

State of California
Natural Resources Agency
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION
FIVE-YEAR STATUS REVIEW OF BAKER'S LARKSPUR (*Delphinium bakeri*)

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Baker's larkspur, CDFW photo by Doreen Smith

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I. EXECUTIVE SUMMARY

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

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

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

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

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

II. INTRODUCTION

A. Five-Year Status Review

This Five-Year Status Review addresses Baker's larkspur (*Delphinium bakeri* Ewan), which is designated as an endangered species under the California Endangered Species Act (CESA) (Fish and G. Code, § 2050 et seq.; Cal. Code Regs., tit. 14, § 670.2, subd. (a)(27)(A)). Upon a specific appropriation of funds by the Legislature, the California Department of Fish and Wildlife (Department) shall, or if other funding is available, in the absence of a specific appropriation, may, review species listed as endangered or threatened under CESA every five years to determine if the conditions that led to the original listing are still present (Fish and G. Code, § 2077, subd. (a)). Baker's larkspur is also listed as endangered under the Federal Endangered Species Act. Pursuant to Fish and Game Code section 2077, subdivision (b), the U.S. Department of the Interior, U.S. Fish and Wildlife Service (USFWS) was contacted in an effort to coordinate this status review with their five-year review process (under review in 2019) (Prevost, pers. comm. 2019).

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

B. Listing and Status Review History

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

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

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

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

III. BIOLOGY

A. Taxonomic and Physical Description

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

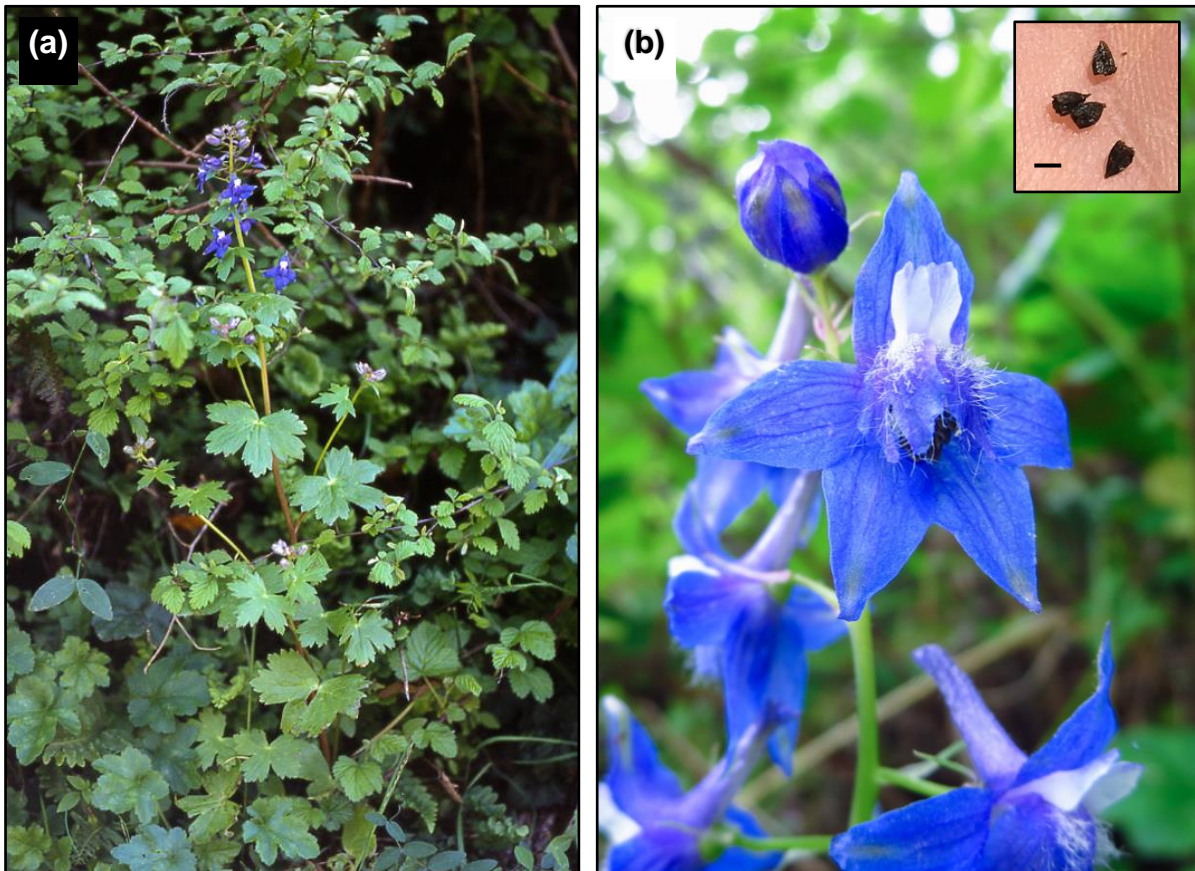


FIGURE 1. Photos of Baker's larkspur (*Delphinium bakeri*). (a) A mature plant in bloom, and (b) the flowers of Baker's larkspur, with a close-up of the seeds shown in the inset (scale bar = 1 mm). Photos (a) and (b) by Holly Forbes (inset by Raffica La Rosa).

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

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

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

B. Life History and Ecology

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

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

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

C. Habitat Necessary for Species Survival

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

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

i. Vegetation Communities

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

ii. Geology and Soils

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

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

iii. Climate and Hydrology

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

IV. DISTRIBUTION AND ABUNDANCE

A. Range and Distribution

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

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

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

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

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

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



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

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

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

¹Element Occurrence, CNDDDB

²Assessor’s Parcel Number

³Taken from county parcel ownership data

⁴Exact location unknown

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

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

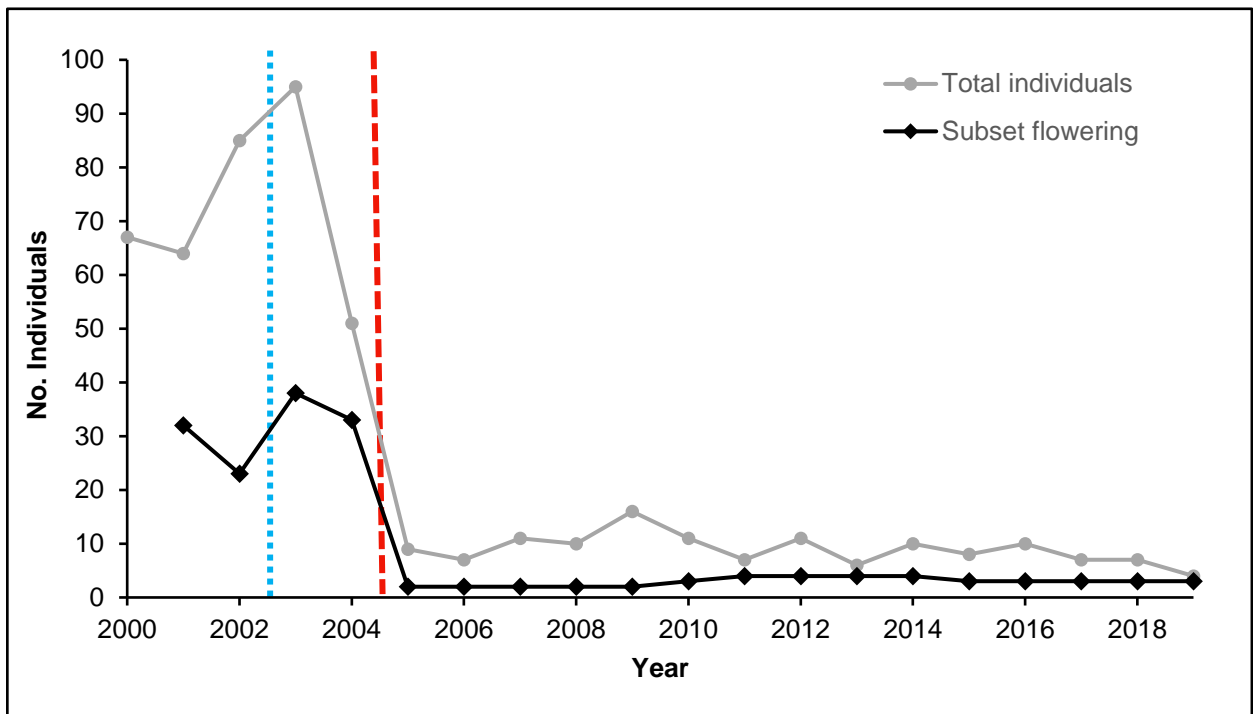


FIGURE 3. Population trend of Baker's larkspur (*Delphinium bakeri*). Population size (gray) and the subset of individuals that were flowering (black) at the naturally occurring Marshall Petaluma Road population (CNDDDB EO #1) between 2000-2019. The dotted blue line indicates when the population was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

(a) 2001



(b) post-mowing in 2002



(c) post-fire in 2004

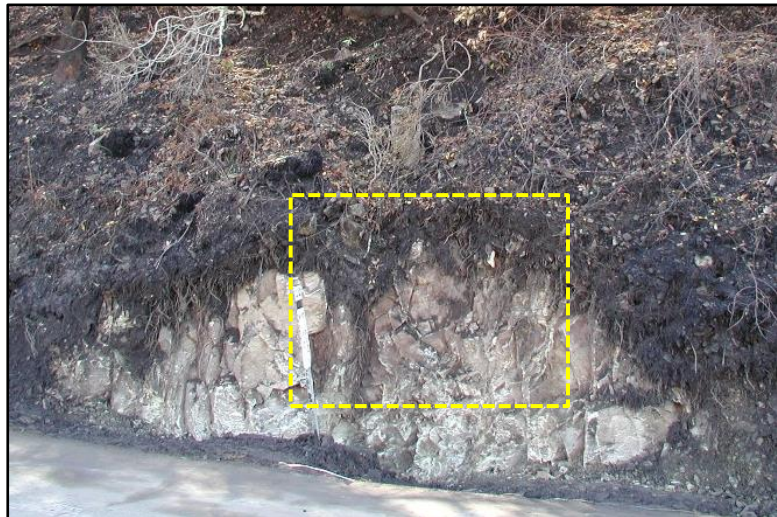


FIGURE 4. Threats to Baker's larkspur (*Delphinium bakeri*) on Marshall Petaluma Road. Photos of the Marshall Petaluma Road population (CNDDDB EO #1) between 2001 and 2004 when the population was severely reduced by natural and human causes. Photos show the population (a) in 2001, (b) after mowing in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

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

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

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

B. Population Trend and Abundance

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

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

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

In the winter of 2004, a fire created conditions that led to a mudslide that filled the culvert below the roadcut on which the plants were growing (Figure 4c). The road subsequently flooded, and a Marin County emergency road crew cleared the culvert to recover proper drainage. In addition, several meters above the culvert was also excavated down to bedrock, which reduced the population of Baker's larkspur to just nine individuals (Figure 4d; Figure 3, red dashed line). The population has not recovered from these events (Figure 3). After these events, the population has consistently had between 6-16 plants, with 2-4 reproductive individuals annually. Consequently, any seeds produced by this population have a greater likelihood of being inbred, which will reduce the genetic variation of the population.

- *Chileno Valley Ranch* – In December 2009, a total of 45 mature Baker's larkspur plants were outplanted into three introduction sites at this location. The sites were in close proximity and fenced to exclude cattle. In January 2011, 30 additional plants were added to the same three sites. As of 2018, these three sites had failed to become established populations (Table 2). In winter 2018/2019, 28 individuals were outplanted into a new site on the property. It will be several years before the success of this introduction can be determined.
- *Soulajule Reservoir* – In January 2010, 40 mature Baker's larkspur plants were outplanted into one introduction site near the southwest edge of the reservoir. In January 2011, 70 mature plants were outplanted in two additional nearby introduction sites (35 plants each). These two sites were abandoned after they stopped producing flowers and seeds in 2014. Plants in the three sites flowered well initially, but only the first site near

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

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

V. THREATS AND SURVIVAL FACTORS

A. Factors Affecting Ability to Survive and Reproduce

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

- *Present or threatened modification or destruction of its habitat* – Conversion of land to “grainfields” (Ewan 1942), along with conversion to grazing land and the encroachment of non-native grasslands, led to the extirpation of the two historical populations. Similar land conversions are ongoing and have reduced possible habitat across the historical range of Baker’s larkspur (Forbes, in litt. 2004). Lack of adequate habitat also diminishes the chances of the Marshall Petaluma Road population expanding beyond its current restricted habitat. If not collected, most seeds produced by the Marshall Petaluma Road population currently fall into the culvert or fall onto the paved road. Furthermore, habitat of the natural population could be reduced by future road maintenance or efforts to upgrade or widen the county road.
- *Overexploitation* – In 1992, all seeds that were produced by the Marshall Petaluma Road population were taken illegally, possibly for horticultural purposes (USFWS 2000; CDFG 2005). The poacher was never identified, and the seeds were not recovered. Removing the yearly reproductive output for an entire population can negatively impact the species. There has not been any evidence of this type of activity since, however it remains a threat as larkspurs produce showy flowers, and horticultural trade markets for rare plants could shift, making rare larkspurs highly desirable.
- *Human-related activities* – At the time of listing, the only remaining natural population had suffered several setbacks that reduced its population size to just nine plants. The most impactful activities were associated with roadside maintenance. There were two poorly timed mowing events that destroyed plants before they could fully set seed. The most damaging event occurred in October 2004 after a fire burned the area, resulting in a mudslide that filled the culvert below the population. Road crews used a backhoe to clear the culvert, and in the process excavated the entire slope above the culvert down to bedrock; this was where most of the population was located, and the natural population has not recovered from this event.

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

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

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

- *Competition* – Baker's larkspur competes with surrounding vegetation for resources such as sunlight. At the Marshall Petaluma Road population, the ecological succession of the roadside (i.e., the change of the plant community over time) has been ongoing since the backhoe removed all soil down to bedrock. Since then, detritus has collected, new soil has been deposited, and Marin County has refrained from mowing the area where Baker's larkspur grows, so the surrounding vegetation has rebounded and Baker's larkspur faces increased competition from encroaching woody shrubs.
- *Predation* – Baker's larkspur faces predation from animals that eat its leaves, stems, or seeds. Loss of individuals throughout the season due to herbivory has been identified through monthly censuses (UCBG). Herbivory by slugs has been the primary threat to the populations that have been introduced into sites near Marshall Petaluma Road, and is partially responsible for their inability to become established populations that do not require consistent human intervention. For plants that can successfully reproduce and set seed, seed predation is another event that hinders success of the introduced populations and survival of the natural population.

B. Degree and Immediacy of Threats

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

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

MANAGEMENT AND RECOVERY

A. Impact of Existing Management Efforts

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

i. Marshall Petaluma Road Population Monitoring

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

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

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

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

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

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

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

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

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

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

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

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

VI. RECOMMENDATION TO THE COMMISSION

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

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

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

Series	Site(s)¹	Population type²	Texture	Topsoil	Cation activity	Soil group
Barnabe ³	T	N	loamy-skeletal	mixed	active	isomesic lithic haplustolls
Blucher	CM, T	N	fine-loamy	mixed	superactive	thermic fluvaquentic haploxerolls
Bonnydoon	CVR, SR	I	loamy	mixed	superactive	thermic shallow entic haploxerolls
Cole ⁴	T	N	fine	mixed	superactive	thermic pachic argixerolls
Kneeland	CM	N	fine-loamy	mixed	superactive	isomesic ultic haploxerolls
Los Osos ⁵	CVR	I	fine	smectitic	none	thermic typic argixerolls
McMullin	MPR, SR	N, I	loamy	mixed	superactive	mesic lithic ultic haploxerolls
Saurin	SV	I	fine-loamy	mixed	superactive	thermic typic haploxerolls
Tocaloma	MPR, SR, SV	N, I	fine-loamy	mixed	superactive	mesic typic haploxerolls

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

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

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

⁴Part of a soil complex with the Blucher series

⁵Part of a soil complex with the Bonnydoon series