

State of California  
Natural Resources Agency  
Department of Fish and Wildlife

REPORT TO THE FISH AND GAME COMMISSION

FIVE-YEAR SPECIES REVIEW OF MILO BAKER'S LUPINE (*Lupinus milo-bakeri*)

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Milo Baker's lupine, CDFW photo by Jeb Bjerke

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## I. EXECUTIVE SUMMARY

Milo Baker's lupine (*Lupinus milo-bakeri* C.P. Smith) is currently listed as threatened under the California Endangered Species Act (CESA). The California Department of Fish and Wildlife (Department) has prepared this Five-Year Species Review pursuant to Fish and Game Code section 2077, subdivision (a) to evaluate whether conditions that led to the original listing of Milo Baker's lupine are still present. This species review is based on the best scientific information currently available to the Department regarding each of the components listed under section 2072.3 of the Fish and Game Code, and Section 670.1, subdivisions (d) and (b)(6)(C), of Title 14 of the California Code of Regulations. In addition, this document contains a review of the identification of habitat that may be essential to the continued existence of the species, and the Department's recommendations for management activities and other recommendations for recovery of the species (Fish & G. Code, § 2077, subd. (a)).

Milo Baker's lupine is an annual herb in the legume family (Fabaceae) and is about 1-2 m (3-6 ft) tall, commonly with blue flowers that yellow with age. This species is endemic to (exists only in) California, and its range is restricted to Round Valley in eastern Mendocino County and Bear Valley in western Colusa County. Many of the occurrences are on privately owned land, tribal land, or in state-controlled road rights-of-way. Milo Baker's lupine was uplisted from rare to threatened in 1987, and at that time it was known from only 14 small occurrences along roadsides or in grasslands on ancient river deposits. Today only one occurrence of Milo Baker's lupine is confirmed to still exist. This lone roadside occurrence is extremely vulnerable and is at risk of extinction.

At the time of listing in 1987, the Department described the major threats as: urbanization, road improvement, and herbicide application (CDFG 1986a). These same threats remain today, with road maintenance (e.g., mowing, widening, resurfacing, and herbicide application) posing the biggest threat. Milo Baker's lupine is also susceptible to new threats including competition from surrounding invasive shrubs and vines, water diversions for agriculture, including unpermitted *Cannabis* grows, and loss of genetic diversity.

With only one remaining extant occurrence of Milo Baker's lupine, the recovery of the species will require sustained cooperation between state agencies, collaboration with private landowners, and consultation with local tribes to protect the known remaining subpopulations, quantify the genetic diversity of this natural population, and conduct surveys to determine if additional populations may exist. Additional information will also be needed to determine suitable habitat for the reintroduction of Milo Baker's lupine within its known range.

In completing this Five-Year Species Review for Milo Baker's lupine, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Milo Baker's lupine as threatened have worsened, and recommends a change in the status of Milo Baker's lupine from threatened to endangered. The Department's recommendation shall be further considered by the Fish and Game Commission as a petition with a Departmental recommendation to accept and consider the petition (Fish and G. Code § 2072.7).

## **II. INTRODUCTION**

### **A. Five-Year Species Review**

This Five-Year Species Review addresses Milo Baker's lupine (*Lupinus milo-bakeri* C.P. Smith), which is designated as a threatened species under the California Endangered Species Act (CESA) (Fish and G. Code § 2050 et seq.; Cal. Code Regs. tit. 14 § 670.2, subd. (b)(6)(C)). 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)). Milo Baker's lupine is not listed under the Federal Endangered Species Act, and thus has no specific federal protections.

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

### **B. Listing and Review History**

In 1978, the Department recommended that Milo Baker's lupine be listed as endangered under Fish and Game Code, section 1901, the Native Plant Protection Act (NPPA). On October 6, 1978, the Fish and Game Commission (Commission) voted to list Milo Baker's lupine as rare, rather than endangered. At the time of the initial listing, the main identified threats to the species included: present or threatened modification or destruction of its habitat (e.g., urban expansion and road widening) and other human-related activities, such as the application of herbicides (CDFG 1978).

In 1986, the Department recommended uplisting Milo Baker's lupine from rare to threatened under the California Endangered Species Act (CESA) (CDFG 1986a). The uplisting was effective on February 15, 1987. The Department has not previously conducted a five-year species review of Milo Baker's lupine. This Five-Year Species Review was prepared by Dr. Raffica La Rosa in the Department's Native Plant Program within the Habitat Conservation Planning Branch.

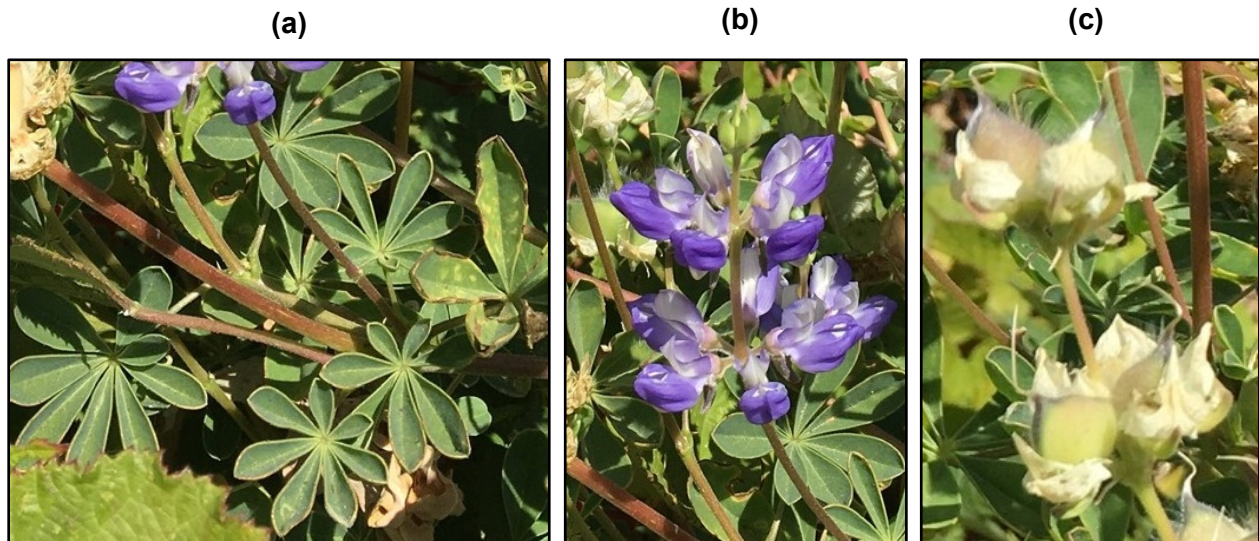
### **C. Notifications and Information Received**

On November 26, 2019, the Department notified persons who had expressed their interest in CESA actions in writing to the Commission that a five-year review was planned for Milo Baker's

lupine (Fish and G. Code, § 2077(a)). The e-mail notification included a link to the Department's web page for five-year species reviews of threatened and endangered species.

#### D. Taxonomic and Physical Description



Milo Baker's lupine was first described by Charles Piper Smith (1940). It is an annual herb in the legume family (Fabaceae). Sholars (2012) described the vegetative and reproductive characters and measurements of Milo Baker's lupine. The plants are tall, reaching 1-2 m (3.3-6.6 ft). The stems of Milo Baker's lupine are smooth with a light waxy coating and plants can have many branches. The leaves are palmately compound, consisting of 7-9 leaflets originating from a single point (Fig. 1a). Leaflets are 10-30 mm (0.4-1.2 in) long, 4-9 mm (0.2-0.4 in) wide, with hairy adaxial (upper) surfaces. Milo Baker's lupine blooms June-September. The inflorescences are at the ends of the branches, and they measure 5-22 cm (0.2-0.9 in) in length, having flowers clustered in one to several whorls. Each flower (Fig. 1b) is 10-16 mm (0.4-0.6 in) and is commonly pale blue-purple, rarely yellow, but fading to yellow with age. The peapod-like fruits (Fig. 1c) are hairy, contain up to two dark brown seeds when ripe, and are 1 cm (0.4 in) long.



**Figure 1. A Milo Baker's lupine plant** showing the (a) leaves, (b) flowers, and (c) fruits. Photos by Raffica La Rosa.

Milo Baker's lupine has sometimes been taxonomically lumped with butter lupine (*Lupinus luteolus* Kellogg), but these two species differ significantly and reliably in a number of ways and are currently considered to be distinct species (Table 1) (Sholars 2012). Milo Baker's lupine grows much taller than butter lupine and it flowers later in the season. The flowers of butter lupine are yellow, but flowers of Milo Baker's lupine are typically blue until they age, when they become yellowed. The stems of Milo Baker's lupine are pithy until late in life when the plants produce seeds.

**Table 1. Traits to distinguish between Milo Baker's lupine and butter lupine** (Knight 1965). Leaflet shape images are from Wikimedia Commons contributors (2006a, 2006b).

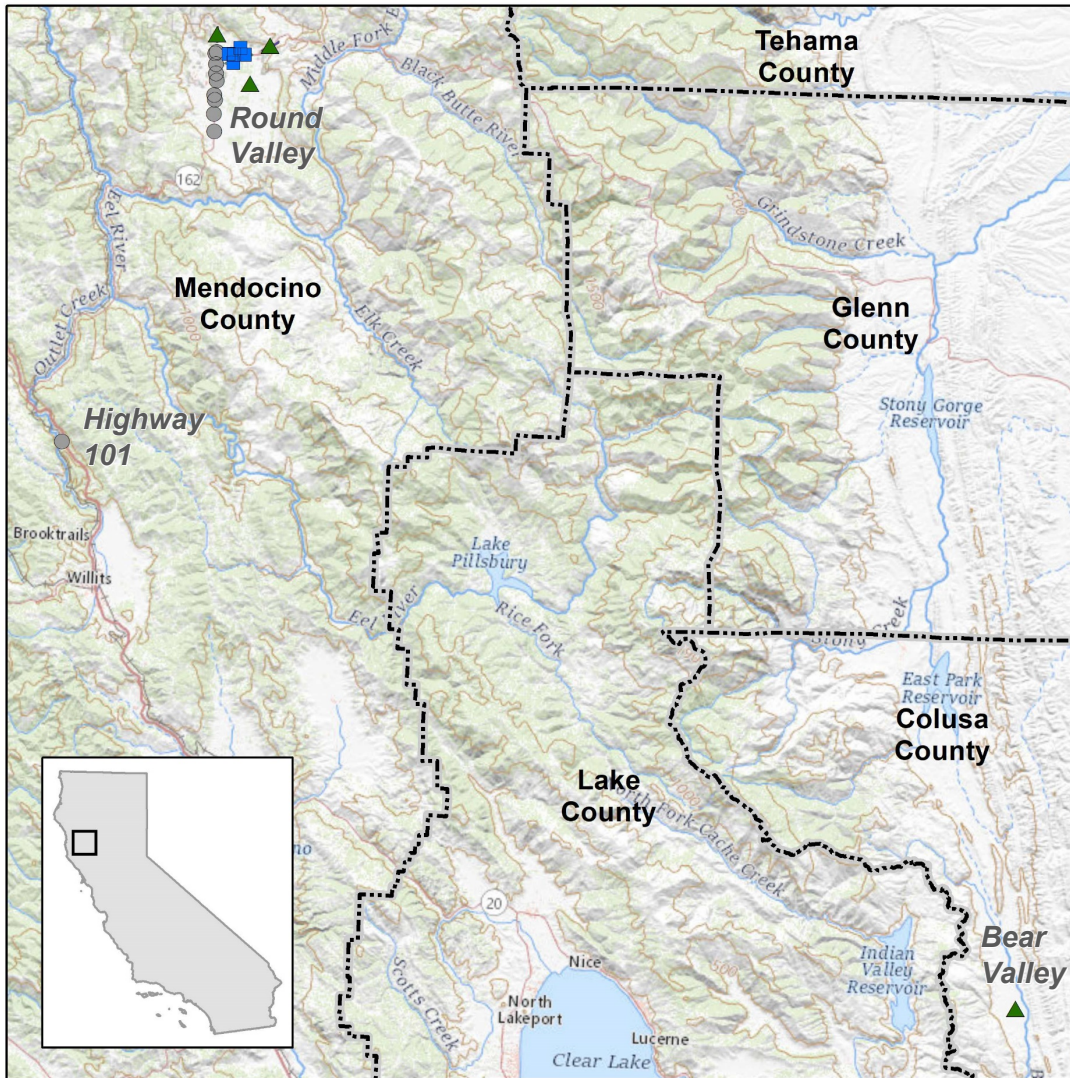
Trait	Milo Baker lupine ( <i>Lupinus milo-bakeri</i> )	butter lupine ( <i>Lupinus luteolus</i> )
<b>Status in late June</b>	young inflorescences that are not yet flowering	mostly in fruit with only a few flowers remaining
<b>Height</b>	greater than 75 cm (29 in)	less than 75 cm (29 in)
<b>Leaflet keel angle</b>	keeled (folded along the midrib) to ~45 degrees	keeled (folded along the midrib) to ~90 degrees
<b>Leaflet shape</b>	 oblong	 obovate to suboblong
<b>Flower color</b>	most flowers are blue, becoming pale yellow in age	yellow
<b>Stem</b>	has pith until seed stage, becoming hollow with age	generally hollow during its life

### III. DISTRIBUTION AND ABUNDANCE

#### A. Range and Distribution

Milo Baker's lupine was first collected by Milo S. Baker two miles east of Covelo on Ranger Station Road on August 12, 1940. It was described and named later that year by Charles Piper Smith (1940). Natural occurrences of Milo Baker's lupine have been documented from only two regions of California—in the Outer North Coast Range at about 410 m (1350 ft) elevation in Round Valley in Mendocino County and the Inner North Coast Range at about 402 m (1320 ft) elevation in Bear Valley in western Colusa County (Sholars 2012, CNDDDB 2019). An additional occurrence from Highway 101 near Longvale was documented (CNDDDB 2019), but Milo Baker's lupine is presumed to have been unintentionally introduced there. The historical range of Milo Baker's lupine is unknown but may have extended beyond Round Valley and Bear Valley.

The distribution of Milo Baker's lupine is documented within the California Natural Diversity Database (CNDDDB). The CNDDDB documents “elements,” which are plant or animal taxa, or natural communities that are of conservation concern within California. For plants, an “element occurrence” (EO; occurrence) is a location record for a site which contains an individual, population, or a cluster of subpopulations of a special status element. Populations, individuals, or subpopulations that are located within 0.4 km (0.25 mi) of each other generally constitute a single occurrence (Bittman 2001).



California Department of Fish and Wildlife, Habitat Conservation Planning Branch, D.Mastalir, 20200618  
 Basemap Source: ESRI USGS Topo

Milo Baker's lupine California Natural Diversity Database Occurrences	
■	Known to be extant
▲	Presumed extant
●	Possibly extirpated

**FIGURE 2. Distribution and range map of Milo Baker's lupine.** The subpopulations of the only confirmed extant population are shown with blue squares. Populations that are presumed extant by CNDDDB are shown as green triangles, and those possibly extirpated are gray circles (CNDDDB 2019).



At the time of listing in 1987, the Department was aware of 14 occurrences where Milo Baker's lupine had been previously documented. Twelve of these occurrences were in Round Valley near Covelo. In 1984, 11 of these 12 occurrences may have been negatively impacted by the application of herbicide intended to target unwanted brush on the sides of roads and increase visibility for motorists; six of these Milo Baker's lupine occurrences may have been extirpated in the process or were already extirpated. In addition to the occurrences in and around Covelo, there is a record of one occurrence along Highway 101 near Longvale southwest of Covelo, and a record of one occurrence in Bear Valley to the southeast (Fig. 2). In 2020, only one occurrence (EO 2) is confirmed to be extant, and another five are listed as "presumed extant" in the CNDDDB (Figs. 2 and 3); however, recent surveys and data collected by the Department, but not yet incorporated into the CNDDDB, may change the status of these occurrences from "presumed extant" to "possibly extirpated" in the coming year. The main regions where Milo Baker's lupine has been documented are as follows:

- Round Valley (EOs 1-12, 14-16, and 19) – This area in Mendocino County is the source of the original 1940 collection that would later be named Milo Baker's lupine. The plants now grow only along the side of Highway 162 and associated crossroads. There were originally 12 occurrences in Round Valley in the mid-1980s. Some of these occurrences have been collapsed into single EOs due to their close proximity. The single confirmed extant occurrence (EO 2) consists of five subpopulations (A-E) and occurs 3.2 km (1.9 mi) northeast of Covelo (Fig. 3).
- Bear Valley (EO 18) – This occurrence is on Bear Valley Ranch in Colusa County, about halfway between Clearlake and Maxwell. Bear Creek and its associated tributaries run through the valley, and the description from the 1985 herbarium specimen (CMNHH 1985) describes Milo Baker's lupine as growing on mostly heavy black clay soil near the edges of gullies that are very wet in the springtime. When this occurrence was discovered in 1985, it was taxonomically intermediate between Milo Baker's lupine and butter lupine (Table 1), but taxonomists identified it to be Milo Baker's lupine. Department staff revisited this occurrence on July 17, 2020 and found only butter lupine in the area where Milo Baker's lupine was allegedly found in 1985 (Appendix A). Consequently, Milo Baker's lupine has not been seen at this occurrence since 1985 (Table 2). Genetic study of the 1985 herbarium specimen and specimens collected in 2020 may be able to clearly confirm the species identity.
- Highway 101 (EO 13) – This occurrence is near Longvale in Mendocino County. Over 100 plants were seen at this occurrence, but only in 1985 and 1986. John Booth, from the Department, along with current Department staff suspected that seeds were unintentionally moved to this location as the result of the dumping of road scraping spoils piles by Caltrans and Mendocino County road crews in this area (CNDDDB 2019). Milo Baker's lupine has not been seen at this location since 1986 (Table 2).

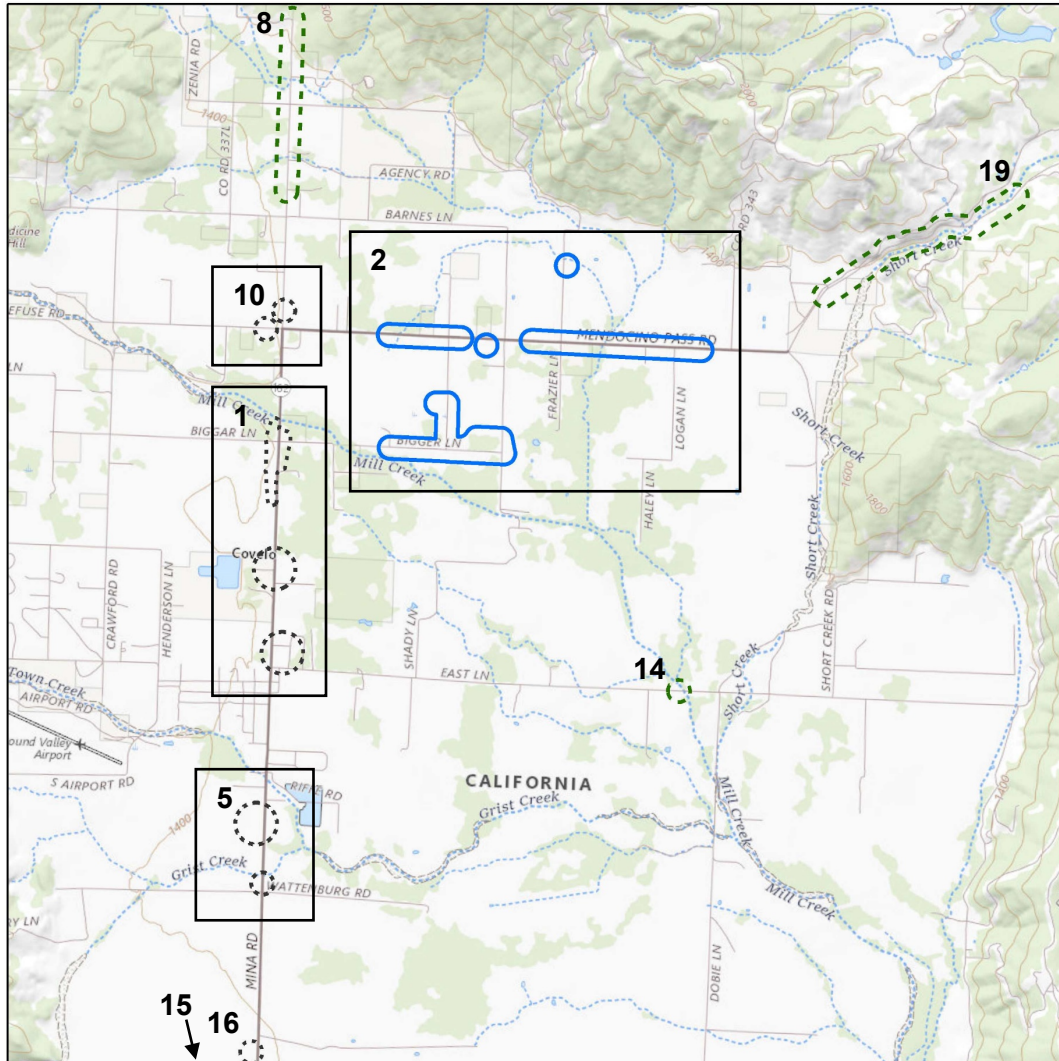
**TABLE 2. Element occurrences (EOs) listed in the CNDDDB** giving their origin, location, years last surveyed, and when Milo Baker's lupine was last seen at each occurrence. Sources: (CNDDDB 2019, Frederickson et al. 2020, Garrison 2020b, Leppig 2020)

EO #	Natural/ Introduced	Location	Year last surveyed	Presence last confirmed	Notes
1	Natural	Round Valley; Covelo	2016	1986	
2	Natural	Round Valley; Covelo	2020	2020	Only confirmed extant population
5	Natural	Round Valley; Covelo	2020	1986	
8	Natural	Round Valley; Unspecified	2016	1942	Known only from herbarium collection.
10	Natural	Round Valley; Covelo	2016	1982	
13	Likely introduced	Longvale	2016	1986	May have been introduced from road scraping spoils piles
14	Natural	Round Valley; Covelo	2016	1979	
15	Natural	Round Valley; Covelo	2016	1986	
16	Introduced	Round Valley; Covelo	2020	1986	Introduced by Caltrans in 1985
18	Natural	Bear Valley	2020	1985	May have been a variant of butter lupine rather than Milo Baker's lupine
19	Natural	Round Valley; Covelo	2016	1980	Specific location unknown

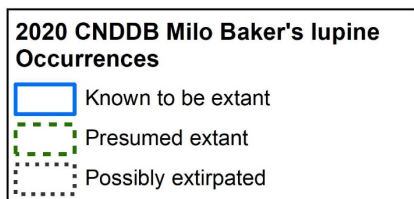
## B. Population Trend and Abundance

The single confirmed occurrence of Milo Baker's lupine (EO 2) consists of five subpopulations, A-E (Fig. 3). In 1982 and 1984, these subpopulations collectively had over 1000 plants, but they declined to near zero by 2002 (CNDDDB 2019). Herbicide treatments and poorly-timed mowing events (i.e., mowing during late flowering) were the major events that led to this decline. In 2016, Caltrans inadvertently mowed several of these subpopulations. Recovery activities by the Department and Caltrans had led to an increase in several of the subpopulations by 2019, up to a total of 208 plants. During that time, however, one of the subpopulations (EO 2E) decreased to zero plants. In 2020, early surveys in February and April found no plants at two subpopulations (EOs 2C and 2E), but the remaining three subpopulations totaled 1777 juvenile plants (Frederickson et al. 2020). A final survey of reproductive individuals is forthcoming, but based on 2019 surveys, the reduction of individuals between April to September may result in a total of 700 potentially reproductive plants by September when seeds are developing.

Milo Baker's lupine has likely declined to zero in all other occurrences since their peak population sizes in the mid-1980s. Few to no surveys of the occurrences were conducted between 1987 and 2014, but all of the occurrences have been visited within the past four years, and only one has produced Milo Baker's lupine (Fig. 3).



California Department of Fish and Wildlife. Habitat Conservation Planning Branch. D.Mastalir. 20200618  
 Basemap Source: ESRI USGS Topo



**FIGURE 3. Distribution of Milo Baker's lupine near Covelo, CA in Round Valley.** The only confirmed extant population is outlined in solid blue, presumed extant by the CNDDB is dashed green, and possibly extirpated is dotted gray. Element occurrence numbers are labeled (CNDDB 2019).

## IV. BIOLOGY

### C. Life History and Ecology

As an annual, Milo Baker's lupine relies on a seedbank to perpetuate from one generation to the next, and populations can fluctuate across years depending on conditions. It is not known how many years seeds can remain viable in the soil. Seeds generally sprout at the onset of winter rains in October-January. Plants reach reproductive maturity in June-September. Some of the pollinators that have been seen on Milo Baker's lupine include bumble bees (*Bombus* spp.) and honey bees (*Apis mellifera*) (Garrison 2019), but it is not known if plants are able to self-pollinate without pollinators or if they are even self-compatible or if pollen must be moved between plants to produce viable seeds.

Plants in the legume family often rely on a bacterial symbiosis to gain nitrogen from the atmosphere. Lupine species may form mutualisms with bradyrhizobia (*Bradyrhizobium* spp.) bacteria (Robinson et al. 2000), which are bacteria that can be found in the soil and in small root nodules of plants that have been colonized. This mutualism allows the plants to live in disturbed and nutrient-deficient habitats because they can trade some of the carbohydrates that they produce through photosynthesis to the bradyrhizobia in exchange for a plant-friendly useable form of nitrogen ( $\text{HN}_3$ ) that the bradyrhizobia have converted from atmospheric nitrogen ( $\text{N}_2$ ). Milo Baker's lupine has been difficult to propagate, possibly because the soil used at the nurseries does not contain microbes that can form this symbiotic relationship with Milo Baker's lupine. This can make propagating plants in a nursery to produce seed for reintroductions very difficult. The California Botanic Garden (CBG; formerly Rancho Santa Ana Botanic Garden) was able to grow Milo Baker's lupine plants to maturity from seed with some success, and they were able to clone Milo Baker's lupine from cuttings of mature plants to increase the total number of flowering plants for seed production for future potential reintroductions (Sale et al. 2019).

### D. Habitat Necessary for Species Survival

Milo Baker's lupine is currently known almost entirely from roadside occurrences, plus one grassland occurrence. It may have once been widespread in Round Valley (Chesnut 1974); however, there are no Milo Baker's lupine collections prior to 1940 or additional information to confirm this observation. Consequently, the natural habitat of this species before roads were constructed through Covelo is not known. In the open and grazed grassland habitat of Bear Valley in 1985, Milo Baker's lupine was seen growing near dark soil rich in clay by gullies that were very wet in the springtime (CMNHH 1985, CNDDDB 2019).

It is presumed, based on the current location of Milo Baker's lupine in wet, roadside ditches, that this species used to be common along streams and in areas of high groundwater in the Covelo area (CDFG 1986a). The occurrence in Bear Valley that was last seen in 1985 was growing along Bear Creek and associated tributaries, as well as along Bear Valley Road. Beyond this, little is definitively known about the habitat necessary for survival of the species.

#### i. VEGETATION COMMUNITIES

The current roadside habitat for Milo Baker's lupine consists primarily of weedy species due to the high frequency of human disturbance. In the rights-of-way that have low ditches and lack biodiversity, the vegetative community is dominated by blackberry (*Rubus* spp.) and poison oak (*Toxicodendron diversilobum*). Other species that have been documented include yellow star thistle (*Centaurea solstitialis*), canary grass (*Phalaris* sp.), and puncture vine (*Tribulus terrestris*) (CDFG 1986a). Milo Baker's lupine may be an early successional or ruderal species, growing best in areas with recently disturbed soil with low nutrients and little competition from other plant species.

#### ii. GEOLOGY AND SOILS

The Geologic Map of California (2010) shows that the area around Covelo and across Round Valley is made of Quaternary deposits, which consist of “alluvium, lake, playa, and terrace deposits; unconsolidated and semi-consolidates.” The soil survey (Soil Survey Staff 2019) from the Covelo area in and around Highway 162 confirms that the soil is derived from alluvium (i.e., ancient river deposits) from sedimentary rock, and sometimes metamorphic rock (Appendix B). At a fine scale, the soil types are not identical between the subpopulations, but are similar to each other at a more coarse scale. All soils in which Milo Baker's lupine is found appear to be deposits from ancient waterbodies (Soil Survey Staff 2019).

#### iii. CLIMATE AND HYDROLOGY

Round Valley, the region with the greatest number of Milo Baker's lupine occurrences historically, experiences a Mediterranean climate, which is characterized by hot, dry summers and cold, wet winters. The hottest month is July, with daily high/low average of 34.1°C/11.4°C (93°F/53°F), and the coldest month is December with a daily high/low of 11.1°C/-0.1°C (52°F/32°F) (Your Weather Service 2020).

Historically, Milo Baker's lupine may have been common along streams and in areas of high groundwater (CDFG 1986a). Round Valley receives about 107.8 cm (42.5 in) of precipitation annually. On average, precipitation is heaviest November through March, and near zero in July and August when Milo Baker's lupine is at the end of its blooming period and seeds are developing. The climate and hydrology of Bear Valley is very similar to Covelo in Round Valley, based on climate data from Clearlake, CA (Your Weather Service 2020), which is 40 km (25 mi) to the southwest; however, Bear Valley may have less annual precipitation. Bear Creek runs through the center of Bear Valley, which may supply the needed soil moisture during the spring months when Milo Baker's lupine is growing.

## V. THREATS AND SURVIVAL FACTORS

### A. Factors Affecting Ability to Survive and Reproduce

From the time Milo Baker's lupine was listed as rare under the NPPA, and later listed as threatened under CESA in 1987, the greatest threat to the species has been human-related activities. These activities have been primarily in the form of road maintenance, including road widening and shoulder repair, herbicide application to control for blackberry in the roadside ditches, and mowing. For this Five-Year Species Review, the Department has identified additional threats, including human-related activities such as trail construction, targeted destruction of plants, competition from invasive species, and low genetic variation and random events that pose a threat to species with small populations. Explanations of how these factors threaten the survival of Milo Baker's lupine are described below.

- **Road maintenance**—At the time of listing, nearly all the Milo Baker's lupine occurrences had been sprayed with herbicide intended for weedy blackberries and to increase visibility for motorists. Caltrans has since modified their use of herbicides around the Milo Baker's lupine populations, and has a no-spray requirement along Highway 162 within elemental occurrences (CDFW 2018), but subsequent herbicide application remains a possible threat to the species.

Annual summer roadside mowing is a human-related activity that is the greatest threat to Milo Baker's lupine. Nearly all of the known occurrences of Milo Baker's lupine are along road edges. State and county road crews annually mow the sides of roads in the summer to improve visibility for motorists and for fire safety. The timing of mowing can result in no seed being produced in a given year if the mowing occurs prior to plants setting seed. As annuals, if a plant population is impacted before the plants have produced seed, the population could lose an entire generation. If there are no seeds remaining in the seed bank, the population would be at risk of extirpation due to that single catastrophic event. In many cases, Caltrans controls the road right-of-way, but it does not own the right-of-way for roadside subpopulations of Milo Baker's lupine on tribal lands. Caltrans will, however, manage road edges with landowner permission, and any mowing will be performed by Caltrans. Sometimes private landowners have mowed stretches of the roadside containing Milo Baker's lupine, despite Environmentally Sensitive Area signs warning of its presence. This happened most recently in June 2020 (Garrison 2020b).

In addition to these weed management techniques, road construction activities in the form of road widening, resurfacing, bridge repairs, and trail building can also be very damaging to Milo Baker's lupine in Round Valley, particularly if activities extend onto the shoulder within a few meters of the edge of the road and/or occur during the growing season. The Mendocino Council of Governments will be constructing a walking trail along the west edge of a section of Highway 162 that runs through Covelo to accommodate local residents that need to travel along that route by foot (Garrison 2019).

- **Human destruction/poaching**—On a site visit in 2019, there was evidence that all the large plants at a very small subpopulation (EO 2E) adjacent to Barnes Lane had been deliberately removed by humans. This type of activity can extirpate a population or may prevent the population from expanding into new locations.
- **Present or threatened modification or destruction of its habitat**—Livestock grazing may be a serious threat across the range of Milo Baker's lupine and is presumed to have been a major cause of the reduction of Milo Baker's lupine across Round Valley. Some species of lupine contain compounds that are poisonous to livestock, sometimes causing birth defects (Davis 1982), but the toxicity of Milo Baker's lupine is unknown. Thus, Milo Baker's lupine may be threatened directly by consumption or trampling by cattle or indirectly by broad removal by ranchers to avoid potential consumption by cattle.

New threats identified by the Department include water diversion for agriculture that affects soil moisture, and unpermitted driveways that destroy sections of roadside that is important habitat for Milo Baker's lupine. Illegal *Cannabis* grows present a threat to Milo Baker's lupine through both mechanisms—diversion of water and driveway creation. First, at least one subpopulation was directly reduced by an unpermitted driveway (Garrison 2019). Secondly, illegal *Cannabis* grows typically divert water away from surface water sources (e.g. streams and rivers) that may normally provide the necessary soil moisture for any not-yet-discovered Milo Baker's lupine populations near streams. Indirectly, diverted water may reduce available water in the roadside ditches that the Milo Baker's lupine relies upon.

Changes in climate may also threaten the continued existence of Milo Baker's lupine. Conservative climate scenarios, where emissions peak around the year 2040 then decrease, predict that the average maximum and minimum temperatures from across the entire year are expected to increase 2 and 3°C (3.6 and 5.4°F), respectively, by 2099, leading to a hotter growing season (GIF 2020). Under this same climate scenario, the amount of daily precipitation is predicted to increase only 0-0.2 mm (0-0.008 in) per day, which is about 0-7.3 cm (2.9 in) per year (Your Weather Service 2020). This increase in precipitation may not account for the stress the higher temperatures will place on Milo Baker's lupine.

- **Loss of genetic diversity and random events**—Milo Baker's lupine populations likely experienced several human-induced genetic bottlenecks in the history of the species. Since Milo Baker's lupine was first formally identified in 1940, it has only been known from small occurrences along roadsides. Isolated events, such as mowing and herbicide application, extirpated or drastically reduced already small populations and subpopulations. Each time that happened, it may have caused a bottleneck event (i.e., significant reduction in population size), which is typically followed by loss of genetic diversity. Because the current distribution of Milo Baker's lupine is restricted to such a small area, the entire species may have low genetic diversity, which can threaten the existence of the species by making it less able to adapt to environmental changes (Ellstrand and Elam 1993) and susceptible to inbreeding depression. Self-pollination can further reduce genetic diversity through inbreeding depression, and it is unknown what proportion of seed produced by Milo Baker's

lupine is generally the result of self-pollination. Additionally, small populations and species with small distributions are further at risk of extirpation and extinction by random events. With such small population sizes, confined to very small areas, Milo Baker's lupine is highly vulnerable to extirpation.

- **Competition**—Milo Baker's lupine faces competition from weedy species, particularly by poison oak and invasive and native blackberry that grow alongside Milo Baker's lupine in roadside ditches.
- **Predation**—There is evidence of small rabbit browsing of nursery-grown Milo Baker's lupine plants (Sale et al. 2017), some cattle browsing of naturally occurring plants, and herbivory by pocket gophers (York 2017) Given the current distribution of the populations along roadsides, herbivory may not be a major threat to the existing distribution, but may prevent the expansion of Milo Baker's lupine throughout its range. By one account, Milo Baker's lupine may have historically covered much of Round Valley (Chesnut 1974), and the drastic reduction in its distribution would likely have been attributable to increased livestock grazing in conjunction with direct destruction by humans.

## **B. Degree and Immediacy of Threats**

The primary threats faced by Milo Baker's lupine have consistently been human-related activities and modification of habitat since this species was placed on the CESA list of threatened species in 1987. As an annual plant, Milo Baker's lupine depends entirely on its seed bank and annual seed production to replenish that seed bank. There is only one confirmed extant occurrence consisting of a handful of small subpopulations, all growing on the side of the road. Without constant protective measures, this population could become extirpated due solely to regular summer mowing. The recorded occurrence of a Bear Valley population, about 160 km (100 mi) southeast of Covelo, was last seen in 1985, and there has been no confirmation of its continued presence; there is also some concern regarding its taxonomic identity. Milo Baker's lupine is presently in danger of extinction; without continued protection of the natural subpopulations, and management through recovery projects, Milo Baker's lupine could become extinct at any time. Accidental or intentional mowing by government agencies and private landowners, competition from surrounding invasive shrubs and vines, modifications of habitat from illegal *Cannabis* grows and road construction, loss of genetic diversity, and random events are all current and serious threats to Milo Baker's lupine.

## **VI. MANAGEMENT AND RECOVERY**

### **A. Impact of Existing Management Efforts**

Initial management efforts were put in place on March 27, 1986 through a Memorandum of Understanding (MOU) between Caltrans and the Department. This MOU was in response to Caltrans broadly applying herbicide along the roadsides in Round Valley in 1984 to reduce vegetation encroachment towards the road. This activity reduced the global population of Milo Baker's lupine by an estimated 60 percent (Booth 1984, Hunter 1984). The MOU was instituted



on July 1, 1985 (Cochrane 1985). The agreement stated that Caltrans would: (1) not spray pre-emergent herbicide in three areas where Milo Baker's lupine was known to occur, (2) only use contact herbicide on blackberries before the lupine had germinated and after it had set seed, (3) not mow until after July or August once Milo Baker's lupine is in fruit, and (4) set aside an area along Highway 162 to try outplanting Milo Baker's lupine (CDFG 1986b). The reduction in herbicide application was an immediate benefit to the populations. The shift in mowing time was also beneficial, but there would later be an accidental mowing incident in 2016 that again resulted in a population decline of Milo Baker's lupine (Manji 2016). The outplanting project in 1985 at EO 16 appeared to result in additional plants at first, but the quality of data collection was not detailed enough to quantitatively assess the population over time (Vierra 1987).

When road or bridge maintenance is necessary, the Department has sometimes collected seed prior to the activities that would be detrimental to the population or subpopulation so the area could be re-seeded afterwards. An example of this occurred in 1980 when the Department requested time to collect seed before the Mendocino County Public Works Department mowed the roadside (Hunter 1980). Agreements such as these rely heavily on clear communication between agencies sustained over many years; any miscommunication could result in the mowing, spraying, or leveling of a population, potentially resulting in eventual extirpation.

Recent management efforts since 2016 have been undertaken in Covelo through another Cooperative Agreement (#01-0390) between the Department and Caltrans (CDFW 2018). This agreement was developed in response to a Notice of Violation issued by the Department to Caltrans because of mowing activities that occurred on June 9, 2016. Caltrans was fined, and the fine and MOU have resulted in the following management efforts, including a revision of maintenance prescriptions with CDFW's approval.

i. UPDATE ENVIRONMENTALLY SENSITIVE AREA DATABASE

Update Environmentally Sensitive Area (ESA) database to include presence of Milo Baker's lupine and all known state-listed plants within Caltrans' District 1 rights-of-way and their associated ESA maintenance prescriptions. Provide this information to G. Leppig (Senior Environmental Scientist Supervisor) at the Department in Region 1.

ii. SELECTIVELY-TIMED MOWING TO REMOVE COMPETITIVE SPECIES

Milo Baker's lupine faces competition from blackberry and poison oak that co-occur along roadsides in disturbed habitats. Caltrans typically mows brush on roadsides to increase motorist visibility and for fire safety. To achieve these goals, Caltrans will mow blackberry earlier in the season outside the boundaries of Milo Baker's lupine populations to avoid damage to the lupine plants. No additional mowing will be performed where Milo Baker's lupine grows until its seed is mature, so as not to disrupt Milo Baker's lupine from completing its life cycle.

iii. SOIL SCRAPING OR RIPPING AT SITES OF OLD ELEMENT OCCURRENCES

In 2017, the Department recommended a seed bank viability experiment where the treatment was "scraping" or "ripping" about 30 cm (12 in) of soil from the road shoulder and ditch. The goal

was to expose the soil underneath that may have been covered by sediment or “road slash” dumped decades earlier to see if there was a seed bank for Milo Baker's lupine that would sprout once exposed. It is also possible that these sites may have originally occurred because soil had been accidentally scraped from roadside locations that contained Milo Baker's lupine seeds banked from natural populations that was then dumped at these new sites. In October 2018, the treatment was applied south of Covelo along Highway 162 (Fig. 3) in 60-meter (200-foot) stretches along the eastern roadside of EO 5 and both roadsides of EO 16. At EO 5, no lupines grew from this treatment, but at EO 16, many lupines grew; however, they were identified as butter lupine and none were Milo Baker's lupine. Milo Baker's lupine did not grow in response to this treatment, but this treatment may be attempted at other occurrences that are possibly extirpated.

#### iv. SEED BULKING

The Department contracted with CBG, as well as a private nursery and a professor at Mendocino College, to grow Milo Baker's lupine for seed bulking by hand pollination to reach a total of about 3000 seeds for long-term conservation storage and 3000 seeds for future reintroduction efforts. Milo Baker's lupine is difficult to propagate, but CBG was able to produce a large store of seeds. By 2019, there were 1127 seeds in permanent storage and 4070 seeds in temporary short-term storage that could be used for reintroductions.

#### v. REINTRODUCTIONS

The most consequential management effort to increase the survival of Milo Baker's lupine will be reintroducing the species to areas where it once grew. The areas most likely to be successful will have the appropriate habitat and soil microbes for Milo Baker's lupine to grow successfully. However, reintroducing plants is difficult and success rates tend to be very low (Fiedler 1991).

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

The Department's recommendations for management and recovery of Milo Baker's lupine begin with the continued preservation of current natural populations and subpopulations in and around Covelo through monitoring activities, promotion of plant recruitment into the population, and surveys for new populations. In Covelo, the known occurrences of Milo Baker's lupine are located near the Round Valley Reservation. The Department has reached out to the Round Valley Indian Tribes to increase attention to the plight of Milo Baker's lupine and to facilitate the Tribe's involvement with recovery activities (Garrison 2019). Recovery of Milo Baker's lupine is dependent on the cooperation of all stakeholders in the area, and on reintroductions into the historical range of the species to increase the number of individuals and occurrences.

Recommendations include:

- Complete a recovery plan that the Department can implement in collaboration with local landowners, the Round Valley Indian Tribes, the Mendocino Council of Governments, Caltrans, and local schools.

- Conduct a habitat assessment: model habitat criteria to identify possible suitable habitat in the vicinity of Round Valley and beyond, then survey the region to locate new occurrences that may have gone undetected. Model suitable habitat for possible outplantings or reintroductions using information on:
  - hydrological regime, duration, timing, and/or total precipitation, soil inundation, and flooding or surface flow for germination and tap root development (Garrison 2020a);
  - soil profiles and composition;
  - associations with other plants, such as within oak woodland communities, which were once common across Round Valley;
  - what, if any, disturbance (e.g., fire) is needed/required.
- Consider augmenting or expanding the only natural extant population by planting wild-collected seeds or first-generation bulked seeds from propagation efforts.
- Continue outreach efforts with landowners in the historical range of Milo Baker's lupine for permission to survey possible suitable habitat. If found, discuss employing tools such as Safe Harbor Agreements (Fish and G. Code § 2089.2 et seq.) to incentivize recovery and conservation of the species. For example, there is currently a ranch with an inholding in Covelo off Highway 162, and the owner is willing to partner with the Department to help with recovery efforts (Garrison 2020b). The landowner has granted access to their property for surveys and outplanting if it is deemed suitable habitat for Milo Baker's lupine.
- Engage in consultation and continued coordination with the Round Valley Indian Tribes to develop and implement recovery and management actions.
- Avoid damage to Milo Baker's lupine from the construction of a paved roadside trail along the west side of Highway 162 through Covelo and to the north. The Department should ensure that any planned and permitted trails will be routed in such a way as to avoid damage to Milo Baker's lupine.
- Create educational and informational opportunities to build public support for conservation.
- Continue collecting seeds annually following protocols that consider genetic diversity and rarity, such as the protocols provided by the CBG (RSABG 2009), and place them in long-term conservation storage at Department-approved facilities.
- Conduct a genetic analysis of the extant subpopulations in Round Valley, and Bear Valley if available, to quantify current genetic diversity within and among populations, providing the most scientifically-grounded information for making decisions about management actions. It is critical to preserve genetic diversity of the species to increase its chances of adapting to any long-term environmental changes (i.e., climate change).
- Assess the genetic and phenotypic relationship between Milo Baker's lupine and its close relative, butter lupine (*L. luteolus*). Grow the two in a common garden to help assess genetic differences and confirm the physical differences that support their taxonomic identity.
- Enforce legal water use by *Cannabis* growers and proper permitting for property modifications, where possible.

## **VII. RECOMMENDATION TO THE COMMISSION**

Pursuant to Fish and Game Code section 2077, the Department has prepared this Five-Year Species 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 Species Review, the Department submits the following recommendation to the Commission:

In completing this Five-Year Species Review for Milo Baker's lupine, the Department finds there is sufficient scientific information to indicate that the conditions that led to the listing of Milo Baker's lupine as threatened have worsened, and recommends a change in the status of Milo Baker's lupine from threatened to endangered. The Department's recommendation shall be further considered by the Commission as a petition with a Departmental recommendation to accept and consider the petition (Fish and G. Code § 2072.7).

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**Appendix A. Occurrence population size, ownership, quantity of subpopulations, and population trends of Milo Baker's lupine by Element Occurrence (EO).** (CDFG 1986a, CNDDDB 2019, Frederickson et al. 2020, Garrison 2020b, Leppig 2020).

\*Planted by Caltrans (CNDDDB 2019). \*\*Trend may change to "Possibly Extirpated" once CNDDDB receives completed surveys.

\*\*\*Early survey of juvenile plants only. Subpopulations are the number of polygons mapped by the CNDDDB.

EO	1	2	5	8	10	13*	14	15	16*	18	19
<b>Owner</b>	Caltrans	Caltrans/ Private	Caltrans	Unknown	Caltrans	Caltrans	Unknown	Caltrans	Caltrans	Private	Caltrans
<b>Subpops.</b>	3	5	2	1	2	1	1	1	1	1	1
<b>Year/Trend</b>	Possibly Extirpated	Presumed Extant/ Decreasing	Possibly Extirpated	Presumed Extant**	Possibly Extirpated	Presumed Extant**	Presumed Extant**	Possibly Extirpated	Possibly Extirpated	Presumed Extant**	Presumed Extant**
<b>1942</b>				>0							
<b>1943-1978</b>											
<b>1979</b>					1-10		2				
<b>1980</b>											>0
<b>1981</b>											
<b>1982</b>	500	>1000	175		1-10						
<b>1983</b>	0										
<b>1984</b>	1-10	>1000	<100		0						
<b>1985</b>	1-10	>100	0		0	>100				>500	
<b>1986</b>	>350	>10,000	100			>100		20	40		
<b>1987-2002</b>											
<b>2003</b>		>0									
<b>2004-2013</b>											
<b>2014</b>	0		0		0			0	0		
<b>2015</b>		77									
<b>2016</b>	0	86	0	0	0	0	0	0	0		0
<b>2017</b>		42									
<b>2018</b>		20									
<b>2019</b>		208	0						0		
<b>2020</b>		<1777***							0	0	

0	1-10	11-100	101-1000	>1000
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**APPENDIX B. Soil composition of naturally occurring Milo Baker's lupine at Occurrence 2.**  
 Subpopulations are A-E (Soil Survey Staff 2019).

<b>Series</b>	<b>Subpopulation</b>	<b>Slope</b>	<b>Texture</b>	<b>Source</b>	<b>Rock type</b>
Clear Lake clay, high precipitation	B, C, D	0-2%	undefined	Clayey alluvium	Metamorphic & Sedimentary
Cole	A	0-2%	loam, drained	Alluvium	Metamorphic & Sedimentary
Cole	B	0-1%	silty clay loam	Alluvium	Sedimentary
Russian	E	0-2%	loam	Alluvium	Sedimentary
Talmage	A	0-2%	gravelly sandy loam	Alluvium	Mixed