

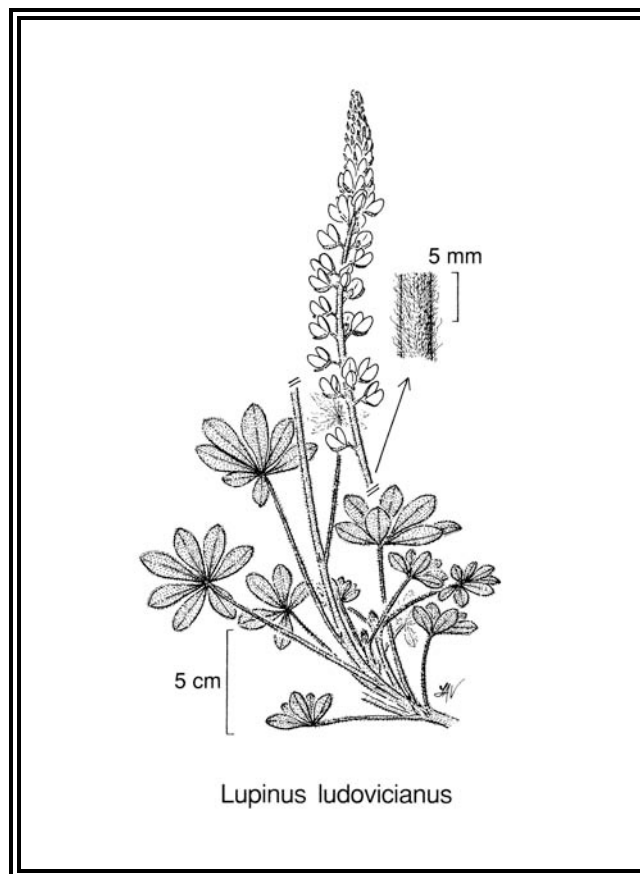


RANCHO SANTA ANA BOTANIC GARDEN OCCASIONAL PUBLICATIONS

NUMBER 13

A CONSERVATION PLAN FOR *LUPINUS LUDOVICIANUS* (SAN LUIS OBISPO COUNTY LUPINE, FABACEAE)

DAISIE I. HUANG



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Published by *Rancho Santa Ana Botanic Garden, 1500 North College Avenue, Claremont,
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2013

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The RANCHO SANTA ANA BOTANIC GARDEN OCCASIONAL PUBLICATIONS series is published by Rancho Santa Ana Botanic Garden, 1500 North College Avenue, Claremont, California 91711-3157.

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PUBLICATION DATA

A Conservation Plan for *Lupinus ludovicianus* (San Luis Obispo County Lupine, Fabaceae). July 2013. Daisy I. Huang. RANCHO SANTA ANA BOTANIC GARDEN OCCASIONAL PUBLICATIONS, Number 13, viii + 9 pages. ISSN 1094-1398. Series Editor Vanessa Ashworth, Managing Editor Lucinda McDade. First printing: 80 copies, July 2013. Copyright © 2013 by Rancho Santa Ana Botanic Garden.

This publication was printed with support from the California Native Plant Society (CNPS). Founded in 1965, CNPS is a science-based non-profit organization dedicated to increasing understanding and appreciation of California's native plants, and to conserving them and their natural habitats. Learn more at <http://CNPS.org>.



CALIFORNIA
NATIVE PLANT SOCIETY

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1.0 EXECUTIVE SUMMARY

Lupinus ludovicianus Greene (San Luis Obispo County lupine) is a woody perennial lupine endemic to the area surrounding Arroyo Grande, California. It is listed as a California Native Plant Society (CNPS) 1B.2 species, meaning that it is “rare, threatened, or endangered in California and elsewhere.” Its distribution is limited to 16 occurrences, all located in San Luis Obispo County (CNPS 2013) on privately owned land. The species is threatened by development, both residential and agricultural. Currently, *L. ludovicianus* is not protected by state or federal listing.

2.0 SCOPE AND PURPOSE

Lupinus ludovicianus is known from 16 historic occurrences, of which seven are now extirpated or probably extirpated. The desirability of the habitat of this species for agriculture (grazing and viticulture) poses a serious risk to the remaining populations. This conservation plan aims to summarize current data about this species in order to facilitate informed decision making by conservationists, policymakers, and scientists.

3.0 METHODS

Historical locality data were extracted from the California Natural Diversity Database [CNDDDB 2013], and field surveys were undertaken to locate these populations, in consultation with Dr. Rhonda Riggins-Pimentel. Most extant occurrences were surveyed in 2007, approximate counts of individual plants were made, and threats were assessed at that time. Not all occurrences were accessible for this study; for those occurrences, inferences were made based on available historical data and communication with Dr. Riggins-Pimentel.

4.0 BACKGROUND

4.1 Species Description

Lupinus ludovicianus is a woody perennial in Fabaceae that produces basally woody erect stems, 30–50 cm in length. Its leaves and stems have densely felty-woolly pubescence (Fig. 1). Leaves are long-petioled, with 7–9 leaflets. The leaflets are characteristically spatulate or oblanceolate and 1.5–3 cm long. Inflorescences are racemose, with peduncles 8–15 cm long and the flower-bearing portion 10–20 cm long. The flowers are whorled, sometimes indistinctly so, and moderately densely arranged. Flowers are lavender to

purple and about 10–12 mm long. The floral banner has a yellow spot. The keel is falcate in shape and ciliate on the upper edges. Seed pods are 2–2.5 cm long, densely hairy, and contain 4–6 seeds. The seeds are obscurely marked, yellowish-gray, and ca. 4 mm in diameter (Greene 1885; Smith 1923*b*; Munz 1959; Isely 1998; Sholars 2012).

4.2 Taxonomy

Genus *Lupinus* was described by Linnaeus in *Species Plantarum* (1753). It occupies a monogeneric subtribe, Lupininae, in tribe Genisteae, subfamily Papilionoideae (Bisby 1981). The genus is a natural group with morphological similarities (e.g., digitately compound leaves) that are supported as synapomorphic in recent molecular phylogenies (Ainouche et al. 2004). Taxa in *Lupinus* may be either annual or perennial, and the genus is found in both the Old and New Worlds. Though likely of Old World origin, the largest centers of diversity are in western North America and western South America. The perennial lupines of western North America appear to be a monophyletic group (Drummond 2008).

Lupinus ludovicianus was first described in 1885 by E. L. Greene based on a specimen collected by M. K. Curran in the hills above San Luis Obispo (Greene 1885). Greene originally noted its similarity to *L. niveus* S. Watson of Guadalupe Island, Mexico, but *L. niveus* is an annual or biannual (Riggins 1993), arguing against a close relationship with the perennial *L. ludovicianus*. *Lupinus ludovicianus* has been recognized in all treatments of the genus in California (Smith 1923*a,b*; Munz 1959; Sholars 2012). Specimens identified as *L. ludovicianus* have been documented since 1885, and no synonyms for the species have been published. A phylogenetic analysis of the *L. albifrons* species



Fig. 1. Leaves of *Lupinus ludovicianus*, showing characteristic felty pubescence (photograph by author).

complex using chloroplast regions placed *L. ludovicianus* within a clade consisting entirely of perennial species, including *L. arboreus* Sims and *L. albifrons* Benth. (Huang and Friar 2011). Its placement within the perennial clade, however, remained unresolved.

4.3 Biology and Ecology

Lupinus ludovicianus grows in grassland openings in oak woodlands or chaparral in the hills of San Luis Obispo County, apparently endemic to limestone-derived soils. It flowers in late spring, April to May, with fruits ripening a few months later (Sholars 2012). No studies have addressed the biology and ecology of this species, but lupine species are generally very similar. Lupines, like many papilionoid legumes, form a symbiotic relationship with rhizobial bacteria that fix nitrogen in the soil (Stepkowski et al. 2007). They have explosively dehiscent seed pods, and many lupines require scarification of seeds before germination can occur (Dunn 1956). Because soil disturbance can scarify seeds, lupines are effective early colonizers of disturbed habitats (Morris and Wood 1989; Halvorson et al. 1992) and can form a significant seed bank over the years (Dunn 1956).

Lupines are pollinated primarily by pollen-seeking bees; flowers do not produce nectar (Dunn 1956). Pollination is by a piston mechanism in which the pollen of the five large anthers is pushed into the tip of the keel by the extension of the filaments of the other five stamens. When a bee lands on the wings and keel of the flower, the petals readily bend down, forcing the pollen out of the keel acumen and onto the bee's abdomen. This action also exposes the stigma of the flower after the pollen has been extruded, enabling pollination (Dunn 1956). Large lupine flowers, such as those of *L. arboreus*, require large bees such as *Bombus* spp. for effective pollination (Dunn 1956), but *L. ludovicianus* has fairly small flowers for a perennial lupine and likely can be effectively pollinated by most bees. Rates of self-fertilization and outcrossing are not known for *L. ludovicianus*.

4.4 Habitat

Lupinus ludovicianus is restricted to grasslands bordering oak woodland and chaparral habitats in San Luis Obispo County, California. It grows on limestone-derived substrates in canopy openings and open scrub environments (D. Huang, pers. obs.; Fig. 2). It is exclusively found on soils of the Santa Margarita formation. Precipitation in the area follows a Mediterranean regime, with the majority of rainfall occurring in the winter months from November through March and averaging 43–63 cm per year (National Weather Service 2013; The Weather Channel

Interactive 2013). The species is found from 50 to 500 m in elevation (Sholars 2012).

4.5 Distribution and Abundance

Lupinus ludovicianus is limited in distribution, its total range encompassing an area of approximately 26 km². Since 1906, sixteen populations of *L. ludovicianus* have been documented in the CNDDDB (Fig. 3, Table 1), and the status of many of these sites has been updated intermittently, though few observations have been added since 1986 (CNDDDB 2013). The Consortium of California Herbaria (CCH) lists 58 herbarium specimens that account for an estimated 20–30 distinct collections (CCH 2013). None of these furnished new collection localities.

4.6 Population Trends

Two populations are considered to have been extirpated by development or heavy grazing, and five more may be extirpated based on present conditions at the site and a lack of plants when surveyed for this study (mostly 2007). The most recently provided information for occurrences did not note trends for any of the sites (CNDDDB 2013). Three populations (Occurrences 2, 5, and 7) were reported to be doing well, with more than 1000 plants noted (CNDDDB 2013). One of these populations (Occurrence 7) is noted as being voluntarily registered with the Nature Conservancy (CNDDDB 2013). However, Occurrences 5 and 7 have since been extirpated or nearly extirpated by development (R. Riggins-Pimentel, pers. comm., 2007; D. Huang, present study), and Occurrence 2 awaits an updated assessment. Several populations have not been accessible for many years (e.g., Occurrences 6, 17, 20, and 21), so their status is unknown. It is reasonable to assume, based on the trends of documented populations, that the general population trends are towards a significant decrease in numbers.

4.7 Threats and Limiting Factors

Lupinus ludovicianus can be locally common, but is limited to areas free of heavy grazing, agricultural or residential development, or road clearance. Development in the areas of the largest populations has mostly extirpated the plants. The area with the greatest number of populations is the greater Arroyo Grande area, but this area is heavily grazed and under development (R. Riggins-Pimentel, pers. comm.). Many historical populations have been extirpated or greatly reduced due to development. The Arroyo Grande area is currently being developed for housing and viticulture and undergoing conversion from its historical use as rangeland.

Table 1. Summary of the most current information available for each Element Occurrence (EO) of *Lupinus ludovicianus* (CNDDDB Element Code PDFAB2B2G0).

EO	EO index #	Site last observed	Presence	Status	Threats	Management
1	19193	6 May 1936	Presumed extant	Site not observed since 1936	Unknown	Private
2	19194	2005	Presumed extant	>1000 seedlings in 1986; plants seen 2005 (RR)	Grazing	Private
4	19196	7 Jul 1986	Possibly extirpated	Plants last seen in 1933	Agriculture	Private
5	12643	17 Apr 2007	Presumed extant	>2000 plants in 1986; <10 plants seen 2007 between road and residential development (DH)	Residential development	Private
6	19192	7 Jul 1986	Possibly extirpated	Access limited; ca. 200 plants seen in 1980, ca. 60 plants remaining after a cattle drive	Grazing	Private
7	12332	2007	Possibly extirpated (CNDDDB 2013: presumed extant)	>2000 plants in 1986; plants still observed in 1994; no plants seen 2007 (RR)	Residential development, Grazing	Private
10	19195	1 Jul 1986	Extirpated	House now occupies site	Residential development	Private
11	12642	30 May 1986	Extirpated	Plants last seen 1958, presumed extirpated (RR 1980)	Agriculture, grazing	Private
17	13876	9 Apr 1982	Presumed extant	Plants last assessed 1982, but site now protected by conservation easement; not visited	Unknown	Private
18	19191	17 Apr 2007	Presumed extant	Decline from ca. 75 plants in 1982 to ca. 30 plants in 2007 (DH)	ORV, grazing	Private
19	19189	1986	Possibly extirpated (CNDDDB 2013: presumed extant)	Developed site; ≤20 plants seen 1980–1986 (RR), but may now be extirpated	Road maintenance, grazing	Private
20	19188	1986	Presumed extant	Ca. 100 plants in 1986; not visited	Agriculture, grazing	Private
21	19186	20 May 1982	Presumed extant	Ca. 150–200 plants in 1982; not visited; site inaccessible	Grazing	Private
22	19185	2007	Possibly extirpated (CNDDDB 2013: presumed extant)	Ca. 20 plants in 1982; none seen in 1986, nor 2007 (RR)	Agriculture, Grazing	Private
23	19183	2007	Presumed extant	>200 plants in 1982; none seen in 1986, but wrong season	Grazing	Private
24	7299	12 Jun 2005	Presumed extant	Ca. 30 plants in 1993, 250 in 2004, <50 plants 2005 (RR); in a vineyard	Viticulture, grazing	Private

RR = Rhonda Riggins-Pimentel; DH = Daisie Huang



Fig. 2. Habitat of *Lupinus ludovicianus* along Hi Mountain Road (photograph by author).

5.0 CONSERVATION

5.1 Conservation Status and Objectives

Lupinus ludovicianus is listed as a CNPS 1B.2 species, meaning that it is “rare, threatened, or endangered in California and elsewhere,” and its distribution is limited to a small number of occurrences (CNPS 2013). While it is cited as being a Forest Service Sensitive Species in a U.S. Forest Service habitat assessment (Stephenson and Calcarone 1999), no systematic conservation plan has been detailed for *L. ludovicianus* to date.

In order to update the status of *L. ludovicianus*, it is necessary to enumerate the goals of a conservation plan and determine how these goals can be achieved.

1. Determine the extent of currently known populations

Many of the known populations have not been visited since the 1980s, and several populations that used to be large have been extirpated by development in the intervening years. In order to assess the health of the

species as a whole, the current state of known populations needs to be assessed.

2. Assess reproductive health of the species

Little is known about the reproductive biology of *L. ludovicianus*. Although it is assumed that its biology is similar to other perennial lupines, its actual reproductive fitness is unknown. Does it have adequate levels of seed set and germination? Does seedling predation or competition with other species reduce its population size? Does grazing, present at many of the sites, including those on the Guidetti Ranch (Occurrences 6 and 17), negatively affect these plants? These factors are unknown for the species. Once these factors are understood, a more specific target for population size and protected area size can be established.

3. Quantify gene flow and population genetics for the species

In order to determine how to best maintain genetic diversity in the protected populations of the species, more information is needed about gene flow within

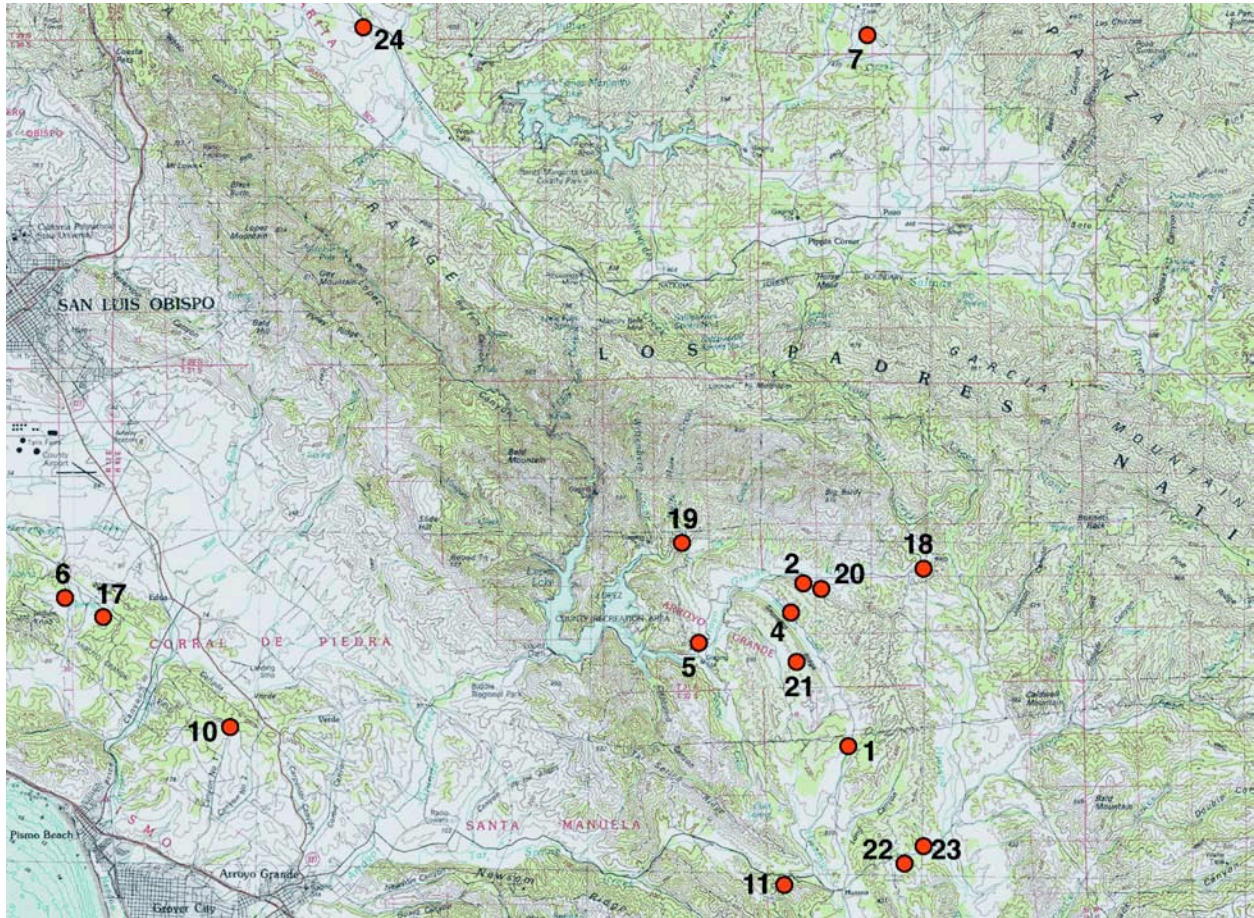


Fig. 3. Documented localities of *Lupinus ludovicianus* occurrences. Map downloaded from the U.S. Geological Survey website (U.S. Department of the Interior 2011) as a 30 × 60 minute quad map for San Luis Obispo.

and between populations (Friar et al. 2000). Once this information is obtained, more enlightened decisions can be made about which populations should be emphasized for conservation and which should be targeted for seed-banking. The goal should be to maintain as much genetic diversity as possible, or at least enough to maintain viable populations.

4. Minimize impacts from disturbance and development at known sites

In many cases, populations of *L. ludovicianus* occur in well-defined areas within grazing lands or near viticulture or residential development. If the direct impact of these uses can be mitigated, the extant populations of *L. ludovicianus* can coexist with human use of nearby land. The health of the populations should be monitored at least every two years.

5. Establish a seed bank for highly threatened populations

For populations that are exceedingly small (less than ca. 30 individuals), seed banking may be the only viable way to maintain the genetic diversity. If possible, ex situ-propagation should be undertaken to increase the size of these highly constricted populations.

5.2 General Conservation Actions

The current status of many historic occurrences is not known, so these localities need to be revisited and mapped. Populations that are still extant should be updated in the CNDDDB, including information on the current size and health of each one. These populations also need to be assessed for current ownership and protection status. Clearly, sites that are no longer extant should be listed as such in the CNDDDB so that conservation efforts will not be misled by outdated information about populations that have been extirpated.

Extant populations need to be assessed for genetic diversity, and gene flow studies should assess the feasibility of propagation to augment existing populations in protected areas.

5.3 Site-Specific Conservation Actions

5.3.1 *Occurrence 1.*—About 1.6 km N of Park Ranch, 35.16268 N, -120.39194 W, el. 354 m. CNDDDB does not list detailed information about this population and its locality, except to say that it was last seen here in 1936. This site should be revisited to determine its current status.

5.3.2 *Occurrence 2.*—Arroyo Grande Creek, along Hi Mountain Road, 35.16268 N, -120.39194 W, el. 280 m; in coast live oak woodland in Santa Margarita Formation, sandy soil. This population was unofficially observed in 2005 (R. Riggins-Pimentel, pers. comm.). Over 1000 seedlings were noted in 1986, so population trends should be simple to assess with another visit to the site. It is located on private land and is threatened by grazing.

5.3.3 *Occurrence 4.*—Saucelito Canyon, upper Arroyo Grande Valley, 35.1983 N, -120.41127 W, el. 232 m. This historic occurrence is presumed extirpated by agricultural development. Element last seen 1933. Site last seen in 1986. A reassessment to confirm extirpation should be done, but it is unlikely that this population can be found or conserved.

5.3.4 *Occurrence 5.*—Canyon of Arroyo Grande Creek, about 7 km E of Lopez Dam, N of confluence with Phoenix Creek, 35.18976 N, -120.44006 W, el. 243 m; in chamise chaparral, with black sage, *Bromus*, *Erodium*, and *Muilla*. On Santa Margarita Formation of sand or sandstone. This population was once the largest known population of *L. ludovicianus* with about 2000 individuals reported in 1986, but is now mostly extirpated by residential development. Fewer than 10 plants were still extant in between the development and the road (D. Huang, pers. obs. 2007). These plants should be assessed for genetic diversity and possible propagation ex situ.

5.3.5 *Occurrence 6.*—Two km ENE of Indian Knob, along both sides of dirt road, 35.20218 N, -120.64567 W, el. 97 m; on siliceous sands of Santa Margarita Formation; ca. 200 plants seen in 1980, reduced to ca. 60 plants after cattle driven through site. Access limited. This population has not been assessed since 1980, but is located on the Guidetti Ranch (R. Riggins-Pimentel, pers. comm. 2007), which has been protected under a conservation easement by the City of San Luis Obispo, and protected by the Nature Conservancy (ECOSLO 2013). This site should be documented and assessed for population trends, current threats, and genetic diversity.

5.3.6 *Occurrence 7.*—(Includes former Occurrences

8 and 9). Park Hill Road, between Toro Creek and Yaro Creek, NE of Santa Margarita Reservoir, 35.35346 N, -120.38725 W, el. 524 m; on hillsides and adjacent flatlands with *Pinus sabiniana*, *Quercus agrifolia*, and *Q. lobata*; associated with *Bromus*, *Chorizanthe*, *Cryptantha*, *Lasthenia*, *Lupinus nanus*, *Orthocarpus*, and *Penstemon*; on sandy soils of Santa Margarita formation. This site was once home to a substantial population of *L. ludovicianus*, with over 2000 plants observed in 1986. Plants were observed but not counted in 1987 and 1990–1994. Probably the largest occurrence. Reported in CNDDDB as threatened by grazing/trampling (cattle do not eat it). This site was voluntarily registered with the Nature Conservancy (stated in the CNDDDB but unconfirmed). However, the area has since been developed and the population is now probably extirpated (R. Riggins-Pimentel, pers. comm. 2007). The site should be checked again to see if any plants are extant. If so, the plants should be assessed for genetic diversity and ex situ-propagation.

5.3.7 *Occurrence 10.*—Site of old Oak Park School, 35.1683 N, -120.59267 W, el. 158 m. Based on CNDDDB, a house now occupies the site of the former school (razed many years ago). Site last seen 1986 (no plants found by Malcolm McLeod and Rhonda Riggins-Pimentel after repeated searches). A reassessment to confirm extirpation should be done, but it is unlikely that this population can be found or conserved.

5.3.8 *Occurrence 11.*—Summit between Arroyo Grande and Huasna, 35.12665 N, -120.41308 W, el. 331 m. Plants last seen 1958. Site last seen 1986. Reported by R. Riggins-Pimentel in 1980 to be extirpated; field[s] in area cultivated and heavily grazed. This historic occurrence is presumed extirpated by agricultural development. A reassessment to confirm extirpation should be done, but it is unlikely that this population can be found or conserved.

5.3.9 *Occurrence 17.*—Hills N of Price Canyon, 2 km ENE of Indian Knob, 35.19729 N, -120.6339 W, el. 134 m. Plants said to do best around gopher diggings. These populations have not been assessed since 1982, but are located on the Guidetti Ranch (R. Riggins-Pimentel, pers. comm. 2007), which has been protected under a conservation easement by the City of San Luis Obispo, and protected by the Nature Conservancy (ECOSLO 2013). This site should be documented and assessed for population trends, current threats, and genetic diversity.

5.3.10 *Occurrence 18.*—Hi Mountain Road, 6.6 km E of ranger station, 35.20995 N, -120.36727 W, el. 366 m; accompanied by coast live oak. CNDDDB reports 75 plants in 1982 and 60 plants in 1986. This site was last

checked in 2007 (D. Huang, present study) and included about 30 individuals along a private fence line. The population seems to be declining and is threatened by grazing and ORV activity. The site should be assessed for genetic diversity and gene flow between plants here and nearby populations (i.e., Occurrences 2 and 20).

5.3.11 *Occurrence 19*.—Along Lopez Canyon Road about 4 km N of Hi Mountain Road, 35.21726 N, -120.44611 W, el. 171 m; hilly area with coast live oak. Two plants reported on N side of road cut, several behind gate along Huffs Road (1980); up to 20 plants seen by R. Riggins-Pimentel (early 1980s), but numbers declined after road maintenance (1986). Site adjacent to USFS (Los Padres NF). This historic occurrence is presumed extirpated. A reassessment to confirm extirpation should be done, but it is unlikely that this population can be found or conserved.

5.3.12 *Occurrence 20*.—Hi Mountain Road, 4 km E of ranger station, 35.20512 N, -120.40055 W, el. 268 m. This population is located near fields and a barn, so cultivation or grazing are possible threats. The size of the population increased from 50 in 1982 to 100 in 1986, but the site has not been visited since then.

5.3.13 *Occurrence 21*.—Saucelito Ridge, SE of Potrero Field and E of Lopez Lake, 35.18526 N, -120.40911 W, el. 317 m; open slopes bordering chamise-dominated chaparral. This population is located on private land along an old firebreak and is currently inaccessible. The last assessment (in 1982) counted 150–200 plants. The site should be revisited and assessed for population trends, current threats, and genetic diversity.

5.3.14 *Occurrence 22*.—Along Huasna Road, about 2.4 km E of Huasna School Road, 35.13213 N, -120.37363 W, el. 900 m; found under coast live oak, with *Muilla*. This was a small population near the road, near Occurrence 23, but growing separately. The population consisted of about 20 plants when found in 1980, no plants were seen in 1986, nor in recent years (R. Riggins-Pimentel, pers. comm. 2007). Threatened by agricultural development and grazing. A reassessment to confirm extirpation should be done, but it is unlikely that this population can be found or conserved.

5.3.15 *Occurrence 23*.—About 1 km N of Huasna Road and 1 km W of Huasna River, SW of Caldwell Mountain, 35.13663 N, -120.36723 W, el. 256 m; on slopes bordering chaparral. This population consisted of 200+ individuals in 1982; no plants were found in 1986 but it may have been too late in the season; the status has not been determined in recent years. Located on a private ranch, the land is grazed but not yet developed

(R. Riggins-Pimentel, pers. comm. 2007). The site should be revisited and assessed for population trends, current threats, and genetic diversity.

5.3.16 *Occurrence 24*.—Santa Margarita Ranch, Cuesta Ridge vineyard, 35.35451 N, -120.55121 W, el. 366 m; in grassland with valley oak; associated with *Bromus hordeaceus*, *Chorizanthe rectispina*, *Clarkia speciosa* subsp. *speciosa*, *Lessingia filaginifolia*, *Linanthus liniflorus*, *Navarretia atractyloides*, *Trichostemma lanceolatum*, etc. Thirty plants seen over about 0.05 acre in 1993; plants were not extirpated by vineyard installation in 2000, and 250 plants seen in 2004; this population was last checked in 2005 (RR) and was small (fewer than 50 plants) at that time. Threatened by viticulture and grazing for weed control. The site should be revisited and assessed for population trends, current threats, and genetic diversity.

5.4 Conservation Tasks

- Each site needs to be evaluated and assessed for population size and viability.
- Populations that are extant but are on private land need to be disclosed to landowners in such a way as to protect their habitat and allow research into their genetic diversity, population trends, and the possibility of *ex situ* conservation.
- If possible, conservation easements should be considered to create protected areas for *L. ludovicianus* and associated species.
- Populations that are too small to be viable should be propagated via a maternal line seed bank, probably at Rancho Santa Ana Botanic Garden (Wall and Macdonald 2009). If deemed advisable, these genotypes could later be integrated into larger nearby extant populations.

5.5 Out-of-State Considerations

There are no out-of-state considerations, as *L. ludovicianus* is endemic to San Luis Obispo County, California.

5.6 Participants

- Private landowners
- U.S. Fish and Wildlife Service, Ventura Field Office
- Los Padres National Forest
- City of San Luis Obispo
- County of San Luis Obispo
- The Nature Conservancy
- California Native Plant Society
- ECOSLO (The Environmental Center of San Luis Obispo County)
- Rancho Santa Ana Botanic Garden

6.0 IMPLEMENTATION

6.1 *Action Assessment*

While *L. ludovicianus* has been recognized as unique to the county of San Luis Obispo through its status as the official county flower (Walters and Keil 1996: 14), its continued existence is highly threatened by loss of habitat. Many of the historical occurrences of *L. ludovicianus* have been extirpated through habitat destruction for residential development and other land use. In order to save this species, priority should be given to protection of lands with occurrences of *L. ludovicianus*.

6.2 *Federal Listing*

Federal and State listing for *L. ludovicianus* may be worthy of further investigation.

6.3 *Prioritized Implementation Schedule*

Monitoring surveys: census all populations (RSABG, CNPS)—Spring 2014

Habitat protection: investigate feasibility of obtaining easements for species habitat (City and County of San Luis Obispo)—2014–2015

Genetic study: study populations for genetic diversity both within and among populations (RSABG)—2015

Ex situ propagation: collect seed for possible future propagation to suitable habitat (RSABG, CNPS)—2015

6.4 *Potential Difficulties in Implementation*

Private landowners may be unwilling to allow researchers to survey populations located on their lands. In addition, they may not be interested in protecting this species, either through observation and protection from development, or through acquisition of conservation easements or sale of lands to public entities. Funding for the genetic study needs to be obtained as well.

ACKNOWLEDGMENTS

This conservation plan is a result of the Rare Plant Conservation course initiated by Drs. Elizabeth Friar and Gary Wallace and offered as part of the graduate

curriculum at Rancho Santa Ana Botanic Garden. I am very grateful to Dr. Rhonda Riggins-Pimentel, Professor Emeritus at California Polytechnic State University, San Luis Obispo, for sharing her extensive knowledge of distributions and localities of *L. ludovicianus*.

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