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

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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.

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 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.

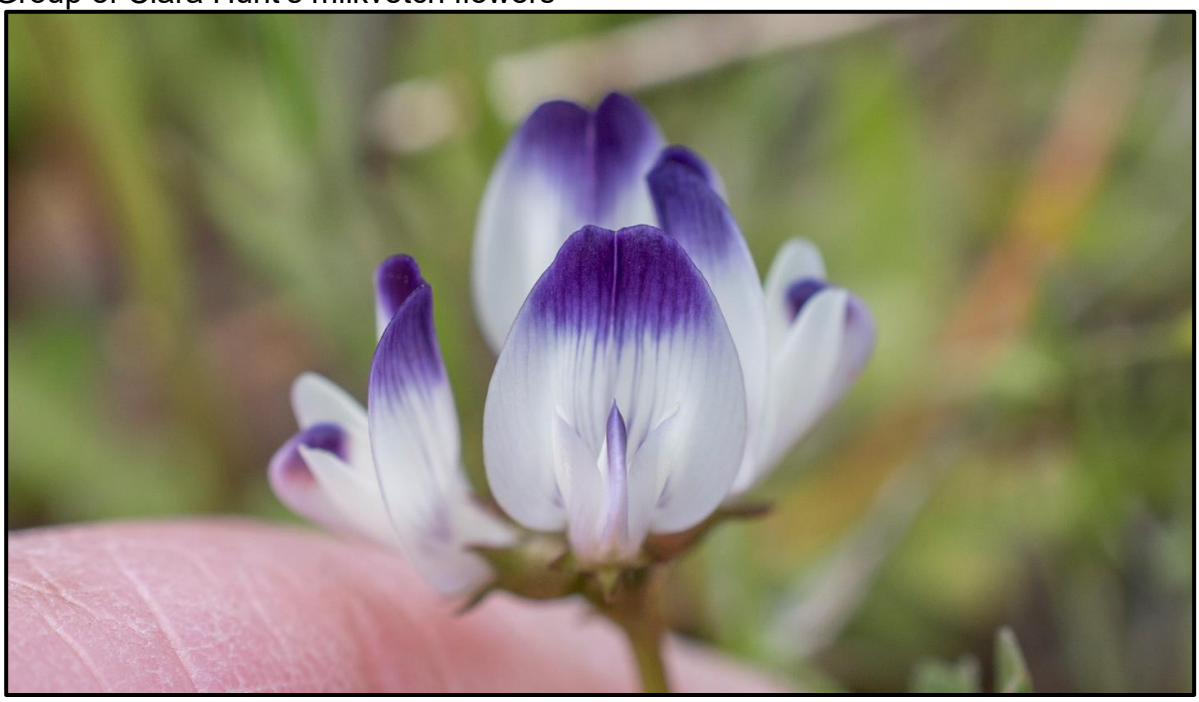
Clara Hunt's milkvetch has a chromosome count of 2n=22 (Liston 1990b).

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) 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

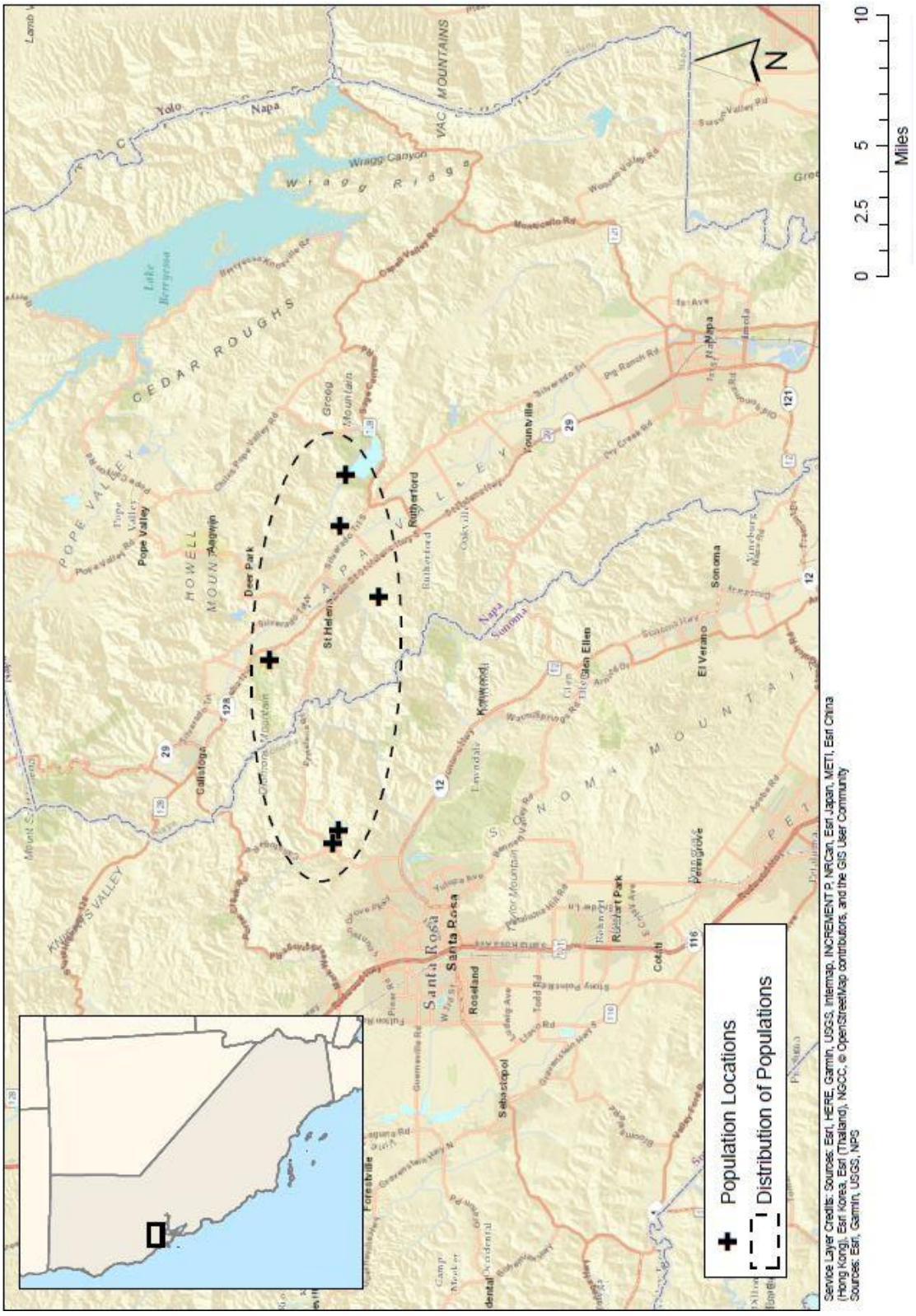
A. Range and Distribution

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

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:

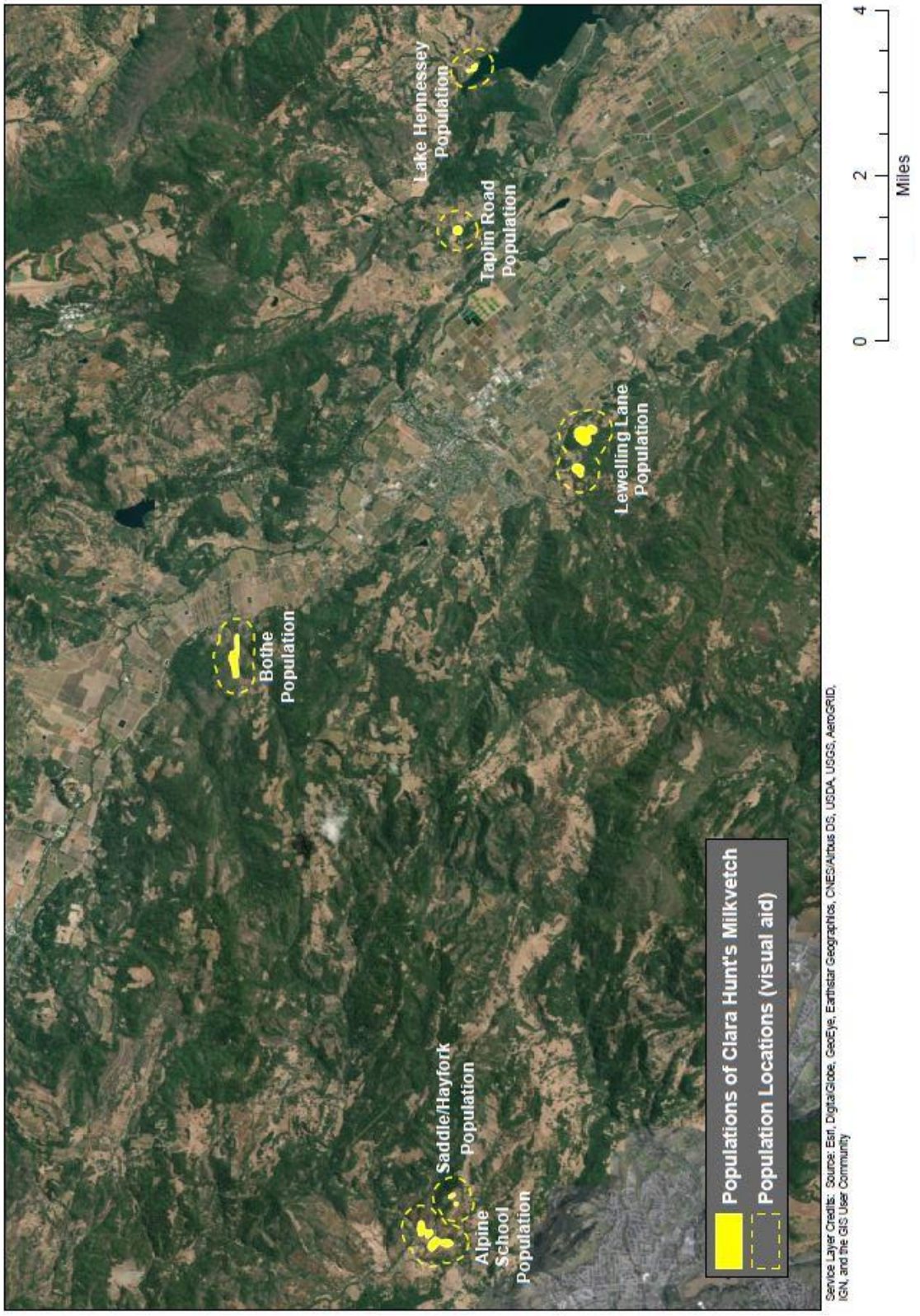
Alpine School: The Alpine School Population is one of two populations of Clara Hunt's milkvetch in Sonoma County. The Alpine School Population is approximately 15 kilometers (9.5 miles) west of St. Helena and approximately 10 kilometers (6 miles) northeast of downtown Santa Rosa. The Alpine School Population 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.

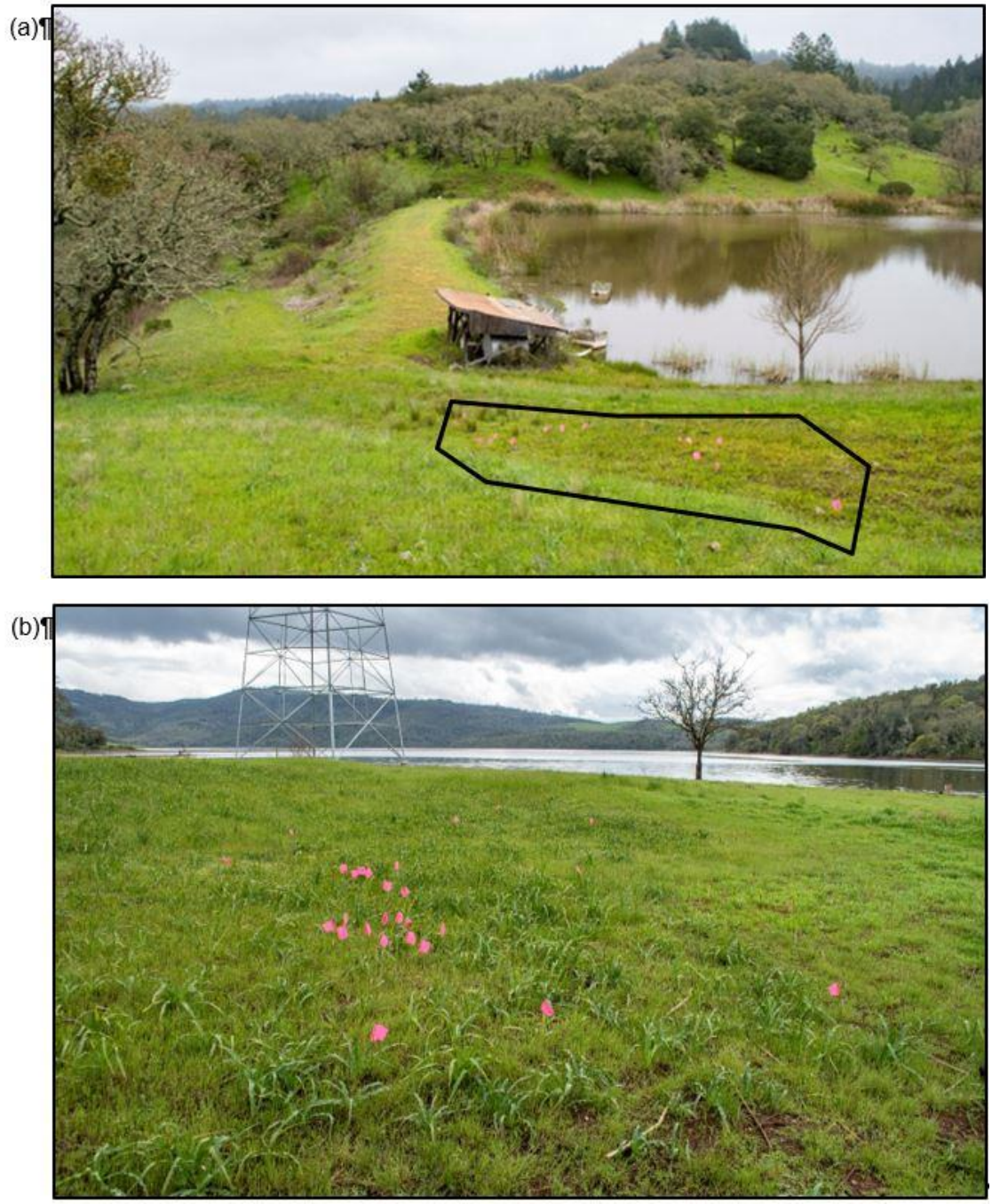
Bothe: The Bothe Population is one of four populations of Clara Hunt's milkvetch in Napa County. The Bothe Population is located within Bothe-Napa Valley State Park, approximately five kilometers (3.1 miles) northwest of St. Helena. The Bothe Population is mapped as one long population in the CNDDB that 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 Figure 3. Clara Hunt's milkvetch (*Astragalus claranus*) Distribution Map





(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,

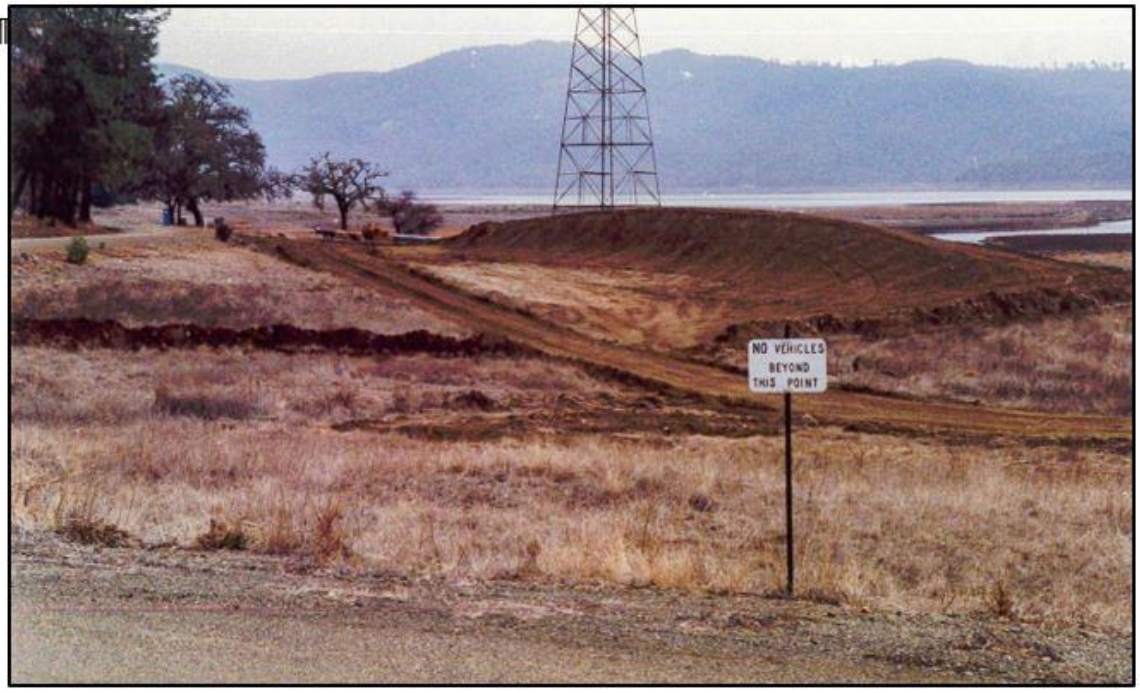
excessive winter or spring herbivory, or the creation of conditions that are favorable for the establishment and spread of invasive plant species. In 2019, the property with the Alpine School Population was being used as pasture for an unknown number of horses. The landowner for the Alpine School Population 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

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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.