Large-Flowered Fiddleneck
(*Amsinckia grandiflora*)

5-Year Review:
Summary and Evaluation

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U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

February 2021

5-YEAR REVIEW

Large-flowered fiddleneck (*Amsinckia grandiflora*)

I. GENERAL INFORMATION

Purpose of 5-Year Reviews:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

The large-flowered fiddleneck (*Amsinckia grandiflora*) (fiddleneck) is an annual, herbaceous plant in the Boraginaceae (borage) family. Mature plants grow to a maximum height of 12 to 36 inches, and an individual can have up to 30 branches, with a single inflorescence occurring on each branch. The fiddleneck has bright, red-orange, trumpet-shaped flowers arranged in a "fiddleneck"-shape inflorescence. Its bright green foliage is covered with coarse, stiff hairs. The blooming period for the fiddleneck is between March to May, though they may bloom earlier and later. As a heterostylous species (i.e., flowers have two or more morphologies), the fiddleneck produces pin and thrum flower forms (morphs), where all flowers on a particular plant consist of only one morph. In pin flowers, anthers are situated within the corolla tube and the stigma, supported by a long style, extends beyond the corolla lip. In thrum flowers, anthers extend beyond the mouth of the corolla and the stigma, on a short style, occurs well within the flower tube. Characteristic of the genus, both flower types have four ovaries at the base of the style, each of which matures into a seed. The fruit is known as a nutlet and is relatively large. The number of nutlets a single plant can produce varies from a few to several thousand. Historically, the plant occurred in a native perennial Nevada bluegrass (*Poa secunda*) community, but presently occurs in non-native grassland.

The fiddleneck is a California endemic that historically ranged from northern Contra Costa County at the San Joaquin River Delta, south to Corral Hollow and adjacent areas in San Joaquin County. Currently, fiddleneck populations[1] occur at 11 sites, though the quality of each population varies. **Table 1** lists each extant or possibly extant population and their current

[1] A population is a group of individuals in a small geographic area.

qualitative assessment. **Appendix 1** documents the populations known since listing with their corresponding California Natural Diversity Database occurrence number and status.

Table 1. List of all currently known, extant or possibly extant populations and the species' Recovery Implementation Team's qualitative assessment.

Population Name	County	Reintroduced or Natural	Year of First Introduction	Current Qualitative Assessment[2]
Carnegie Canyon	San Joaquin	Natural	-	Successful
Introduction Sites #3 and #4	Alameda	Reintroduced	Winter 2014/2015[3]	Successful
Introduction Site #5	San Joaquin	Reintroduced	Winter 2014/2015[3]	Successful
Introduction Site #6	San Joaquin	Reintroduced	Winter 2014/2015[3]	Successful
Droptower (Flashing)	San Joaquin	Reintroduced	Winter 1992/1993[4]	Not Successful
Droptower (Fire Frequency)	San Joaquin	Reintroduced	Winter 1999/2000[5]	Not Successful
Introduction Site #1	Contra Costa	Reintroduced	Winter 2014/2015[3]	Not Successful
Introduction Site #2	Contra Costa	Reintroduced	Winter 2014/2015[3]	Not Successful
Introduction Site #7	San Joaquin	Reintroduced	Winter 2014/2015[3]	Not Successful
Introduction Site #9	San Joaquin	Reintroduced	Winter 2014/2015[3]	Not Successful
Introduction Site #10	San Joaquin	Reintroduced	Winter 2014/2015[3]	Not Successful

Methodology Used to Complete This Review:

This review was prepared by the Sacramento Fish and Wildlife Office, following the Region 8 guidance issued in March 2008. We used information from the Recovery Plan (Service 1997), the Recovery Plan Amendment (Service 2019), the previous 5-year status review (Service 2009), survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database maintained by the California Department of Fish and Wildlife. We also contacted the Recovery Implementation Team that was formally established in 2014 and whose membership includes representatives from the U.S. Bureau of Reclamation, the Lawrence Livermore National Laboratory, the Natural Resources Conservation Service, the California Department of Fish and Wildlife, the East Bay Regional Park District, the Contra Costa Water District, the University of California Botanical Garden at Berkeley, and Vollmar Natural Lands Consulting, Inc., to request any data or information we should consider in our review. The Recovery Plan, the previous status review, communications with the Recovery Implementation Team, and documents from the Recovery Implementation Team were our primary sources of information used to update the species' status and threats. We received no information from the public in response to our Federal Notice initiating this 5-year review. This 5-year review contains updated information on the species' biology and threats, and an

[2] The Qualitative Assessment is an arbitrary determination derived by the Recovery Implementation Team.
[3] VNLC 2016
[4] Carlsen *et al.* 1998
[5] Carlsen *et al.* 2002a

assessment of that information compared to that known at the time of listing or since the last 5-year review. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Lead Field Office: Josh Hull, Recovery and Listing Division Manager, Sacramento Fish and Wildlife Office; (916) 414-6742.

Federal Register (FR) Notice Citation Announcing Initiation of This Review:

A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register on January 27, 2020 (85 FR 4692–4694). No responses regarding the fiddleneck were received from the public.

Listing History:

Original Listing
FR Notice: 50 FR 19374
Date of Final Listing Rule: May 8, 1985
Entity Listed: Species
Classification: Endangered

State Listing
The fiddleneck was listed by the State of California as endangered in 1982.

Associated Rulemakings:

Critical Habitat
FR Notice: 50 FR 19374
Date of Final Listing Rule: May 8, 1985

Review History:

The previous 5-year review was completed in January 2009.

Species' Recovery Priority Number at Start of 5-Year Review:

The recovery priority number for the fiddleneck is 5 according to the Service's 2007 Recovery Data Call for the Sacramento Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This

number indicates that the taxon is a species that faces a high degree of threat and has a low potential for recovery.

Recovery Plan or Outline:

> **Name of Plan or Outline:** Large-Flowered Fiddleneck (*Amsinckia grandiflora*) Recovery Plan
> **Date Issued:** September 29, 1997
> **Dates of Previous Revisions:** September 26, 2019

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment Policy (Policy)

The Endangered Species Act defines "species" as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition of species under the Act limits listing as distinct population segments to species of vertebrate fish or wildlife. Because the species under review is a plant, the Policy is not applicable, and the application of the Policy to the species' listing is not addressed further in this review.

Information on the Species and its Status

Species Biology and Life History

The large-flowered fiddleneck (*Amsinckia grandiflora*) (fiddleneck) is an annual herbaceous plant that germinates with the onset of fall or early winter rain, grows throughout the winter, flowers in the early spring, and then sets seed and dies prior to the summer drought. Mature plants grow to a maximum height of 12 to 36 inches. Individuals can have up to 30 branches with a single inflorescence occurring on each branch. The flowers have four ovaries at the base of the style, each of which matures into a seed called a nutlet. The number of nutlets a single plant can produce varies from a few to several thousand. Since the seeds are relatively large, seed dispersal may be limited with most seeds falling near the maternal plant (Paterson *et al.* 2010).

A single large, multibranched fiddleneck can produce more nutlets than several single stemmed fiddleneck (Pavlik 1988). However, the fiddleneck does not maintain a large seed bank but relies on the previous year's seeds (Pavlik 1995). Additionally, the fiddleneck has a heterostylous reproductive system, which means it has two flower forms or morphs called pin and thrum. In pin flowers, anthers are situated within the corolla tube and the stigma, supported by a long style, extends beyond the corolla lip. In thrum flowers, anthers extend beyond the mouth of the corolla and the stigma, on a short style, occurs well within the flower tube. A heterostylous reproductive system is considered primitive in *Amsinckia* sp. (Ray and Chisaki 1957). It has been hypothesized that this reproductive system was detrimental to the species and the evolution to homostylous reproductive systems, having the same type of flower, allowed its congeners to become more prevalent (Ray and Chisaki 1957; Pantone *et al.* 1995). However, Carlsen *et al.* (2002b) has shown that the heterostylic large-flowered fiddleneck can produce the same amount of seeds as at least one of its homostylic congeners under favorable environmental conditions. In order to do so, the fiddleneck must use more resources in order to achieve the same production (Carlsen *et al.* 2002b).

As part of a recent reintroduction effort, the University of California Botanical Garden at Berkeley (Botanical Garden) developed a captive propagation plan in order to ensure there were enough plugs, which are seedlings that have been grown in small containers, and seeds for the project. During the seed regeneration process, the Botanical Garden noted that seeds typically took 7 to 10 days to germinate and the outdoor daytime temperature variation was beneficial to the germination process (Vollmar Natural Lands Consulting, Inc. [VNLC] 2016). These seedlings were grown outside under 30% shade cloth and then later moved to full sun. The fiddleneck typically began to flower in February or March and continued into May or June (VNLC 2016). Seeds were harvested in early July after the stems had dried. The Botanical Garden found that pin morphs produced twice as many seeds as thrum morphs (VNLC 2016).

Observations from monitoring reintroduced populations have shown that the fiddleneck tends to do better when rain first falls in significant amounts in the late winter and early spring (Pavlik 1991a). Precipitation prior to this period can give annual grasses that are able germinate earlier in the season an advantage, increasing competitive pressure for resources. In addition, too much rain may negatively impact the fiddleneck. Carlsen and Paterson (2018) noted significant population decline following a winter of heavy rainfall at both a natural and reintroduced population in 1998, and at another natural population in 2017.

Spatial Distribution

The fiddleneck was first reported at a few sites in the northern Diablo Range in California, including around Antioch where it was first described. The historical range of the species is from the San Joaquin River Delta in northern Contra Costa County to Corral Hollow and adjacent areas in San Joaquin County in the south (Pavlik and Heisler 1988). At the time of listing, there was one natural population at the Droptower site on U.S. Department of Energy Lands at the Lawrence Livermore National Laboratory's (Laboratory) Site 300 in San Joaquin County. In 1988, a second natural population was discovered in Draney Canyon about ¾ mile west of the first natural population also on the Laboratory's property in Alameda County. A third natural population, Carnegie Canyon (also called Etchelet), was found in 1993 southeast of the Droptower site on present-day Contra Costa Water District (Water District) property. Surveys using information from a detailed habitat analysis used in Phase 1 of a current reintroduction effort (described below) have not identified any additional populations (VNLC 2016).

Attempts to reintroduce the fiddleneck were made in the late-1980s to 1990s, and more recently starting in the mid-2010s. The first reintroductions occurred in the late-1980s to mid-1990s and were established from seed at seven sites throughout the fiddleneck's historical range (Pavlik 1990; Pavlik 1991; Pavlik 1992; Carlsen 1996). These reintroductions were the Lougher Ridge and Black Diamond II populations in northern Contra Costa County, Los Vaqueros I and II populations in southern Contra Costa County, the Droptower (Flashing) and Corral Hollow populations in southwestern San Joaquin County, and the Connolly Ranch population in southern San Joaquin County. The Droptower (Fire Frequency) population was reintroduced in the late-1990s in southwestern San Joaquin County (Carlsen *et al.* 2002a). The recent reintroduction effort (described in detail below) involves seeding and outplanting large-flowered fiddleneck at 10 sites with two populations in northern Contra Costa County, two populations in eastern Alameda County, and six populations in southern San Joaquin County. **Figure 1** shows the general location of each population.

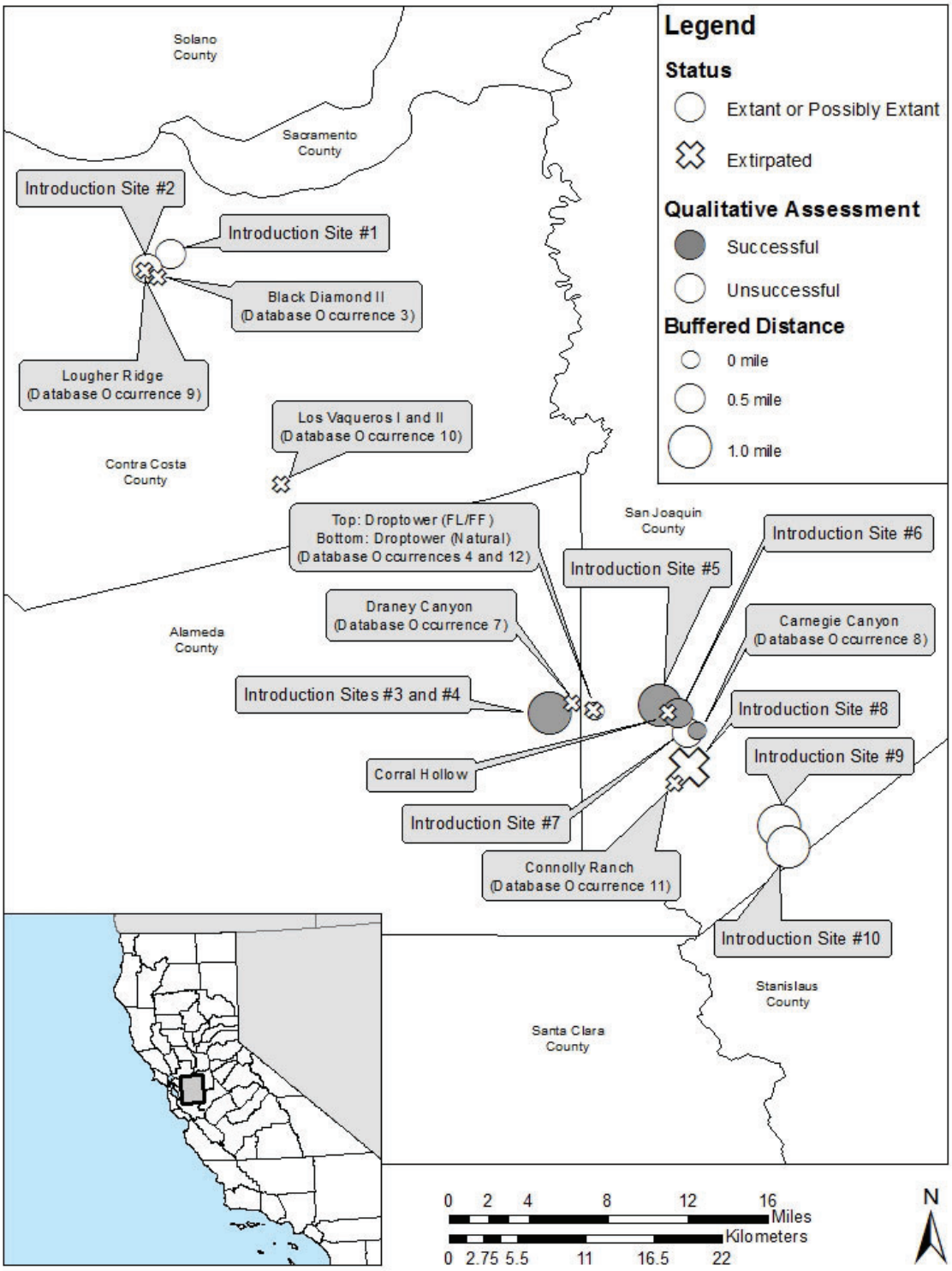

Figure 1. Map of all known populations since listing. Each population's status, Recovery Implementation Team's Qualitative Assessment, and distance from the true location, which is offset by no more than the value assigned, is shown.

The California Natural Diversity Database (Database) identifies nine occurrences of fiddleneck. Database Occurrence 2 is a historical population that was extirpated before the fiddleneck was listed and is not included in this status review. The exact location of this site is unknown as this population was last seen in 1887; however, the Database predicts the site as being near the Judsonville mining camp within the present-day Black Diamond Mines Regional Park near Antioch (Database 2020).

Currently, the only extant natural population is found in Carnegie Canyon in southwestern San Joaquin County. There are 10 extant or possibly extant reintroduced populations: two in northern Contra Costa County, one in eastern Alameda County, and seven in southwestern San Joaquin County.

Abundance

Appendix 1 documents the populations known since listing with their corresponding Database occurrence number and status. The U.S. Bureau of Reclamation (Reclamation) is currently funding the *Captive Propagation and Reintroduction of Large-flowered Fiddleneck (Amsinckia grandiflora) Project in Contra Costa, Alameda, and San Joaquin Counties* led by VNLC (Reclamation 2020). The primary goal of this reintroduction effort is to establish self-sustaining populations within the fiddleneck's historical range (VNLC 2016). The project is currently in the second of two phases.

During Phase 1, VNLC selected 10 sites suitable for fiddleneck reintroduction based on a geographic information system analysis of updated habitat requirements and landowner permission, and seeded and outplanted or transplanted plugs at each site (VNLC 2016). The plugs were grown at the Botanical Garden. Under Phase 2, the four most successful populations from Phase 1, characterized by the largest population size and population heath and vigor data, were identified, and are being actively managed, monitored, and augmented through outplanting only. The populations not selected for Phase 2, either due to a small population size or unsatisfactory population health and vigor data, will not be augmented but will continue to be monitored and managed with subsequent censuses being estimates. Phase 2 started the year after Phase 1 ended (in 2016). Even though the populations not selected for Phase 2 may be short lived, they have been incorporated in Appendix 1 and in this section.

The paragraphs below are grouped by property owner as they are distributed across the species' historical range from north to south.

The Black Diamond Mines Regional Park, managed by the East Bay Regional Park District (Park District), encompasses four populations: Lougher Ridge, Black Diamond II, Introduction Site #1, and Introduction Site #2. The Lougher Ridge population has been monitored infrequently since the last status review and is classified as extirpated in this status review. Three plants were found in 2013 and subsequent monitoring has not located any plants (Lisa Paterson, *in litt.* 2019). The Black Diamond II population was extirpated before the last status review (Service 2009). VNLC was unable to find where this population occurred during habitat assessments for Phase 1 of the reintroduction effort (VNLC 2013). Its status remains unchanged. Two populations (Introduction Site #1 and Introduction Site #2) were reintroduced in Phase 1 of the reintroduction effort near the Lougher Ridge and Black Diamond II populations; however,

these populations were not selected for Phase 2 of the reintroduction effort. Both populations have steadily declined from the first census in 2015 of 509 plants at Introduction Site #1 and 141 plants at Introduction Site #2, to a combined population estimate of 20 plants in 2020 (VNLC 2016; Jake Schweitzer, *in litt.* 2020). The Recovery Implementation Team determined these populations are not successful. For the analysis in this status review, these populations are classified as extant and possibly extant, respectively; do not receive augmentation; not actively managed; and not self-maintaining.

The Los Vaqueros I and II populations were listed as extirpated in the last status review (Service 2009). VNLC was unable to find where these populations occurred during habitat assessments for Phase 1 of the reintroduction effort (VNLC 2013). Their status remain unchanged.

Two natural and two research-focused populations occur on the Laboratory's Site 300. The natural Draney Canyon population was extirpated before the last status review, and its status remains unchanged (Service 2009; Lisa Paterson, *in litt.* 2019). No plants have been seen at the natural Droptower site since 2007, and thus the population is classified as extirpated in this status review (Lisa Paterson, *in litt.* 2019). VNLC noted that the habitat characteristics at this site were different from those of the other natural populations, which may have contributed to its extirpation (VNLC 2016). The natural Droptower site has a northwest aspect and receives more solar radiation and may have sandier soils than the Carnegie Canyon site, the location of the only known extant natural population (VNLC 2016). The two research-focused populations, called Droptower (Flashing) and Droptower (Fire Frequency), are located near the natural Droptower site. These two populations are combined in the Database, but are separated in this document. The Recovery Implementation Team determined these two populations are not successful. For the analysis in this status review, these populations are classified as extant, receive augmentation, actively managed, and not self-maintaining.

Between 1997 and 2010, the natural Droptower population and the two research-focused populations were the only populations known to be actively monitored. The natural Droptower population disappeared after the 2007 monitoring season and the two research-focused populations both saw declines in 2008 and 2009. No individuals were identified at the Droptower (Flashing) site in 2009 and 2010, and the Droptower (Fire Frequency) population had only 56 and 26 plants during the same two years. In 2011, both of these populations had over 100 individuals. In 2019, the Droptower (Flashing) population had 38 plants and the Droptower (Fire Frequency) had 152 plants (Lisa Paterson, *in litt.* 2019).

There are two reintroduced populations (Introduction Site #3 and Introduction Site #4) west of the Laboratory in Alameda County. These populations were selected for Phase 2 of the reintroduction effort and are actively managed and monitored. These populations have increased in size from the first census of 607 (at Introduction Site #3) and 496 plants (at Introduction Site #4) in 2015 to approximately 27,000 plants in 2020 (VNLC 2016; Jake Schweitzer, *in litt.* 2020a). The two populations merged in the 2018 growing season from both natural recruitment and deliberate planting efforts, and are considered one population for the remainder of this document. This population was not augmented in 2019 or 2020 to determine if it is self-sustaining. The Recovery Implementation Team determined this population is successful. For the analysis in this status review, this population is classified as extant, receives augmentation, actively managed, and not self-maintaining.

One reintroduced population (Introduction Site #5) east of the Laboratory in San Joaquin County occurs on private property. This population was selected for Phase 2 of the reintroduction effort and is actively managed and monitored. This population has increased in size from the first census of 163 plants in 2015 to 4,350 plants in 2020 (VNLC 2016; Jake Schweitzer, *in litt.* 2020a). This population was not augmented in 2019 or 2020 to determine if it is self-sustaining. The Recovery Implementation Team determined this population is successful. For the analysis in this status review, this population is classified as extant, receives augmentation, actively managed, and not self-maintaining.

The Corral Hollow population located on California Department of Fish and Wildlife's Corral Hollow Ecological Reserve was listed as extirpated in the last status review (Service 2009). VNLC was able to visit the site to collect habitat information for Phase 1 of the reintroduction effort and did not find any plants (VNLC 2013). Its status remains unchanged.

The Water District purchased the Etchelet Property in San Joaquin County in 2011 as mitigation for the Los Vaqueros Reservoir expansion project and placed a conservation easement on the property. The conservation easement is for the San Joaquin kit fox (*Vulpes macrotis mutica*), California tiger salamander (*Ambystoma californiense*), and California red-legged frog (*Rana draytonii*); however, it also encompasses the natural Carnegie Canyon population of fiddleneck. This population has been regularly monitored since 2010 as research for the Los Vaqueros Reservoir expansion project. This population does not receive augmentation or intensive management. The number of individuals in the Carnegie Canyon population has varied over the monitoring period (see **Figure 2** for census information; Lisa Paterson, *in litt.* 2019). Due to the COVID-19 pandemic, the Carnegie Canyon population was not monitored in 2020. However, based on observations during wintertime management activities, this population was observed to feature populations similar to or larger than 2019 census figures. The Recovery Implementation Team determined this population is successful. For the analysis in this status review, this population is classified as extant, does not receive augmentation, not actively managed, and self-maintaining.

There are two reintroduced populations (Introduction Site #6 and Introduction Site #7) north of the Carnegie Canyon population. The population at Introduction Site #6 was selected for Phase 2 of the reintroduction effort and is actively managed and monitored by VNLC. This population has increased in size from 252 plants in 2015 to 10,000 plants in 2019 (VNLC 2016; Jake Schweitzer, *in litt.* 2020b). This population was not augmented in 2019 or 2020 to determine if it is self-sustaining. The population at Introduction Site #7 was not selected for Phase 2 of the reintroduction effort and has declined from 292 plants in 2015 to 5 plants in 2018 (VNLC 2016; Jake Schweitzer, *in litt.* 2020b). Due to the COVID-19 pandemic, Introduction Site #6, and Introduction Site #7 populations were not monitored in 2020. However, based on observations during wintertime management activities, the population at Introduction Site #6 was observed to feature populations similar to or larger than 2019 census figures. The Recovery Implementation Team determined the population at Introduction Site #6 is successful and the population at Introduction Site #7 is not successful. For the analysis in this status review, the population at Introduction Site #6 is classified as extant, receives augmentation, is actively managed, and is not self-maintaining. The population at Introduction Site #7 is classified as extant, does not receive augmentation, not actively managed, and not self-maintaining.

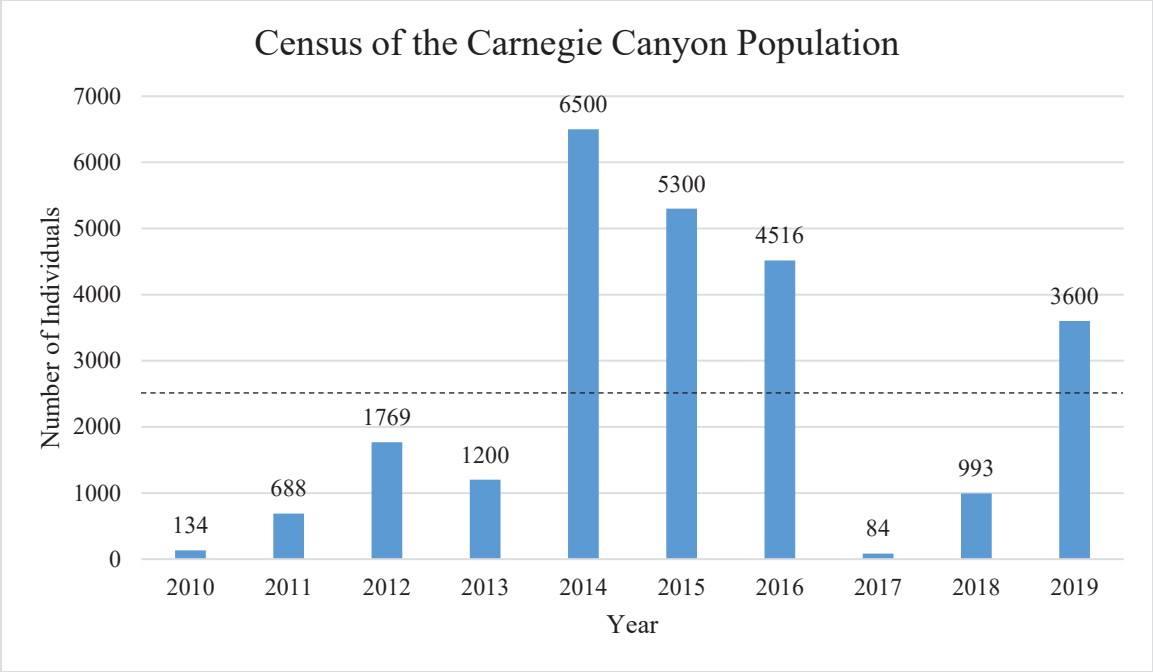

Figure 2. Census of the natural population at the Carnegie Canyon site, which does not receive augmentation. Between 2010 and 2019, the population has averaged 2,478 individuals, which is represented by the dashed line.

There are two reintroduced populations south of the Carnegie Canyon population: Connolly Ranch and Introduction Site #8. The Connolly Ranch population was extirpated before the last status review (Service 2009). VNLC was unable to find where this population occurred during the habitat assessments for Phase 1 of the reintroduction effort (VNLC 2013). Its status remains unchanged. The Introduction Site #8 reintroduction occurs near the Connolly Ranch population; however, this population was not included in Phase 2 of the reintroduction effort and was considered extirpated in 2017 (VNLC 2016; Jake Schweitzer, *in litt.* 2020b).

Two reintroduced populations at Introduction Site #9 and Introduction Site #10 occur further south. These populations were not selected for Phase 2 of the reintroduction effort. Both populations have steadily declined from the first census of 336 at Introduction Site #9 and 299 plants at Introduction Site #10 in 2015 to a combined population estimate of 15 plants in 2020 (VNLC 2016; Jake Schweitzer, *in litt.* 2020a). The Recovery Implementation Team determined these populations are not successful. For the analysis in this status review, these populations are classified as extant and possibly extant, respectively; do not receive augmentation; not actively managed; and not self-maintaining.

Habitat or Ecosystem

Habitat Requirements

As stated in the Abundance section, Reclamation is funding a reintroduction effort led by VNLC. During Phase 1 of the reintroduction effort, VNLC visited as many known occurrences that they were able to locate and recorded the environmental characteristics at each site. After comparing the environmental characteristics at the natural and introduced sites, VNLC (2016) identified

what they considered high quality habitat conditions for the fiddleneck and used these conditions in their initial habitat analysis. The high quality habitat conditions identified in Phase 1 were:

- slopes between 43% and 124%;
- elevations between 728 feet and 1,386 feet;
- a microclimate where:
    - annual precipitation is between 10.8 inches and 16.3 inches;
    - the average January minimum temperature is between 34.2° F and 39.9° F; and
    - the average July maximum temperature is between 90.5° F and 91.4° F;
- solar radiation associated with a steep north-facing slope in an area shaded by the topography;
- grassland or transitional savanna habitat; and
- sandstone-derived clay or clay-loam soils.

During the initial site visits, VNLC (2016) noticed that natural populations (either extant or extirpated) occur in areas that receive less solar radiation and tend to be more mesic than their surrounding area. These sites were located on the northern aspect of the hill and low enough for the surrounding topography to shield the sites from direct sunlight. These sites also allow moisture to collect and stay longer, which VNLC hypothesizes allows these populations to access water later in the year. Since the amount of solar radiation was the most similar amongst the three natural population sites, VNLC made this the discriminating factor when choosing sites for reintroduction.

VNLC noted that none of Pavlik's reintroduction sites were within their 25 sites that are most suitable for reintroduction (VNLC 2013). The 1990s sites were determined to be on less steep terrain and on a less than ideal hillslope position (VNLC 2016). These sites experienced higher levels of solar radiation and competition from annual grasses (VNLC 2013). However, even though the 1990s reintroduction effort failed, the Lougher Ridge population persisted intermittently from 1989 when the site was seeded to 2013.

Habitat Management

Controlling the density of the associated vegetative community, whether native or non-native, is important for the fiddleneck (Service 2009). The previous status review discussed Pavlik's efforts to examine the effectiveness of various management techniques for the control of non-native species. Research since the last status review provided more information on techniques to control density.

Pavlik evaluated the effectiveness of grass-selective herbicide in his reintroduction efforts and on Site 300 (Pavlik 1991a; Pavlik 1996). In January or February of 1991, 1994, 1996, and 1998, herbicide treatments of 1/10 strength Fusilade®-surfactant solution was applied lightly and patchily on higher densities of annual grasses with care not to spray native perennial grasses. After each herbicide treatment, except for the treatment in 1998, fiddleneck numbers increased dramatically; however, the use of herbicide was discontinued due to the large increase of bush lupine (*Lupinus albifrons*) at the native Droptower site and the lack of response by the fiddleneck in 1998 (Carlsen *et al.* 2012).

VNLC used Fusilade DX® herbicide in the winter of 2018/2019 at the four populations identified in Phase 2 of the reintroduction effort to specifically target non-native annual grasses (Jake Schweitzer, *in litt.* 2020b). Herbicide was sprayed in areas with the densest annual grasses and avoided native perennial grasses. Similar to the first three years in the Carlsen *et al.* (2012) study, the fiddleneck numbers increased dramatically. Herbicide can be an effective tool to control the density of competing vegetation, especially when the weather favors annual grasses (Jake Schweitzer, *pers. comm.* 2020). Similarly, VNLC has used vinegar to reduce non-native vegetation cover.

Grazing is a complex issue for the fiddleneck. Trampling by livestock is thought to have extirpated at least one population (Los Vaqueros II), with Pavlik notably calling cattle "inbred, under-selected, methane-mongering flesh factories" out of frustration (Pavlik 1992, p. 18). Livestock trampling is also implicated in negatively impacting the Carnegie Canyon population (Service 2009) and was an issue for Phase 1 of the reintroduction effort (VNLC 2016). During Phase 1 of the reintroduction effort, cattle impacted eight of 30 unfenced plots by trampling or increasing soil erosion (VNLC 2016). Drought may further impact the fiddleneck with respect to grazing, as cattle may move to the more mesic sites associated with the fiddleneck (VNLC 2016). Conversely, grasses or aggressively growing plants overran plots fenced from cattle during Phase 1 of the reintroduction effort.

In areas where herbicide or other management actions cannot be used to control the density of competing vegetation, an appropriate grazing regime is needed (VNLC 2016). VNLC (2016) predicts that a self-sustaining population may be large enough to deter livestock from heavily grazing and thus trampling fiddleneck since livestock tend to prefer grasses instead of forbs. Livestock may provide additional benefits. Livestock may press the seeds into the soil, thus reducing impacts from granivores, or seed-eating animals. Similarly, livestock have been credited with spreading seeds at Introduction Sites #3 and #4 (Jake Schweitzer, *in litt.* 2021). An unusual benefit is the increase of soil disturbance. Ray and Chisaki (1957) noted that *Amsinckia* are colonizers of unstable or disturbed habitat. In the latest reintroduction effort, fiddleneck were found in terraces created on hillsides by grazing animals growing at a higher density and with more branches compared to the rest of the hillside (VNLC 2016).

The Laboratory has examined the effects of prescribed fires on the Nevada bluegrass (*Poa secunda*), a dominant plant in the fiddleneck's natural vegetative community, and the fiddleneck since 2001 and has reported the impacts in their reoccurring *Rare Plant Monitoring and Restoration at Site 300* reports (most recently in Carlsen and Paterson 2018). Prescribed burns at the Laboratory occurred in June or July from 2001 to 2011. Additionally, a wildfire occurred in July 2005 that burned through some of the plots. High frequency (every year) burns were shown to increase the number of Nevada bluegrass with a smaller increase in medium frequency (every three years) burns. There were no significant differences in the number of Nevada bluegrass in low frequency (every five years) burns and in the control plot (burned only in 1998) (Carlsen *et al.* 2012). Since the experimental burns ended, the number of Nevada bluegrass in the high frequency and medium frequency plots decreased to the abundance found in the other two plot types (Carlsen and Paterson 2018). The Laboratory had trouble maintaining the number of fiddleneck in each plot, so the effects of fire on the fiddleneck are not as clear. Carlsen *et al*. (2017) found the control plots had the highest average number of fiddleneck more consistently compared to the other plots. They believe the fire itself negatively impacted the species, as the

fiddleneck nutlets cannot tolerate high temperatures (Carlsen *et al.* 2017; T. Carlsen, unpubl. data in Carlsen *et al.* 2009). However, they also believe fire has benefitted the fiddleneck. Burning can reduce the amount of competing vegetation and has shown at different times in their experiment that fiddleneck responded by being larger and more robust, even if the population numbers were low. A single larger and more robust (multi-branched) fiddleneck can produce more nutlets than several single stemmed fiddleneck (Pavlik 1988)

Changes in Taxonomic Classification or Nomenclature

No change in either taxonomic classification or nomenclature has occurred since the last status review.

Genetics

Although genetic research has not been conducted since the last status review, all of the current fiddleneck populations originate from one of two source populations: Site 300 or Carnegie Canyon. The genetic consequences of introducing populations were considered in Phase 1 of the reintroduction effort (VNLC 2016) and populations established close to a source population receive augmentation with seeds from that source population. Populations established farther away from the two source populations receive augmentation from both.

Species-specific Research and/or Grant-supported Activities

Reintroduction

As stated in the Abundance section, Reclamation, through the Central Valley Project Conservation Program, is currently funding the *Captive Propagation and Reintroduction of Large-flowered Fiddleneck (Amsinckia grandiflora) Project in Contra Costa, Alameda, and San Joaquin Counties* led by VNLC. The primary purpose of this project is to establish new self-perpetuating fiddleneck populations on suitable sites within its known historical range. This reintroduction effort has occurred over two phases. Phase 1 focused on identifying 10 suitable sites for reintroductions followed by seeding or outplanting at those sites. VNLC visited the site of each known population to record their environmental characteristics and used this information to conduct a habitat analysis on a geographic information system to determine the extent of potential habitat within the range of the species. A second, more targeted habitat analysis was conducted to find units of high quality habitat using factors originating from the initial habitat analysis and the site visits. This habitat was broken up into 0.25 or 0.5 acre units based on preferred solar radiation and location. These units were scored using a system of 1, 2, or 3, with 3 indicating within the preferred range, for a variety of factors. These factors include elevation, percent slope, aspect, precipitation, average minimum January temperature, average maximum January temperature, total vegetation cover, tree cover, shrub cover, Nevada bluegrass cover, wildflower cover, bedrock type, soil moisture, density of small mammal burrows, residual dry matter, and accessibility of the site. VNLC identified the 25 best sites from this second habitat analysis, visited as many sites as possible to collect soil samples, and conducted further soil. Afterwards, VNLC selected 10 sites and seeded or outplanted fiddleneck (VNLC 2019). Under Phase 2, the four most successful populations identified from Phase 1 are being monitored, actively managed, and augmented only by outplanting. VNLC has found that planting plugs were

more successful than seeds in their restoration effort. Field work for Phase 2 will end in the spring of 2021.

Floral Output and Production

The number of seeds produced is a better indicator of fiddleneck success than just the number of plants in the population since a single large, multibranched fiddleneck can produce more nutlets than several single stemmed fiddleneck (Pavlik 1988). Pavlik (1990) developed two regression equations for each of his reintroduced populations to estimate the number of nutlets produced with the independent variable being either 1) the sum of inflorescence lengths (in centimeters) or 2) the shoot length (in centimeters). However, Pavlik did not develop these equations for the natural populations (Pavlik 1991b). Rather, the Connolly Ranch equation ($r = 0.86$, $p < 0.01$) (Equation 1) that uses shoot length has been applied to the Laboratory's natural Droptower population since 1991 and occasionally to the Carnegie Canyon population due to the proximity of the populations (Pavlik 1991a; Carlsen and Paterson 2020).

$$\frac{\#\ nutlets}{plant} = 3.42 \times shoot\ length - 36.76 \qquad \text{(Equation 1)}$$

The Laboratory developed an equation similar to Equation 1 from 20 plants in the 1994 Droptower (Flashing) population using the number of inflorescences as the independent variable and continues to use it to this day (Carlsen and Paterson 2020). However, the Laboratory found errors in the 1994 demographic data from the Droptower (Flashing) population in 2017. These errors meant their original equation underestimated nutlet production. The Laboratory created several similar regression equations using a combination of the 1993 and 1994 demographic data and compared the output (Carlsen and Paterson 2020). The Laboratory found that regression equations based on shoot length, including Equation 1, had the largest deviation from the actual nutlet output (R^2 values are between 0.67 and 0.87) with the predicted nutlet output differing from the actual nutlet output by a range of -5,214 to 1,706. A regression equation that only used the number of branches provided an R^2 value of 0.91 and predicted an output of 279 nutlets over the actual output. Additionally, the Laboratory created an equation that uses both the shoot length and number of branches, since nutlet output increases with an increasing number of branches or, for single branched plants, height. The resulting regression equation ($R^2 = 0.95$) (Equation 2) uses a "Robustness Index" (*RI*), which is the product of shoot length (in centimeters) and the number of branches, as the independent variable.

$$\frac{\#\ nutlets}{plant} = 0.3548 \times RI + 0.7292 \qquad \text{(Equation 2)}$$

Equation 2 provided the best fit, and predicted the exact nutlet output.

Fiddleneck populations can produce tens of thousands of seeds in a year (Pavlik 1995). However, Pavlik (1995) has shown that the fiddleneck does not maintain a large seed bank; rather, the fiddleneck relies on seeds surviving from the previous year. This reliance on the previous year's seed stock means that granivory and fire occurring in the dormant season can impact the success of the following year's population. The relatively large nutlet (up to 5mg) is typically set in April or early May, and is the only seed of its size set in that time period in its vegetative community (Espeland *et al.* 2005). Espeland *et al.* (2005) determined that rodents are the primary consumers

of nutlets on Laboratory property and that the sinusoidal nature of rodent populations had more of an impact on the fiddleneck than the amount of cover. As stated earlier, fiddleneck seeds cannot tolerate high temperatures (T. Carlsen, unpubl. data in Carlsen *et al.* 2009). Therefore, rodent populations can have a greater impact on fiddleneck population when fires are started shortly after the fiddleneck sets its seed. The seeds that survive are at a higher risk of predation (Carlsen *et al.* 2009).

Even though large-flowered fiddleneck populations can produce tens of thousands of seeds a year, the number of seeds per plant is lower when compared to other fiddleneck species. In 1974, Ornduff (1976) determined that the natural Droptower population averaged 1.16 nutlets per flower while the bristly fiddleneck (*A. tessellata*) averaged 2.49 nutlets per flower and the common fiddleneck (*A. intermedia*) averaged 2.00 nutlets per flower. Ornduff (1974) predicted that the reproductive success of homostylic *Amsinckia* species has allowed these other *Amsinckia* species to displace the ancestral heterostylic large-flowered fiddleneck across its range. Similarly, Ray and Chisaki (1957) predicted that the homostylic, self-fertilizing flowers such as those found on the common fiddleneck allowed for colonizing plants to increase rapidly. Pantone *et al.* (1995) provided evidence that the large-flowered fiddleneck when compared to the common fiddleneck is constrained by its reproductive system, which it cannot overcome by growing more flowers. However, Carlsen *et al.* (2002b) found that seed output in bristly fiddleneck was not significantly different from the large-flowered fiddleneck in a greenhouse. The large-flowered fiddleneck had to produce twice as many flowers per inflorescence to get a similar seed output. In the field, the bristly fiddleneck produced twice as many nutlets per flower than the large-flowered fiddleneck, which resulted in the bristly fiddleneck having a higher seed output; however, there was not a significant difference in seed output between the two species. Likewise, the large-flowered fiddleneck was able to produce a greater number of flowers per inflorescence in order to produce a similar number of seeds. In other words, the heterostylic large-flowered fiddleneck can produce the same amount of seeds as the homostylic bristly fiddleneck under favorable environmental conditions; however, the large-flowered fiddleneck must use more resources in order to achieve the same production (Carlsen *et al.* 2002b). Therefore, an increase in competition from other species, notably non-native invasive species, can limit the amount of resources available for the large-flowered fiddleneck.

Other Research at the Laboratory

The Laboratory has also focused their research on density and the fiddleneck's associated vegetative community by reviewing biomass data from the Droptower (Flashing) site from 1998 to 2008, Nevada bluegrass persistence data from 2001 to 2011 (though part of this study continues in the study analyzing the impacts of prescribed fire at the Droptower [Fire Frequency] site), and community cover estimates from 2001 to 2011 (Carlsen *et al.* 2012; Carlsen and Paterson 2018). The impact of prescribed burning and Nevada bluegrass persistence in the Droptower (Fire Frequency) site is discussed in the Habitat or Ecosystem section.

The biomass data and Nevada bluegrass persistence data were collected from the same plots at the Droptower (Flashing) site (Carlsen *et al.* 2012). There were two types of plots established in 1993: plots with Nevada bluegrass and plots cleared of all perennial grasses. The plots with Nevada bluegrass were separated by density (low, medium, and high) and additional individuals were planted to increase the density of the desired plot. Plots without perennial grasses were

established with three densities of annual grasses (low, medium, and high). As described previously, prescribed fires were used in these plots in 1998 (southern half of the site), 1999 (southern half of the site), and 2003 (entire site); and a wildfire occurred in 2005 (entire site).

In general, an increase in biomass indicates an increase in the density of the vegetative community, which may decrease the fecundity of the fiddleneck. An increase in biomass may also increase the available cover for granivores. The Laboratory found that biomass production corresponded with the amount of rainfall distribution, with wetter years producing greater biomass. From 1998 through 2001, annual grass plots types typically had higher biomass production than Nevada bluegrass plots. However, there was very little difference between the plot types after 2001. Similarly, while the density of Nevada bluegrass in the plots that were started with Nevada bluegrass was greater than the plots that were started in the annual grass plot, the density of Nevada bluegrass has declined in both plot types since 2006 (Carlsen *et al.* 2012).

Community cover estimates were examined for all three Droptower sites. Initially, the percent cover of each species present, the percent of bare ground, and the percent of thatch were estimated at each plot during the spring census from 2001 to 2011 (Carlsen *et al.* 2012). The percent mean cover, constancy (the number of times the species is in a plot divided by the number of plots), and importance value (the percent mean cover added to constancy) for each species were calculated from this data. High importance values indicate that a particular species covers more of the plot, has a greater number of individuals in each plot, or a combination of the two factors. Between 2007 and 2011, the Laboratory found the non-native soft chess (*Bromus hordeaceus*), the non-native redstem filaree (*Erodium cicutarium*), and non-native oats (*Avena* sp.) had higher importance values at all three Droptower sites. Occasionally, other species had higher importance values at a particular site: the native miniature lupin (*Lupinus bicolor*) and an unknown Poaceae at the Droptower (Flashing) site; the native Nevada bluegrass and native small fescue (*Vulpia microstachys*) at the Droptower (Fire Frequency) site; and the non-native ripgut brome (*Bromus diandrus*), the non-native foxtail chess (*Bromus madritensis*), the non-native rattail fescue (*Vulpia myuros*), and the native goose grass (*Gallium aparine*) at the natural Droptower site. Since 2007, the Shannon's index values for the natural Droptower, the Droptower (Flashing), and the Droptower (Fire Frequency) sites ranged from 1.68 to 2.65, 2.51 to 2.69, and 2.23 to 2.60, respectively. The number of species for each site ranged from 13 to 24, 30 to 36, and 23 to 29, respectively (Carlsen *et al.* 2012).

Five-Factor Analysis

The following five-factor analysis describes and evaluates the threats attributable to one or more of the five listing factors outlined in section 4(a)(1) of the Act.

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Invasion of Annual Non-native Grasses

The primary threat to the large-flowered fiddleneck identified at the time of listing was the invasion of aggressive *Amsinckia* species and annual non-native grasses into the grassland

habitat, which are able to outcompete the fiddleneck. Pavlik *et al.* (1993) presented evidence that the low fecundity of the fiddleneck is the result of intense competition with annual invasive grasses rather than competition with its congeners. Competition with exotic annual grasses resulted in a logarithmic decrease in fiddleneck nutlet production, while the fiddleneck's nutlet production decreased linearly in response to competition from native perennial grasses (Carlsen 1996). While the threat of invasion of aggressive *Amsinckia* species has diminished, the threat of invasion of annual non-native grasses continues throughout its range.

Habitat Conversion

Additionally, habitat conversion associated with agricultural conversion, intensive livestock grazing, and other land-use activities that altered the natural plant communities was listed as a threat at the time of listing. The Recovery Plan (Service 1997) further clarifies the last point as urbanization. Agricultural conversions were not identified as a threat in the last status review. Grazing is discussed in Factor C.

Anthropogenic disturbance from the construction of the drop tower above the natural Droptower site has been suggested to be one of the causes for the extirpation of that population. A memorandum of agreement was signed in 2000 between the U.S. Department of Energy and the Service (Yuan-Soo Hoo and White 2000). This memorandum of agreement limits the future use of the *Amsinckia grandiflora* Reserve (Reserve), the area of the Laboratory's Site 300 where the natural Droptower population and the research-focused Droptower populations occur, to existing projects and to ongoing Laboratory operations related to safety, fire protection, environmental compliance, security, maintenance, and support for groundwater cleanup activities under the Comprehensive Environmental Response, Compensation and Liability Act of 1980. The threat of additional disturbance on Site 300 has been reduced since the implementation of this memorandum of agreement.

The threat of urbanization has been reduced since listing, partly due to the implementation of Habitat Conservation Plans and placement of conservation easements that help direct development away from areas that may be suitable for the fiddleneck. In addition, Habitat Conservation Plans allow a mechanism to preserve land in perpetuity for the species covered by their respective plans. Habitat Conservation Plans are discussed further in Factor D.

The Carnegie Canyon population is the only known extant natural population and is currently located on semi-public land that is protected by a conservation easement, although not specifically for the fiddleneck. The two Droptower populations occur on the 160-acre *Amsinckia Grandiflora* Reserve on federal land. The three populations in Phase 2 of VNLC's reintroduction effort are on properties that are not adequately protected.

Fires on Site 300

At the time of listing, fires resulting from activities on the Laboratory's Site 300 were listed as a threat to the fiddleneck. Following the memorandum of agreement between the U.S. Department of Energy and the Service, the use of fires on Site 300 will follow guidelines established under the Endangered Species Act consultation process for the conservation of the fiddleneck and its habitat. The previous status review discusses this agreement. This threat has been reduced.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

At the time of listing, we stated that the fiddleneck had an unusual flower morphology and highly restricted distribution. Consequently, the species had been the subject of a number of studies concerning the reproductive biology and evolution of *Amsinckia*. However, we are not aware of any impacts due to overutilization.

FACTOR C: Disease or Predation

At the time of listing, it was thought that grazing might have been responsible, in part, for the extirpation of some populations, which led to grazing being considered a threat in the previous status review. It is now believed that grazing itself is not a threat, rather the threat is an inappropriate grazing regime (Service 2019). Grazing, or a similar activity, is needed to keep the grassland community at an appropriate density to support the life cycle of the fiddleneck; too little grazing can result in increased plant density, which may or may not include non-native invasive species. However, too much grazing can increase the risk of trampling. This threat is applicable to all populations except those occurring on Laboratory property, which does not allow grazing on their property and must use another activity to keep the density of the grassland community at an appropriate level.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

At the time of listing, the California Endangered Species Act was not considered to provide adequate protection to the species in its natural habitat. There are several state and federal laws and regulations that are pertinent to federally listed species, each of which may contribute in varying degrees to the conservation of federally listed and non-listed species. These laws, most of which have been enacted in the past 30 to 40 years, have greatly reduced or eliminated the threat of wholesale habitat destruction.

State Protections in California

The State's authority to conserve rare wildlife and plants is comprised of four major pieces of legislation: the California Endangered Species Act, the Native Plant Protection Act, the California Environmental Quality Act, and the Natural Community Conservation Planning Act.

California Endangered Species Act (CESA) and Native Plant Protection Act: The CESA (California Fish and Game Code, section 2080 *et seq*.) prohibits the unauthorized take of State-listed threatened or endangered species. The Native Plant Protection Act (Division 2, Chapter 10, section 1908) prohibits the unauthorized take of State-listed rare or endangered plant species. Pursuant to CESA, it is unlawful to import or export, take, possess, purchase, or sell any species or part or product of any species listed as endangered or threatened. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. The fiddleneck is listed as endangered.

Under the Native Plant Protection Act, where landowners have been notified by the State that a rare or endangered plant is growing on their land, the landowners are required to notify the

California Department of Fish and Wildlife 10 days in advance of changing land use in order to allow salvage of listed plants. We do not consider salvage to provide adequate protection.

California Environmental Quality Act (CEQA): The CEQA requires environmental review of any project that is undertaken, funded, or permitted by the State or a local governmental agency with the potential to impact the environment. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved.

Natural Community Conservation Planning Act: The Natural Community Conservation Program is a cooperative effort to protect regional habitats and species. The program helps identify and provide for area wide protection of plants, animals, and their habitats while allowing compatible and appropriate economic activity. Many Natural Community Conservation Plans are developed in conjunction with Habitat Conservation Plans prepared pursuant to the Federal Endangered Species Act.

Federal Protections

National Environmental Policy Act (NEPA): NEPA (42 U.S.C. 4371 *et seq*.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by federal agencies. Prior to implementation of such projects with a federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the federal agency must propose mitigation alternatives that would offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public.

Endangered Species Act (Act): The Endangered Species Act of 1973, as amended (Act), is the primary federal law providing protection for the fiddleneck. The Service has responsibility for administering the Act, including sections 7, 9, and 10 that address take. Section 9 prohibits the taking of any federally listed endangered or threatened species. Take is defined in Section 3 as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Harass is defined by Service regulations at 50 CFR 17.3 as an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Harm is defined by the same regulations as an act which actually kills or injures wildlife. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering. The Act provides for civil and criminal penalties for the unlawful taking of listed species.

Since listing, the Service has analyzed the potential effects of federal projects under section 7(a)(2), which requires federal agencies to consult with the Service prior to authorizing, funding, or carrying out activities that may affect listed species. For projects without a federal nexus that would likely result in incidental take of listed species, the Service may issue incidental take

permits to non-federal applicants pursuant to section 10(a)(1)(B). Incidental take is defined as take that is incidental to, and is not the purpose of, the carrying out an otherwise lawful activity (50 CFR 402.02). To qualify for an incidental take permit, applicants must develop, fund, and implement a Service-approved Habitat Conservation Plan that details measures to minimize and mitigate the project's adverse impacts to listed species. Many of these Habitat Conservation Plans are coordinated with the State of California's related Natural Community Conservation Planning program.

The status of the fiddleneck as a species listed under the Act has reduced the severity of the effects of habitat loss due to habitat conversion. The species' listed status can also reduce the severity of the effects of habitat loss due to the invasion of annual non-native grasses into the grassland habitat, which continues to be a threat to the fiddleneck throughout its range (see Factor A). Development projects that are subject to section 7 consultation or result in the issuance of an incidental take permit under section 10 typically include habitat compensation, which can reduce the severity of overall habitat loss typically associated with these projects. Habitat compensation can occur via a variety of mechanisms, including the purchase of credits at approved conservation banks, through permittee responsible mitigation, and through the development of Habitat Conservation Plans.

Habitat Conservation Plans:

Habitat Conservation Plans are planning documents required as part of an application for an incidental take permit. They describe the anticipated effects of the proposed taking; how those impacts will be minimized or mitigated; and how the Habitat Conservation Plan is to be funded. Habitat Conservation Plans can apply to both listed and non-listed species, including those that are candidates or have been proposed for listing. Regional Habitat Conservation Plans develop large-scale conservation strategies within a specific region that are designed to conserve functional ecological systems and the covered species that depend on them. Such Habitat Conservation Plans aim to avoid a fragmented conservation landscape by working with local land use authorities and a designated implementing entity to conserve, enhance, and manage a preserve system. Project-level Habitat Conservation Plans are designed to fully offset the impacts associated with the permitted activity by contributing to a larger conservation design.

Being included as a covered species under a Habitat Conservation Plan can result in habitat being set aside and managed for the species as mitigation for impacts associated with covered activities, such as planned urban development, within the Habitat Conservation Plan permit area. In addition to mitigation, avoidance, minimization, and other conservation measures (e.g. monitoring, seasonal work windows, habitat management, etc.) are implemented. Habitat Conservation Plans can also utilize banks, in-lieu fee programs, or other mechanisms to preserve habitat in perpetuity and contribute to a regional conservation strategy.

There are three Habitat Conservation Plans that include the large-flowered fiddleneck as a covered species: the San Joaquin Multispecies Habitat Conservation Plan (permit issued in 2001), the East Contra Costa County Habitat Conservation Plan/Natural Community Conservation Plan (permit issued in 2007), and the Pacific Gas and Electric San Joaquin Valley Operations and Maintenance Habitat Conservation Plan (permit issued in 2007). None of these

Habitat Conservation Plans have preserved land specifically for the protection of the fiddleneck; however, they have preserved land that may be suitable to the fiddleneck.

More information about Habitat Conservation Plans that include the large-flowered fiddleneck as a covered species can be found at: *https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=5558.*

Recovery Implementation Team:

The Recovery Implementation Team is an appointed recovery team, per section 4(f)(2) of the Act, and is advisory to the Service. The Recovery Implementation Team is composed of members representing scientists, technical experts, managers, and stakeholders qualified to assist in implementation of recovery actions. Members are appointed by the Regional Director of the California Great Basin Region of the U.S. Department of Interior. Members must have a commitment to working collaboratively for the recovery of the species and be knowledgeable about relevant issues. The Service chooses Recovery Implementation Team members to provide the Service with technical advice, to coordinate with the Service to implement recovery actions, and to help focus available funding on critically needed recovery implementation projects. In addition, if deemed necessary by the Service, the Recovery Implementation Team may facilitate a comprehensive revision of the current Recovery Plan in order to incorporate new information on the biology and population status of the species, to provide an updated framework for addressing threats to the species, and to re-prioritize the action necessary for species recovery.

Current membership includes representatives from Reclamation, the Laboratory, the Natural Resources Conservation Service, the California Department of Fish and Wildlife, the Park District, the Water District, the Botanical Garden, and VNLC.

Summary of Factor D

In summary, the Endangered Species Act is the primary federal law that provides protection for this species since its listing as endangered in 1985. Other federal and state regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

Primitive Reproduction System

At the time of listing, the relatively primitive reproductive system of the fiddleneck was thought to put the species at a competitive disadvantage with its congeners and with non-native plants. While it is predicted that the homostylic congeners are able to colonize more quickly (Ray and Chisaki 1957), the seed output by the heterostylic fiddleneck can be similar to one of its congeners if the fiddleneck has unlimited resources (Carlsen *et al.* 2002b). Additionally, Pavlik *et al.* (1993) has shown that managers can control the amount of competition from non-native grasses with varying degrees of success on the amount of seeds produced. Habitat management

is needed for the fiddleneck to overcome its primitive reproductive system. This factor continues to threaten the fiddleneck at all sites.

Stochastic Events and Small Population Size

Additionally, the risk of stochastic extinction associated with the small number of populations and their small size continues to threaten the species. A stochastic event, a landslide, extirpated the Draney Canyon population in 1997. This threat was discussed in the last status review and largely remains unchanged. The Carnegie Canyon population is the only known extant, self-maintaining natural population. The reintroduced populations receive augmentation from stored seeds, which will allow the sites to be replanted if a localized stochastic event occurs. The two Droptower populations normally receive augmentation from seed stored at the Laboratory, but have also received plugs from VNLC's reintroduction effort. VNLC's reintroduced populations receive augmentation from fiddleneck grown at the Botanical Garden. Surveys to locate additional natural populations have yielded no positive results (VNLC 2016).

Climate Change

Climate Change continues to threaten the fiddleneck at all sites. This threat was discussed in the previous status review and remains unchanged. Current climate predictions for the San Francisco Bay Area indicate average annual maximum temperatures will increase under two different emissions scenarios (Representative Concentration Pathway 4.5 and 8.5) (Ackerly *et al.* 2018). These projections indicate the San Francisco Bay Area will see a small but imperceptible increase in the amount of annual precipitation, an increase in extreme precipitation events, and an increase in intensity and duration of drought conditions. Although the specific effects of climate change on the fiddleneck are unknown, the effects of a changing precipitation cycle including extreme wet or drought conditions in the spring, and increased fire frequency and intensity have the potential to adversely affect the species.

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners and interested parties on ways to minimize threats to listed species, and on criteria that may be used to determine when recovery goals are achieved. There are many paths to accomplishing the recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, overall, the threats have been minimized sufficiently, and the species is robust enough, to downlist or delist the species. In other cases, new recovery approaches and/or opportunities unknown at the time the recovery plan was finalized may be more appropriate ways to achieve recovery. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on progress that has been made toward recovery since the species was listed (or since the most recent 5-year review) by eliminating or reducing the threats discussed in the five-factor analysis. In that

context, progress towards fulfilling recovery criteria serves to indicate the extent to which threat factors have been reduced or eliminated.

The Service finalized the *Large-Flowered Fiddleneck (Amsinckia grandiflora) Recovery Plan* in 1997 and the *Recovery Plan Amendment for the Large-flowered Fiddleneck* in 2019. The recovery plan amendment updated the original downlisting criteria to reflect the current scientific understanding of the species' threats and conservation needs, and described delisting criteria for the species, which was lacking in the original recovery plan.

The large-flowered fiddleneck may be downlisted to threatened status when:

1. **A minimum of six management areas[6] are secured and protected from threats that caused listing initially, including urbanization, agricultural conversion, competition with invasive vegetation, and livestock overgrazing.** This criterion addresses listing factors A, C, and E.

   This criterion has not been met. The Carnegie Canyon population is the only known extant natural population and it is adequately protected from threats. As described earlier in the document, the Water District purchased the Etchelet Property as mitigation for the Los Vaqueros Reservoir expansion and placed a conservation easement over most of the property. The conservation easement is for the protection of other listed species, though the fiddleneck benefits from this protection.

   Of the reintroduced populations, only those occurring on the Laboratory property are adequately protected from threats. The memorandum of agreement protecting these populations was briefly mentioned in the last section and is described in the previous status review.

   None of the populations selected for Phase 2 of the reintroduction effort are on lands that are adequately protected. Two of the populations occur on private land and are not protected by a conservation easement or a similar protective instrument. The population on the Water District's Etchelet property is outside of the conservation easement.

2. **Sufficient information has been obtained to ensure the perpetuation of suitable habitat[7], and appropriate management, based on this information, is being implemented at each management area[6] in perpetuity.** This criterion addresses listing factors A, C, and E.

   This criterion has not been met. There are currently no defined management areas.

[6] A management area is land consisting of one or more populations of large-flowered fiddleneck and its associated community that is protected adequately to maintain ecosystem and evolutionary processes.
[7] Suitable habitat characteristics include soil quality, slope, and amount of solar radiation; a negligible amount of edge effects; and appropriate levels of grass cover and/or a grazing regime.

3. **Each management area[6] has an average of 3,000 individuals over two precipitation cycles[8] or 10 years, whichever is longer, with sufficient acreage of suitable habitat[7] to support an expanded population[1] and provide an appropriate buffer.** This criterion addresses listing factor E.

   This criterion has not been met. Assuming all populations are in one management area, the Carnegie Canyon population, which is the only population that does not receive intensive management, had 3,600 individuals when it was last monitored in 2019. Based on information provided by the Laboratory (Lisa Paterson *in litt.* 2019), this population has averaged 1,126 individuals over the previous two precipitation cycles (1997 through 2019). However, this population was not monitored between 1997 and 2010.

4. **The six management areas[6] concurrently demonstrate self-maintenance without intensive management intervention (e.g., hand-pollination, seed collection, off-site propagation) needed to prevent population decline for two precipitation cycles[8] or 10 years, whichever is longer.** This criterion addresses listing factors A, C, and E.

   This criterion has not been met. The Carnegie Canyon population is the only population that has demonstrated self-maintenance.

The fiddleneck may be downlisted to threatened status when:

Factor A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

A/1 A minimum of 12 management areas[6] that encompass sufficient acreage with suitable habitat[7] characteristics and an appropriate buffer area to conduct specific management actions have been protected in perpetuity. Twelve areas will provide sufficient redundancy for the species to withstand potential catastrophic events.

This criterion has not been met. See Downlisting Criteria 1 for more information.

Factor B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

The overutilization for commercial, recreational, scientific, or educational purposes is not known to threaten the fiddleneck at this time. Therefore, no recovery criteria have been developed for this factor.

Factor C: Disease or Predation

C/1 Predation pressure by granivores and herbivores is at a level that does not result in a declining population trend for any of the management areas over four precipitation cycles[8] or 20 years, whichever is longer.

It is unknown whether this criterion has been met. The populations regularly receive augmentation, which hides predation pressure by granivores. The reintroduced

[8] A precipitation cycle is a series of years that encompass average, above-average, and below-average rainfall conditions, starting and ending with average precipitation. The populations must demonstrate the ability to survive both precipitation extremes.

populations are protected from herbivores, specifically cattle, due to fences that are installed around the small populations when they are flowering.

Factor D: Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms is not known to threaten the fiddleneck at this time. Therefore, no recovery criteria have been developed for this factor.

Factor E: Other Natural or Manmade Factors Affecting Its Continued Existence

E/1 Each management area[6] has an average of 16,000 individuals over four precipitation cycles[8] or 20 years, whichever is longer.

This criterion has not been met. See Downlisting Criteria 3 for more information.

E/2 The twelve management areas[6] concurrently demonstrate self-maintenance without intensive management interventions (e.g., hand-pollination, seed collection, off-site propagation) needed to prevent population decline for four precipitation cycles[8] or 20 years, whichever is longer.

This criterion has not been met. The Carnegie Canyon population is the only population that has demonstrated self-maintenance.

IV. SYNTHESIS

Ongoing conservation efforts for the large-flowered fiddleneck have increased the species' distribution from the three sites within Site 300 identified in the last status review to 11 sites spread throughout the historical range. However, only one population does not receive intensive management, is considered self-maintaining, and is on property adequately protected from threats. The remaining 10 populations are used in studies whose purpose is to better understand the fiddleneck's habitat requirements. These populations are not self-maintaining, receive various levels of management, and are on lands with varying levels of protection. Two populations receive supplemental augmentation and active management and are on adequately protected lands. Three populations receive supplemental augmentation and active management but are on inadequately protected lands. Five populations no longer receive supplemental augmentation or active management and are on lands with varying levels of protection.

After reviewing the best available scientific information, we conclude that the fiddleneck continues to meet the definition of an endangered species and no change in its status is recommended at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened

____ Uplist to Endangered

____ Delist (indicate reason for delisting according to 50 CFR 424.11):

____ *Extinction*

____ *Recovery*

____ *Original data for classification in error*

__X_ No Change

New Recovery Priority Number and Brief Rationale:

No change in recovery priority number.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Continue to study the habitat requirements of the large-flowered fiddleneck to determine what factors enable sufficient recruitment to maintain population viability (i.e., self-maintenance without augmentation) and to identify future recovery sites.

2. Continue working with the Natural Resources Conservation Service to develop guidance for grazing on properties where fiddleneck occurs and grazing is allowed.

3. Ensure self-perpetuating fiddleneck populations are protected in perpetuity.

4. Continue to maintain a seed bank to have viable seeds for restoration.

5. Conduct surveys to try to locate additional natural occurrences of the fiddleneck.

6. Continue to monitor the populations selected for Phase 2 of the reintroduction effort through the remainder of the precipitation cycle.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW

Large-flowered Fiddleneck (*Amsinckia grandiflora*)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X__ No change needed

Review Conducted By: __Sacramento Fish and Wildlife Office_____

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Sacramento Fish and Wildlife Office

Approve MICHAEL FRIS Digitally signed by MICHAEL FRIS Date: 2021.04.09 09:38:08 -07'00' Date _____

APPENDIX 1 – Large-flowered Fiddleneck: Status of Occurrences, prepared for the 2021 5-year Review.

Table 1. List of all known large-flowered fiddleneck populations since listing, their general locations, their status in the 2009 status review, and their current status. The Introduction site's names were renamed to Introduction Site #1-10 since the original names are the landowner's name where they occur. Most of these populations are on private property, and we changed the names to protect the private property owner.

Population Name	Landowners[9]	County	Database Occurrence Number	Reintroduced or Natural	Status in the 2009 status review	Current Status	Current Qualitative Assessment[2]
Carnegie Canyon	Water District	San Joaquin	8	Natural	No plants seen in 2003	3,600 plants in 2019[10]	Successful
Introduction Sites #3 and #4	Private	Alameda	-	Reintroduced	-	27,000 plants in 2020. Introduction Site 3# combined with Introduction Site #4 in 2018.	Successful
Introduction Site #5	Private	San Joaquin	-	Reintroduced	-	4,350 plants in 2020	Successful
Introduction Site #6	Water District	San Joaquin	-	Reintroduced	-	10,000 plants in 2019[6, 11]	Successful
Droptower (Flashing)	Laboratory	San Joaquin	12	Reintroduced	7 plants in 2008	38 plants in 2019	Not Successful
Droptower (Fire Frequency)	Laboratory	San Joaquin	12	Reintroduced	56 plants in 2008	152 plants in 2019	Not Successful
Introduction Site #2	Park District	Contra Costa	-	Reintroduced	-	Extant[12]	Not Successful
Introduction Site #7	Water District	San Joaquin	-	Reintroduced	-	Extant[6, 7]	Not Successful
Introduction Site #9	Private	San Joaquin	-	Reintroduced	-	Extant[7]	Not Successful
Introduction Site #1	Park District	Contra Costa	-	Reintroduced	-	Possibly Extant	Not Successful

[9] The landowners' abbreviations are:
Park District – East Bay Regional Park District
Water District – Contra Costa Water District
Department – California Department of Fish and Wildlife
Laboratory – Lawrence Livermore National Laboratory

[10] Due to the COVID-19 Pandemic, access was not granted to monitor this site in 2020.
[11] The population appeared to be as large in 2020 as it was in 2019 (Jake Schweitzer, *in litt.* 2020b).
[12] This population has not been monitored since 2018; however, plants were seen in 2020.

Population Name	Landowners[9]	County	Database Occurrence Number	Reintroduced or Natural	Status in the 2009 status review	Current Status	Current Qualitative Assessment[2]
Introduction Site #10	Private	San Joaquin	-	Reintroduced	-	Possibly Extant	Not Successful
Droptower	Laboratory	San Joaquin	4	Natural	No plants seen in 2008	Extirpated	Not Successful
Draney Canyon	Laboratory	Alameda	7	Natural	Extirpated	Extirpated	Not Successful
Lougher Ridge	Park District	Contra Costa	9	Reintroduced	173 plants in 2005	Extirpated	Not Successful
Corral Hollow	Department	San Joaquin	-	Reintroduced	Extirpated?	Extirpated	Not Successful
Black Diamond II	Park District	Contra Costa	3	Reintroduced	Extirpated	Extirpated	Not Successful
Los Vaqueros I	Water District	Contra Costa	10	Reintroduced	Extirpated	Extirpated	Not Successful
Los Vaqueros II	Water District	Contra Costa	10	Reintroduced	Extirpated	Extirpated	Not Successful
Connolly Ranch	Private	San Joaquin	11	Reintroduced	Extirpated	Extirpated	Not Successful
Introduction Site #8	Private	San Joaquin	-	Reintroduced	-	Extirpated	Not Successful

Sources:
Lisa Paterson, *in litt.* 2019
Jake Schweitzer, *in litt.* 2020b