on a soil chemical analysis, Ruygt (1994) found all soils sampled in Clara Hunt's milkvetch habitat to be medium to strongly acidic (pH 5.2-6.0). There were very low levels of manganese at the Bothe and Lewelling Lane populations compared with levels at nearby unoccupied habitat, suggesting that tolerance to low manganese may be a key parameter determining milkvetch habitat at those locations. Clara Hunt's milkvetch also appears to have the ability to tolerate low levels of calcium and potentially toxic levels of magnesium. Clara Hunt's milkvetch also appears to be tolerant of levels of nickel and aluminum that may be toxic to other plants in acidic soils (McCarten 1986, Ruygt 1994). In summary, Clara Hunt's milkvetch appears to be adapted to poor quality soils that retard the growth of other plant species.

C. Climate, Hydrology and Other Factors

Clara Hunt's milkvetch populations occur in a Mediterranean climate, which consists of cool, wet winters and warm, dry summers. Although precipitation at Clara Hunt's milkvetch populations may occur in any month of the year, over 95 percent of the precipitation falls from October to May, which is typical for much of California. Between 1983 and 2018 the average annual precipitation at Clara Hunt's milkvetch populations has been approximately 88 centimeters (34.8 inches) (PRISM 2019). Rainfall can vary dramatically at Clara Hunt's milkvetch populations from month to month and from year to year. Among the Clara Hunt's milkvetch populations, climate data suggests that the Bothe Population receives the most precipitation and the Lake Hennessy Population receives the least, although the difference between the two populations is relatively low (approximately 9 centimeters/3.5 inches) (Ruygt 1994, PRISM 2019). Precipitation occurs mainly as rain; snowfall and hail occur infrequently and melt almost immediately. The coldest month of the year at Clara Hunt's milkvetch populations is typically December, which has an average low temperature of approximately 38.8°F. The hottest month of the year is typically July, after Clara Hunt's milkvetch plants have died.

Between 1983 and 1992, Ruygt (1994) noted an apparently positive correlation between November precipitation, as a percentage of average precipitation, and the number of Clara Hunt's milkvetch plants in a monitoring quadrat at the Bothe Population. This could suggest that rainfall in the early growing season is a critical factor for Clara Hunt's milkvetch seed germination and establishment.

Clara Hunt's milkvetch likely receives most of its water from precipitation. Ruygt (1994) assessed soil drainage and water holding capacity in soil pits at the Alpine School, Bothe, Lake Hennessey and Lewelling Lane populations of Clara Hunt's milkvetch. Based on Rugyt's assessment, soil water holding capacity appears to be lowest at the Bothe Population, and highest at the Lewelling Lane and Lake Hennessey populations. Drainage class was assessed as "somewhat excessive" at one of the two soil pits at the Alpine School Population, and was assessed as "well-drained" or "moderately well-drained" at the remaining soil pits at the Alpine School, Bothe, Lake Hennessey and Lewelling Lane populations of Clara Hunt's milkvetch (Ruygt 1993, Soil Survey Division Staff 1993). This could suggest that Clara Hunt's milkvetch is also adapted to drought tolerance or tolerance of well-drained soils.

High densities of Clara Hunt's milkvetch plants have been observed in areas disturbed by gopher mounds (Ruygt 1993, Evans pers. comm. 2019). Additionally, after removal of a soil stockpile placed on a portion of the Lake Hennessey Population in the fall of 1990, particularly robust Clara Hunt's milkvetch individuals were found in areas that had been scraped bare (Ruygt 1994). This suggests that soil disturbance and competing vegetation could be important factors affecting germination, establishment, and growth of Clara Hunt's milkvetch.

The incline of slopes at Clara Hunt's milkvetch habitat is generally slight (0 to 10 degrees), and the slope aspect varies widely (Ruygt 1993, Department observation).

VI. THREATS AND SURVIVAL FACTORS

A. Factors Affecting Ability to Survive and Reproduce

The August 1989 "Report to the Fish and Game Commission on the Status of Clara Hunt's Milkvetch (*Astragalus clarianus*)" prepared by the Department identified several factors affecting the ability of Clara Hunt's milkvetch to survive and reproduce that the Commission considered in listing Clara Hunt's milkvetch under CESA. The factors identified in the 1989 report were: present or threatened modification or destruction of habitat, predation, and stochastic (chance) extinction events due to small population size. These factors continue to threaten Clara Hunt's milkvetch with extinction. In addition to the factors identified in 1989, the Department has also identified invasive plants, vegetation community succession, climate change, and possibly herbivory as additional factors affecting the ability of Clara Hunt's milkvetch to survive and reproduce.

i. Present or Threatened Modification or Destruction of Habitat

Three Clara Hunt's milkvetch populations are considered to have a moderate to high risk of habitat elimination or degradation, and three populations are considered to have a low risk of habitat elimination or degradation. The risk of habitat elimination or degradation at each of the Clara Hunt's milkvetch populations is discussed below.

Alpine School. The threat of habitat elimination from development or significant change in land use at the Alpine School Population is low. The Sonoma County Agricultural Preservation and Open Space District holds a conservation easement that protects the property from development and significant land use changes. Degradation of Clara Hunt's milkvetch habitat at the Alpine School Population could still take place as a result of domestic animal grazing, equipment use, or other unforeseen activities by the landowner in the future, particularly if the activities result in trampling, excessive or inadequate soil disturbance, hydrological changes,

excessive winter or spring herbivory, or the creation of conditions that are favorable for the establishment and spread of invasive plant species. In 2019, the property with the Alpine School Population was being used as pasture for an unknown number of horses. The landowner for the Alpine School Population also owns a portion of the Saddle/Hayfork Population, so land use changes could affect both populations simultaneously. Historical scientific collections suggest that the Alpine School Population previously occupied a larger area that extended to the north side of St. Helena Road. Prior to state listing the north side of St. Helena Road was converted to vineyards and a horse stable was built, reducing the total area of the population (McCarten 1985).

Bothe. The threat of habitat elimination and habitat degradation at the Bothe Population is low because the property is owned and managed by the California Department of Parks and Recreation as Bothe-Napa Valley State Park. There is very little human activity at the Bothe Population because there are no maintained hiking trails in the vicinity. Alteration of the Bothe Population of Clara Hunt's milkvetch habitat from vegetation encroachment is discussed below under the heading "Vegetation Encroachment".

Lake Hennessey. The threat of habitat elimination and degradation at the Lake Hennessey Population is moderate to high. Prior to listing, the Lake Hennessey Population was likely reduced in size when Lake Hennessey was created in the 1950s (USFWS 2009). The Lake Hennessey Population is almost entirely on land owned by the City of Napa and a small portion on the north side of Conn Valley Road is on private property. The Lake Hennessy Population is adjacent to the Lake Hennessey reservoir, and is frequently visited for recreation. The City of Napa placed a portable toilet on the population in 1987 or 1988 and continues to maintain a portable toilet and garbage cans for the area (Liston 1990a, Department observation). A utility tower is maintained in the immediate vicinity of the population. In the fall of 1990, the City of Napa permitted topsoil vendors to remove topsoil from the drought-exposed bed of Lake Hennessey, and the soil was stockpiled on approximately 30 percent of the Lake Hennessey Population (Figure 6a) (Ruygt 1994). Much of the stockpiled soil was removed in 1992 and 1993. A portion of the population covered by the soil stockpile recovered surprisingly well in 1992, with 325 individuals observed; however, the area was subsequently degraded by the invasion of weedy species such as goatgrass (*Aegilops triuncialis*). In February of 1991, the Department installed a fence along Conn Valley Road to prevent vehicles from driving onto the population. Sometime between April 2015 and March 2016, wood chips from an unknown source were spread over the area, extending onto a portion of the Lake Hennessey Population (Google Earth 2019). Due to the relatively un-weathered appearance of the wood chips shown in Figure 6b, the addition of wood chips to the area may be a periodic or ongoing occurrence. It is unclear whether or not the addition of wood chips to the area has had an effect on Clara Hunt's milkvetch. Although the Lake Hennessey Population has not been monitored regularly, the available information suggests that the population is declining.

Lewelling Lane. The threat of habitat elimination and habitat degradation from development or change in land use at the Lewelling Lane Population is moderate to high. The Lewelling Lane Population occurs on several private parcels with different landowners, and the land use zoning for these parcels is "Agricultural Preserve" or "Agricultural Watershed" (Napa County 2015). The Agricultural Preserve district classification is: "intended to be applied in the fertile valley and foothill areas of Napa County in which agriculture is and should continue to be the predominant land use, where uses incompatible to agriculture should be precluded and where the development of urban type uses would be detrimental to the continuance of agriculture and the maintenance of open space which are economic and aesthetic attributes and assets of the county" (Napa County Code of Ordinances section 18.16.010). The Agricultural Watershed

(a)

(b)

(a) Clara Hunt's milkvetch habitat at the Lake Hennessey Population buried under soil dredged from Lake Hennessey in 1990 (Source: Ruygt 1994, Photo by W. Grummer).
(b) Clara Hunt's milkvetch habitat at the Lake Hennessey Population on March 27, 2019 showing wood chips on the site.

Figure 6. Human Disturbance to Clara Hunt's milkvetch (*Astragalus claranus*) Habitat at the Lake Hennessey Population

district classification is: “intended to be applied in those areas of Napa County where the predominant use is agriculturally oriented, where watershed areas, reservoirs and floodplain tributaries are located, where development would adversely impact on all such uses, and where the protection of agriculture, watersheds and floodplain tributaries from fire, pollution and erosion is essential to the general health, safety and welfare” (Napa County Code of Ordinances section 18.20.010). A number of land uses such as agriculture, housing, and wine production could occur in Agricultural Preserve and Agricultural Watershed districts, and many of these land uses could result in the elimination or degradation of Clara Hunt’s milkvetch habitat (Napa County Code of Ordinances sections 18.16.20 and 18.20.020).

Saddle/Hayfork. The threat of habitat elimination from development or change in land use at the Saddle/Hayfork Population is low. The Saddle/Hayfork Population occurs on two parcels: one is private property that is protected by a conservation easement, and the other is the Saddle Mountain Open Space Preserve that is owned and managed by the Sonoma County Agricultural Preservation and Open Space District for aesthetic and habitat values (Sonoma County Agricultural Preservation and Open Space District 2019). Degradation of Clara Hunt’s milkvetch habitat at the Saddle/Hayfork Population could still occur as a result of modified land uses and land management activities in the future, particularly if land use activities on the private property result in trampling, excessive or inadequate soil disturbance, hydrological changes, excessive winter and spring herbivory, or the creation of conditions that are favorable for the establishment and spread of invasive plant species. In 2019, the portion of the population that occurs on private property was being used as pasture for an unknown number of horses. The landowner for the Alpine School Population also owns a portion of the Saddle/Hayfork Population, so land use changes could affect both populations simultaneously.

Taplin Road. The threat of habitat elimination and habitat degradation from development or change in land use at the Taplin Road Population is moderate to high. The Taplin Road Population occurs on one private parcel with the land use zoning of “Agricultural Watershed” (Napa County 2015). A number of land uses such as agriculture, housing, and wine production could occur in the Agricultural Watershed district, and many of these land uses could result in the elimination or degradation of Clara Hunt’s milkvetch habitat (Napa County Code of Ordinances section 18.20.020).

ii. Invasive Plants

Invasive species are often cited as the second greatest threat to biodiversity behind habitat loss (Wilcove et al. 1998, Levine et al. 2003, Pimentel et al. 2004) and North America has accumulated the largest number of naturalized plants in the world (van Kleunen et al. 2015). Many studies hypothesize or suggest that competition is the process responsible for observed invasive species impacts to biodiversity; however, invasive species may impact native species in different ways (Levine et al. 2003). Invasive species may threaten native populations through competition for light, water, or nutrients; addition of harmful biochemicals to soil; alteration of soil chemistry; thatch accumulation that inhibits seed germination and seedling recruitment; changes in natural fire frequency; disruptions to pollination or seed-dispersal mutualisms; changes in soil microorganisms; diseases; or other mechanisms. The magnitude of invasive species impacts in Mediterranean habitats, such as those in California, largely depends on the characteristics of the invading species and the habitat being invaded (Fried et al. 2014). The invader’s life form and ability to create very dense stands have an effect on the magnitude of impacts, with creeping plant species having greater effect (Gaertner et al. 2009, Fried et al. 2014). Greater invasive species impacts also have been recorded in areas with high soil moisture (Reever Morghan and Rice 2006, Fried et al. 2014). Invasive species may also

influence native species colonization rates, and may thus lead to declines in local diversity over longer timescales (Yurkonis and Meiners 2004). Nitrogen deposition from air pollution may also increase the suitability of previously nutrient-poor habitats for invasive species, allowing such habitats to become more easily invaded (Weiss 1999). Studies have not been conducted on the impact of invasive species on Clara Hunt's milkvetch specifically; however, the negative impacts of plant invasions on Mediterranean ecosystems have been well demonstrated (Gaertner et al. 2009, Fried et al. 2014).

Invasive Mediterranean grasses such as barbed goatgrass, soft chess, annual false brome (*Brachypodium distachyon*), rattlesnake grass (*Briza maxima*), ripgut brome (*Bromus diandrus*), medusahead (*Elymus caput-medusae*), and Italian ryegrass (*Festuca perennis*), have been observed in close proximity to Clara Hunt's milkvetch populations and pose a significant risk to the species (Ruygt 1993, Cal-IPC 2019a, Evans pers. comm. 2019). These Mediterranean grasses can compete with Clara Hunt's milkvetch for light, water, and nutrients, and may also form a layer of dead thatch that inhibits Clara Hunt's milkvetch germination the following year. Additional invasive species that are not grasses, such as yellow star thistle (*Centaurea solstitialis*), red-stem filaree (*Erodium cicutarium*), French Broom (*Genista monspessulana*), burclover (*Medicago polymorpha*), English plantain (*Plantago lanceolata*), and curly dock (*Rumex crispus*) have also been documented in close proximity to Clara Hunt's milkvetch populations (Ruygt 1993, Cal-IPC 2019a).

There is also evidence that invasive weeds may alter the soil microbe community, which can impact the relative fitness of native forbs and ecosystem composition. In a study of yellow star thistle and barbed goatgrass in serpentine grasslands, Batten et al. (2004) found that the soil microbial community differed significantly between native and invaded areas. Changes to the soil microbial community could impact nutrient cycling processes, and could make inhospitable soils more susceptible to plant species invasions.

Cheat grass (*Bromus tectorum*), an annual grass, is not currently a serious problem in Napa and Sonoma Counties; however, most of Napa County and eastern Sonoma County are expected to become suitable habitat for cheat grass by the year 2050 due to climate change (Cal-IPC 2019b). Cheat grass threatens ecosystems by overcrowding native habitats and increasing the frequency and extent of wildfires. Wildfires can increase nitrogen availability, making soils more suitable for cheat grass, which in turn can create a feedback loop by increasing the frequency of fire (Kerns and Day 2017). There is also evidence that cheat grass itself can increase soil nitrogen availability, which could potentially help it invade habitats with poor quality soils. Stark and Norton (2015) found that under wet conditions (i.e. winter and spring conditions), cheat grass increased soil nitrogen availability, and that faster rates of nitrogen cycling by cheat grass were accompanied by greater concentrations of soil organic carbon and nitrogen. If cheat grass spreads significantly in Napa and Sonoma Counties by the year 2050, it may become a serious additional threat to the continued existence of Clara Hunt's milkvetch.

Invasive plant species pose a serious threat to Clara Hunt's milkvetch by affecting ground cover. Sparse vegetation cover is a common trait of Clara Hunt's milkvetch habitat and may be a necessary condition for the species. Invasive plant species can form dense stands of vegetation that are taller than vegetation in natural Clara Hunt's milkvetch habitat, and thus invasive vegetation may significantly reduce the amount of habitat that is available for Clara Hunt's milkvetch. Impacts from invasive plant species on Clara Hunt's milkvetch have become more severe since Clara Hunt's milkvetch was listed. In addition, due to the effects of climate change

and the continued spread of invasive plants in California, the impacts from invasive plant species on Clara Hunt's milkvetch will likely become a greater threat in the future.

iii. Vulnerability of Small Populations

Clara Hunt's milkvetch has a narrow distribution with only six small populations occupying relatively small areas. Although range-wide population monitoring for Clara Hunt's milkvetch has not been conducted, population estimates have always been relatively low, and it has been 20 years since an individual population reached more than 1,500 plants. The Department recognizes that species with few populations and small population sizes are highly vulnerable to extinction due to stochastic (chance), demographic, environmental, and genetic events (Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). Chance events, such as a landslide, drought, or fire could result in the loss of all or a significant portion of a Clara Hunt's milkvetch population. Chance environmental conditions that result in seed germination without subsequent growth and reproduction could also deplete the soil seed bank and threaten the long-term persistence of Clara Hunt's milkvetch. The Bothe Population and Lake Hennessey Population appear to be the smallest Clara Hunt's milkvetch populations, and may therefore be the most vulnerable to extirpation due to chance events.

Impacts to a species that have already taken place may also lead to an "extinction debt," where species that appear abundant disappear over time (Tilman et al. 1994, Kuussaari et al. 2009). Extinction processes often occur with a time delay and populations living close to their extinction threshold might survive for long periods of time before they go extinct (Hanski and Ovaskainen 2002, Lindborg and Eriksson 2004, Helm et al. 2006, Vellend et al. 2006). Habitat specialist species, such as Clara Hunt's milkvetch, may also be more sensitive to changes in habitat and thus more prone to local extinction than generalist species (Helm et al. 2006, Krauss et al. 2010, Cousins and Vanhoenacker 2011, Guardiola et al. 2013).

iv. Climate Change

Warming of the climate is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia (IPCC 2014). Experimental and empirical evidence indicates that climate change is negatively impacting wildlife species and natural systems across the globe (Parmesan and Yohe 2003, Parmesan 2006). According to the California Global Warming Solutions Act of 2006, climate change is now considered one of the greatest threats to California's ecosystems, and over the current century, climate change will alter the fundamental character, production, and distribution of the ecosystems in California (Snyder et al. 2002, Snyder and Sloan 2005, California Energy Commission 2009b). Climate change is a major challenge to the conservation of California's natural resources, and it will amplify existing risks and create new risks for natural systems.

Numerous studies indicate that by the end of the century California's climate will be considerably warmer than today's, more winter precipitation will fall as rain instead of snow, snowpack will be substantially diminished, and snowpack will melt much earlier in the year (Kim et al. 2002; Knowles and Cayan 2002; Snyder et al. 2002; Miller et al. 2003; Hayhoe et al. 2004; Leung et al. 2004; Vanrheenen et al. 2004; California Energy Commission 2009a, 2009b; Melillo et al. 2014). California is also more vulnerable to climate fluctuations relative to the rest of the United States because it derives a disproportionate percentage of its water supply from only a small number of winter storms, typically in the form of "atmospheric rivers" (Dettinger 2011, Dettinger et al. 2011).

Department staff assessed the vulnerability of Clara Hunt's milkvetch to climate change using the NatureServe Climate Change Vulnerability Index Version 3.02 (CDFW 2019, Natureserve 2016). Based upon the Department's assessment, Clara Hunt's milkvetch has a climate change vulnerability index value of Moderately Vulnerable (MV), indicating that abundance and/or range extent of Clara Hunt's milkvetch within the geographical area assessed is likely to decrease by 2050. Factors contributing to this vulnerability assessment include Clara Hunt's milkvetch's limited seed dispersal capabilities and the species' restriction to habitat with poor quality soils that retard the growth of other plant species.

v. Vegetation Community Succession

Vegetation community succession is a threat to Clara Hunt's milkvetch, particularly at the Bothe Population. Clara Hunt's milkvetch is generally found in sparsely-vegetated openings in oak woodland without significant shrub or tree overstory. Growth of trees and shrubs at the Bothe Population is reducing and eliminating openings in oak woodland that have been utilized by Clara Hunt's milkvetch. Clara Hunt's milkvetch has not been observed at the Bothe Population since 2009, despite surveys in 2012, 2014, 2015, and 2019. Without disturbance, the suitable habitat for Clara Hunt's milkvetch at the Bothe Population may be eliminated. Large-scale disturbance events in Clara Hunt's milkvetch habitat likely occur from wildfires and smaller-scale disturbance can occur from wind, tree mortality, and other factors.

vi. Herbivory and Predation

Evidence of herbivory and predation of Clara Hunt's milkvetch in the form of partial loss of leaves, severed flower heads, and penetration of fruit walls has been observed. A spittle bug (*Aphrophora* sp.) and aphid (Aphidoidea) have also been observed on Clara Hunt's milkvetch plants, although no damage from these insects was observed (Ruygt 1994). Ruygt also conducted a pollinator exclusion study with 55 Clara Hunt's milkvetch plants at the Lewelling Lane Population in 1994, and observed fruit parasitism and herbivore damage of plants outside of pollinator exclusion screens to be substantially higher (67%) than plants within pollinator exclusion screens. While some herbivory and predation is expected in natural systems, comprehensive herbivory and predation studies have not been conducted, and it is unknown whether or not herbivory and predation are significant factors affecting the ability of Clara Hunt's milkvetch populations to survive and reproduce.

The Alpine School Population and a portion of the Saddle/Hayfork Population are subject to grazing by horses and could be subject to grazing by other domestic animals in the future. It is unknown whether or not grazing by horses and other domestic animals is beneficial and/or detrimental to the species or its habitat.

B. Degree and Immediacy of Threats

The six known populations of Clara Hunt's milkvetch are all threatened to some degree by elimination and degradation of habitat, invasive plants, the vulnerability of small populations, and climate change. The Bothe Population is currently also threatened by vegetation community succession. All six populations could also be threatened by herbivory and predation, but more information on this potential threat is needed.

The Department is not currently aware of any development projects proposed within or near Clara Hunt's milkvetch populations; nevertheless, land use activities on private property such as domestic animal grazing, equipment use, trampling, or other unforeseen activities could occur at

any time. These activities threaten the Alpine School, Lewelling Lane and Taplin Road populations. The current recreational and utility tower land use at the Lake Hennessey Population is an immediate and ongoing threat, particularly because available information suggests that the Lake Hennessey Population is declining.

Invasive plants are also present at all Clara Hunt's milkvetch populations and pose an immediate and ongoing threat to the species throughout its range, particularly in situations where an organic thatch layer is allowed to accumulate. In addition, the inherent vulnerability of small populations is an ongoing threat to all Clara Hunt's milkvetch populations. Climate change is likely to affect Clara Hunt's milkvetch abundance and/or range extent by the year 2050, particularly if conditions in Clara Hunt's milkvetch habitat become more favorable for invasive plant species such as cheat grass. Vegetation community succession appears to have already had a significant adverse effect on the Bothe Population, and the population may now be extirpated or may only exist in the soil seed bank. The degree and immediacy of threats from herbivory and predation are not currently known.

Based on the best available scientific information, the Department considers Clara Hunt's milkvetch to be in serious danger of becoming extinct throughout all, or a significant portion of its range.

VII. MANAGEMENT AND RECOVERY

A. Impact of Existing Management Efforts

There are currently no rangewide management efforts for Clara Hunt's milkvetch.

i. Saddle Mountain Open Space Preserve Management Plan

A portion of the Saddle/Hayfork Population is on the Saddle Mountain Open Space Preserve, owned by Sonoma County. The Sonoma County Agricultural Preservation and Open Space District prepared a management plan for the Saddle Mountain Open Space Preserve in early 2019 that includes management strategies for enhancement of plant communities and habitats; native plant revegetation; establishment of buffer zones; restoration of landscape disturbance processes; management of visitor use impacts; and ongoing monitoring and evaluation (Sonoma County Agricultural Preservation and Open Space District 2019). Implementation of invasive species control, habitat enhancement, and fuel management projects under the Saddle Mountain Open Space Preserve Management Plan could be beneficial for the Saddle/Hayfork Population of Clara Hunt's milkvetch.

ii. Conservation Seed Banking

Clara Hunt's milkvetch seed was collected from the Alpine School, Lake Hennessey, Lewelling Lane, and Taplin Road Populations in 2009, and approximately 1,969 seeds are stored at Rancho Santa Ana Botanic Garden conservation seed storage facilities (Rancho Santa Ana Botanic Garden 2018). Rancho Santa Ana Botanic Garden conducted germination tests on 30 Clara Hunt's milkvetch seeds in 2009, approximately four months after they were collected. After breaking the seed coat and placing the seeds in agar, 29 (97%) of the Clara Hunt's milkvetch seeds successfully germinated (CDFW 2010).

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

The Department recommends that the following actions be conducted to prevent the extinction of Clara Hunt's milkvetch:

- Complete a recovery plan for Clara Hunt's milkvetch in collaboration with the U.S. Fish and Wildlife Service.
- Convene a working group or recovery team to implement a Clara Hunt's milkvetch recovery plan in collaboration with the U.S. Fish and Wildlife Service.
- Implement demographic monitoring of all Clara Hunt's milkvetch populations.
- Determine the most effective management techniques for controlling invasive vegetation and maintaining Clara Hunt's milkvetch habitat via scientific research or adaptive management.
- Protect the Lake Hennessey, Lewelling Lane and Taplin Road populations from habitat elimination and degradation so that all remaining populations of Clara Hunt's milkvetch are protected, and the habitat that is essential for the continued existence of the species is preserved.
- Develop a habitat suitability model for Clara Hunt's milkvetch, and search for additional populations.
- Implement a limited controlled burn or vegetation clearing at the Bothe Population in collaboration with the California Department of Parks and Recreation and the California Department of Forestry and Fire Protection.
- If habitat manipulation efforts at the Bothe Population do not result in growth and reproduction of the species, implement a species reintroduction project at Bothe-Napa Valley State Park.
- Investigate ways to reduce impacts from recreational use, invasive species, and remnant topsoil piles at the Lake Hennessey Population in collaboration with the City of Napa.
- Work with landowners to ensure that impacts to the Lewelling Lane and Taplin Road populations are avoided in the future, and investigate possible landowner incentives for habitat protection.
- Collect seeds from the Saddle/Hayfork and Bothe populations for long-term conservation storage. Request that Rancho Santa Ana Botanic Garden conduct seed viability tests on the Clara Hunt's milkvetch seed collected in 2009, and collect additional Clara Hunt's milkvetch seed from wild populations, if necessary.

VIII. RECOMMENDATION TO THE COMMISSION

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

In completing this Five-Year Status Review for Clara Hunt's milkvetch, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Clara Hunt's milkvetch have changed, and recommends a change in the status of Clara Hunt's milkvetch from threatened to endangered. This Five-Year Status Review shall be considered by the Commission as a petition with a Department recommendation to accept and consider the petition (Fish and G. Code §§ 2072.7 and 2077).

IX. SOURCES

A. Literature Cited

The following sources of information were used during the preparation of this Five-Year Status Review:

ABRAMS, L. 1944. Illustrated Flora of the Pacific States, Vol. II. Stanford University Press, Stanford.

ALT, D.D. AND HYNDMAN, D. W. 1975. Roadside geology of northern California. Missoula, Mont.: Mountain Press Publishing Company.

BAILEY, E.H., W.P. IRWIN, AND D.L. JONES. 1964. Franciscan and related rocks and their significance in the geology of western California (Vol. 183). California Division of Mines and Geology.

BARNEBY, R.C. 1964. Atlas of North American Astragalus. Memoirs of the New York Botanical Garden, Vol 13. p. 1052. (see page 1052)

BASKIN, C.C. AND J.M. BASKIN. 1998. Seeds: ecology, biogeography, and evolution of dormancy and germination. Academic Press. San Diego, California

BATTEN, K.M., SCOW, K.M., DAVIES, K.F., AND S.P. HARRISON. 2006. Two Invasive Plants Alter Soil Microbial Community Composition in Serpentine Grasslands. Biological Invasions 8:217.

BITTMAN, R. 2001. The California Natural Diversity Database: A Natural Heritage Program for Rare Species and Vegetation. Fremontia 29:3-4.

CAL-IPC (CALIFORNIA INVASIVE PLANT COUNCIL) 2019A. The Cal-IPC Inventory. Available online at: https://www.cal-ipc.org/plants/inventory/. [Accessed May 28, 2019]

CAL-IPC (CALIFORNIA INVASIVE PLANT COUNCIL) 2019b. CalWeedMapper Species Report for *Bromus tectorum*. Available online at: https://calweedmapper.cal-ipc.org/maps/. [Accessed May 28, 2019]

CDFW (CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE). 2010. Final Performance Report for Seed Collection and Banking of 50 Plant Species of Critical Conservation Concern. U.S. Fish and Wildlife Service: Endangered Species Act (Section-6) Grant Number E-2-P-31.

CDFW (CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE). 2019. Climate change vulnerability assessment for Clara Hunt's milkvetch (*Astragalus claranus*) using the Natureserve Climate Change Vulnerability Index. Release 3.02.

CALIFORNIA ENERGY COMMISSION. 2009a. Projections of potential flood regime changes in California. CEC-500-2009-050-D. March 2009. California Energy Commission, Sacramento, California.

CALIFORNIA ENERGY COMMISSION. 2009b. The impact of climate change on California's ecosystem services. CEC-500-2009-025-D. March 2009. California Energy Commission, Sacramento, California.

CNDDB (CALIFORNIA NATURAL DIVERSITY DATABASE). 2019. Rarefind 5 [Internet]. California Department of Fish and Wildlife. [Accessed: May 30, 2019].

COUSINS, S.A.O. AND D. VANHOENACKER. 2011. Detection of Extinction Debt Depends on Scale and Specialization. Biological Conservation 144:782-787.

DETTINGER, M. 2011. Climate change, atmospheric rivers, and floods in California: A multimodel analysis of storm frequency and magnitude changes. Journal of the American Water Resources Association 47:514-523.

DETTINGER, M.D., F.M. RALPH, T. DAS, P.J. NEIMAN, AND D.R. CAYAN. 2011. Atmospheric rivers, floods, and the water resources of California. Water 3:445-478.

FISCHER, M., AND D. MATTHIES. 1998. Effects of Population Size on Performance in the Rare Plant *Gentianella germanica*. Journal of Ecology 86: pp. 195-204.

FRIED, G, B. LAITUNG, C. PIERRE, N. CHAGUÉ, AND F.D. PANETTA. 2014. Impact of Invasive Plants in Mediterranean Habitats: Disentangling the Effects of Characteristics of Invaders and Recipient Communities. Biol Invasions 16: pp. 1639-1658.

GAERTNER, M., A.D. BREEYEN, C. HUI, AND D.M. RICHARDSON. 2009. Impacts of Alien Plant Invasions on Species Richness in Mediterranean-type Ecosystems: A Meta-analysis. Progress in Physical Geography 33(3): pp. 319-338.

GRAYMER, R.W., E.E. BRABB, D.L. JONES, J. BARNES, R.S. NICHOLSON, AND R.E. STAMSKI. 2007. Geologic Map and Map Database of Eastern Sonoma and Western Napa Counties, California Scientific Investigations Map 2956 and accompanying pamphlet. U.S. Department of the Interior. U.S. Geological Survey.

GOOGLE EARTH. 2019. 38.5018°N, 122.3840°W. Imagery Dates: April 25, 2015 and March 16, 2016.

GREEN, T. W. AND G. E. BOHART. 1975. The pollination ecology of *Astragalus cibarius* and *Astragalus utahensis* (Leguminosae). Amer. J. Bot. 62:379-386.

GROOM, M.J., MEFFE, G.K., AND C.R. CARROLL. 2006. Principles of Conservation Biology, Third Edition. Sinauer Associates, Inc., Sunderland, Massachusetts.

GUARDIOLA, M., J. PINO, AND F. RODÁ. 2013. Patch history and spatial scale modulate local plant extinction and extinction debt in habitat patches. Diversity and Distributions 19:825-833.

HANSKI, I. AND O. OVASKAINEN. 2002. Extinction debt at extinction threshold. Conservation Biology 3: 666.

HARRISON, S., J. MARON, AND G. HUXEL. 1999. Regional Turnover and Fluctuation in Populations of Five Plants Confined to Serpentine Seeps. Conservation Biology 14(3): pp. 769-779.

HAYHOE, K., D. CAYAN, C.B. FIELD, P.C. FRUMHOFF, E.P. MAURER, N.L. MILLER, S.C. MOSER, S.H. SCHNEIDER, K.N. CAHILL, E.E. CLELAND, L. DALE, R. DRAPEK, R.M. HANEMANN, L.S. KALKSTEIN, J. LENIHAN, C.K. LUNCH, R.P. NEILSON, S.C. SHERIDAN, AND J.H. VERVILLE. 2004. Emissions pathways, climate change, and impacts on California. Proceedings of the National Academy of Sciences of the United States of America 101:12422-12427.

HELM, A., I. HANSKI, AND M. PÄRTEL. 2006. Slow response of plant species richness to habitat loss and fragmentation. Ecology Letters 9:72-77.

HUNTER, J. 1989. Report to the Fish and Game Commission on the Status of Clara Hunt's Milkvetch *(Astragalus clarianus*). Status Report 89-11. State of California, The Resources Agency, Department of Fish and Game, Sacramento.

IPCC. 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

JEPSON, W.L. 1925. Manual of the Flowering Plants of California. University of California Press, Berkeley, California.

KARRON, J.D. 1987a. The pollination ecology of co-occurring geographically restricted and widespread species of *Astragalus* (Fabaceae). Biol. Conserv. 39:179-193.

KARRON, J.D. 1989. Breeding Systems and Levels of Inbreeding Depression in Geographically Restricted and Widespread Species of Astragalus (Fabaceae). Amer. J. Bot. 76(3): 331-340.

KERNS, B., AND M. DAY. 2017.The Importance of Disturbance by Fire and Other Abiotic and Biotic Factors in Driving Cheatgrass Invasion Varies Based on Invasion Stage. Biological Invasions 19(6):1853-1862.

KIM, J., T. KIM, R.W. ARRITT, AND N.L. MILLER. 2002. Impacts of increased CO_2 on the hydroclimate of the western United States. Journal of Climate 15:1926-1942.

KLEIN, A., T. KEELER-WOLF AND J. EVENS. 2015a. Classification of the Vegetation Alliances and Associations of Sonoma County, California Volume 1 of 2 – Introduction, Methods, and Results. Prepared by the California Department of Fish and Wildlife Vegetation Classification and Mapping Program and California Native Plant Society Vegetation Program for The Sonoma County Agricultural Preservation and Open Space District and the Sonoma County Water Agency.

KLEIN, A., T. KEELER-WOLF AND J. EVENS. 2015b. Classification of the Vegetation Alliances and Associations of Sonoma County, California Volume 2 of 2 – Vegetation Descriptions. Prepared by the California Department of Fish and Wildlife Vegetation Classification and Mapping Program and California Native Plant Society Vegetation Program for The Sonoma County Agricultural Preservation and Open Space District and the Sonoma County Water Agency.

KNOWLES, N. AND D.R. CAYAN. 2002. Potential effects of global warming on the Sacramento/San Joaquin watershed and the San Francisco estuary. Geophysical Research Letters 29:38-1-38-4.

KRAUSS, J., R. BOMMARCO, M. GUARDIOLA, R.K. HEIKKINEN, A. HELM, M. KUUSSAARI, R. LINDBORG, E. ÖCKINGER, M. PÄRTEL, J. PINO, J. PÖYRY, K.M. RAATIKAINEN, A. SANG, C. STEFANESCU, T. TEDER, M. ZOBEL, AND I. STEFFAN-DEWENTER. 2010. Habitat

fragmentation causes immediate and time-delayed biodiversity loss at different trophic levels. Ecology Letters 13:597-605.

KUUSSAARI, M., R. BOMMARCO, R.K. HEIKKINEN, A. HELM, J. KRAUSS, R. LINDBORG, E. OCKINGER, M. PÄRTEL, J. PINO, F. RODÀ, C. STEFANESCU, T. TEDER, M. ZOBEL, AND I. STEFFAN-DEWENTER. 2009. Extinction debt: a challenge for biodiversity conservation. Trends in Ecology and Evolution 24:564-71.

LEUNG, L.R., Y. QIAN, X. BIAN, W.M. WASHINGTON, J. HAN, AND J.O. ROADS. 2004. Mid-century ensemble regional climate change scenarios for the western United States. Climatic Change 62:75-113.

LEVINE J.M., M. VILA, C.M. D'ANTONIO, J.S. DUKES, K. GRIGULIS, AND S. LAVOREL. 2003. Mechanisms Underlying the Impacts of Exotic Plant Invasions. Proceedings of the Royal Society of London B 270: pp 775-781.

LINDBORG, R. AND O. ERIKSSON. 2004. Historical landscape connectivity affects present plant species diversity. Ecology 7:1840.

LISTON, A. 1990a. An evolutionary study of *Astragalus* sect. Leptocarpi subsect. Californici (Fabaceae). Ph.D. dissertation, Claremont Graduate School, Claremont, California.

LISTON, A. 1990b. Chromosome Counts in *Astragalus* (Fabaceae). Madroño. 37(1): pp. 59-60.

LISTON, A. 1992. Isozyme Systematics of *Astragalus* sect. Leptocarpi subsect. Californici (Fabaceae). Systematic Botany. 17(3): pp 367-379.

MACDONALD, J. 2016. Photograph of *Astragalus claranus* seeds and fruits. Available online at: http://www.hazmac.biz/seedphotoslistgenus.html. [Accessed May 28, 2019].

MCCARTEN, N. 1985. A Survey of Astragalus clarianus: A Rare Plant Species of the North Coast Range. A Report to The California Nature Conservancy.

MCCARTEN, N. 1986. Ecology of the Serpentine Vegetation in the San Francisco Bay Region. Pp 335-339 in Conservation and Management of Rare and Endangered Plants. Proceedings from a conference of the California Native Plant Society. Edited by T.S. Elias. California Native Plant Society, Sacramento, 630 pp.

MELILLO, J. M., T.C. RICHMOND, AND G.W. YOHE, Eds. 2014. Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program. 841 pp. doi:10.7930/J0Z31WJ2.

MILLER, N.L., K.E. BASHFORD, AND E. STREM. 2003. Potential impacts of climate change on California hydrology. Journal of American Water Resources Association 39:771-784.

NAPA COUNTY. 2015. Napa County Zoning as of January 23, 2015. Napa County Planning, Building and Environmental Services.

NATURESERVE. 2016. Climate Change Vulnerability Index. Release 3.02. Available online at http://www.natureserve.org/conservation-tools/climate-change-vulnerability-index. [Accessed May 29, 2019].

PARMESAN, C. 2006. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology, Evolution, and Systematics 37:637-669.

PARMESAN, C. AND G. YOHE. 2003. A globally coherent fingerprint of climate change impacts across natural systems. Nature 421:37-42.

PIMENTEL, D., R. ZUNIGA AND D. MORRISON. 2004. Update on the Environmental and Economic Costs Associated with Alien-invasive Species in the United States. Ecological Economics 52. pp. 273-288

PRIMACK, R.B. 2006. Essentials of conservation biology, Fourth Edition. Sinauer Associates, Sunderland, Massachusetts.

RANCHO SANTA ANA BOTANIC GARDEN. 2018. Excel Spreadsheet of Seed Germination Data. Available online at: https://www.rsabg.org/conservation/seed-conservation. [Accessed May 30, 2019].

REEVER MORGHAN, K.J. AND K.J. RICE. 2006. Variation in Resource Availability Changes the Impact of Invasive Thistles on Native Bunchgrasses. Ecological Applications, Vol. 16, No. 2 (Apr., 2006): pp. 528-539

RUYGT, JAKE. 1994. Ecological Studies of Clara Hunt's Milkvetch Astragalus claranus and a Proposal for Habitat Restoration at Conn Valley Road, Napa County. Prepared by California Native Plant Society for California Department of Fish and Game.

SAWYER, J.O. AND T. KEELER-WOLF. 1995. A Manual of California Vegetation. California Native Plant Society. Sacramento, CA.

SHAFFER, M.L. 1981. Minimum population sizes for species conservation. Bioscience 31:131-134.

SHAFFER, M.L. 1987. Minimum viable populations: coping with uncertainty. pp. 69-86 in M.E. Soule (ed.). Viable populations for conservation. Cambridge University Press, Cambridge, England.

SNYDER, M.A., J.L. BELL, AND L.C. SLOAN. 2002. Climate responses to doubling of atmospheric carbon dioxide for a climatically vulnerable region. Geophysical Research Letters 29:9-1 to 9-4.

SNYDER, M.A. AND L.C. SLOAN. 2005. Transient Future Climate over the Western U.S. using a Regional Climate Model. Earth Interactions 9:1.

SOIL SURVEY DIVISION STAFF. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

SOIL SURVEY STAFF. 2019. Web Soil Survey. Natural Resources Conservation Service, United States Department of Agriculture. Available online at http://websoilsurvey.nrcs.usda.gov/. [Accessed February 27, 2019].

SONOMA COUNTY AGRICULTURAL PRESERVATION AND OPEN SPACE DISTRICT. 2019. Saddle Mountain Open Space Preserve Management Plan. February 2019.

STARK, J., AND J. NORTON. 2015. The Invasive Annual Cheatgrass Increases Nitrogen Availability in 24-Year-Old Replicated Field Plots. Oecologia 177(3):799-809.

SUGDEN, E. A. 1985. Pollinators of *Astragalus monoensis* Barneby (Fabaceae): New host records, potential impact of grazing. Great Basin Naturalist 45:299-312.

TILMAN, D., R.M. MAY, C.L. LEHMAN, AND M.A. NOWAK. 1994. Habitat destruction and the extinction debt. Nature 371:65–66.

THORNE, J.H., J.A. KENNEDY, J.F. QUINN, M. MCCOY, T. KEELER-WOLF, AND J. MENKE. 2004. A vegetation map of Napa County using the manual of California vegetation classification and its comparison to other digital vegetation maps. Madroño 51. pp.343-363.

U.S. FISH AND WILDLIFE SERVICE [USFWS]. 2009. *Astragalus claranus* (Clara Hunt's milkvetch) 5-Year Review: Summary and Evaluation. Sacramento Fish and Wildlife Office. Sacramento CA. August 2009.

U.S. FISH AND WILDLIFE SERVICE [USFWS]. 2019. 5-Year Review Clara Hunt's milkvetch (*Astragalus claranus*). Sacramento Fish and Wildlife Office. Sacramento CA. May 2, 2019.

VAN KLEUNEN, M. et al. 2015. Global Exchange and Accumulation of Non-native Plants. Nature 525, pp. 100-103

VANRHEENEN, N.T., A.W. WOOD, R.N. PALMER, AND D.P. LETTENMAIER. 2004. Potential implications of PCM climate change scenarios for Sacramento-San Joaquin River Basin hydrology and water resources. Climate Change 62:257-281.

VELLEND, M., K. VERHEYEN, H. JACQUEMYN, A. KOLB, H. VAN CALSTER, G. PETERKEN, AND M. HERMY. 2006. Extinction debt of forest plants persists for more than a century following habitat fragmentation. Ecology 87:542-548.

WAGNER D.L., G.J. SAUCEDO, K.B. CLAHAN, R.J. FLECK, V.E. LANGENHEIM, R.J. MCLAUGHLIN, A.M. SARNA-WOJCICKI, J.R. ALLEN, AND A.L. DEINO. 2011. Geology, geochronology, and paleogeography of the southern Sonoma volcanic field and adjacent areas, northern San Francisco Bay region, California. Geosphere 7(3):658-683.

WEISS, S.B. 1999. Cars, Cows, and Checkerspot Butterflies: Nitrogen Deposition and Management of Nutrient-Poor Grasslands for a Threatened Species. Conservation Biology Volume 13, No. 6, December 1999: pp. 1746-1486.

WILCOVE, D.S., D. ROTHSTEIN, J. DUBOW, A. PHILLIPS AND E. LOSOS. 1998. Quantifying Threats to Imperiled Species in the United States. Bioscience 48: pp. 607-615.

WOJCIECHOWSKI, M.F. AND R. SPELLENBERG. 2012. ASTRAGALUS. PP. 729-752 IN BALDWIN, B.G., D.H. GOLDMAN, D.J. KEIL, R. PATTERSON, T.J. ROSATTI, AND D.H. WILKEN, eds. The Jepson Manual: Vascular Plants of California, second edition. University of California Press, Berkeley, California.

YURKONIS, K.A., AND S.J. MEINERS. 2004. Invasion Impacts Local Species Turnover in a Successional System. Ecology Letters 7: pp. 764-69.

B. Personal Communication

EVANS, ROB. 2019. Conversation between Jeb Bjerke and Rob Evans, independent consultant, regarding *Astragalus claranus* at the Sonoma County Agricultural Preservation and Open Space District Saddle Mountain Open Space Preserve.

Appendix A: Table of Clara Hunt's Milkvetch Population Information

Population Name	EO#	"early 80s"	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alpine School	3					17		24	50	322		4,500	2,660	994		2,100	350	1,106	7				0*				0*	1,500		1,000-1,500								25-75
Bothe	7		120	142	200	53?	14	8	110	90	11	200	101	7	21	39*		30		2	3		8	0	15			8			0		0	0				0
Lake Hennessey	11	~700		200 300	200	400		81	200	2	10	325	156	9		15*		42								3 or 4		40		1		15		26	19	22	60-150	27
Lewelling Lane	12										15	450	2,238	6,192	345+	332+	106	212	83	134	108	251						450										
Saddle/Hayfork	14																										pres	300	152+	90	25		0		77	0	2	40
Taplin Road	13																60	290										60							10			

1,000 - 10,000 Plants
100 - 1,000 Plants
10 - 100 Plants
1-10 Plants or present
0 Plants or unknown
pres = present

*California Natural Diversity Database does not have a primary source for this number, It was included in a table compiled by the US Fish and Wildlife Service for their 2009 5-year status review.

5-Year Species Reviews

Fish and Game Commission Meeting

December 11-12
Stafford Lehr

California Endangered Species Act 5-Year Species Reviews

- Background
- 5-year Review Process
- Scheduled Species Reviews
- Next Steps
- Summary

Background

- Fish & Game Code § 2077
  - ❖ Mandates review of CESA-listed species every 5 years, if funding is available
  - ❖ Review elements
    - Listing and current conditions
    - Best available science
    - Essential habitat
    - Department recommendations
- Funding authorized in 2018

5-Year Review Process

- CDFW report preparation
- Two-meeting Commission process:
  1. Receipt
  2. Presentations and decision
     - ❖ No further action -OR-
     - ❖ Full species assessment

Planned Species Reviews

Fish:

- Owens pupfish
- Desert pupfish
- Owens tui chub
- Shasta crayfish
- Central Valley spring-run Chinook salmon

Plants:

- ❖ **Baker's larkspur**
- ❖ **Clara Hunt's milkvetch**
- Kenwood Marsh checkerbloom
- Milo Baker's lupine
- Ventura Marsh milkvetch
- Slender-petaled thelypodium
- White sedge

Wildlife:

- Riparian brush rabbit
- Santa Cruz long-toed salamander
- Fresno kangaroo rat

► *www.wildlife.ca.gov/Conservation/CESA/Five-Year-Reviews*

Next Steps…

- Presentations at February meeting
- Department may recommend:
  - ❖ No status change
  - ❖ Delist, down-list, or up-list
- Commission considers and potentially acts on each review

Summary

- Funds received for 5-year reviews on CESA-listed species (FGC § 2077)
- 15 reviews planned over two years
- Two-meeting process
  1. Receipt (2 received today)
     - Baker's larkspur
     - Clara Hunt's milkvetch
  2. Consideration and potential actions
     - Presentations and decisions (February)

Questions ◈ Thank You