FGC - 670.1 (3/94)



# A PETITION TO THE STATE OF CALIFORNIA FISH AND GAME COMMISSION

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Sections 2072 and 2073 of the Fish and Game Code relating to listing and delisting endangered and threatened species of plants and animals.

## I. SPECIES BEING PETITIONED:

Common Name: Lassics lupine

Scientific Name: ( *Lupinus constancei* )

## II. RECOMMENDED ACTION:

(Check appropriate categories)

a. List ☑ b. Change Status ☐

As Endangered ☑ from __________

As Threatened ☐ to __________

Or Delist ☐

## III. AUTHOR OF PETITION:

Name: Dave Imper | Cynthia Elkins, Center for Biological Diversity

Address:

Phone Number:

*I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.*

Signature: [signature]

Date: July 15, 2016

## PETITION TO THE STATE OF CALIFORNIA FISH AND GAME COMMISSION SUPPORTING INFORMATION FOR

| Lassics lupine | (*Lupinus constancei*) |
|---|---|
| **Common Name** | **Scientific Name** |

## EXECUTIVE SUMMARY

Provide a brief statement explaining why the petitioned action is being recommended. Include a brief summary of each section of the petition. If a species is being petitioned for listing, state why its survival is threatened by any one or a combination of the following factors (listed in Section 670.1, Title 14, CCR):

(1) present or threatened modification or destruction of its habitat;

(2) overexploitation;

(3) predation;

(4) competition;

(5) disease; or

(6) other natural occurrences or human-related activities.

If a species is being recommended for delisting, indicate why State-listing is no longer warranted, and state why any one or a combination of the aforementioned factors no longer threatens its existence.

### 1. POPULATION TRENDS

Describe current population trends (with numbers and rate) and relate these to viable population numbers. Explain survey methodology used to arrive at numbers or estimates and what assumptions, if any, were involved.

### 2. RANGE AND DISTRIBUTION

In the text, indicate the percentage of historic distribution that is in existence and the rate of loss. If appropriate, indicate the number of extant occurrences, populations or portions of populations in California. Indicate whether the rate of loss is accelerating, and estimate when extinction would occur if current trends continue. Discuss the relationship between historic and current acreage and degree of habitat fragmentation. Describe the quality of the existing habitats in terms of ability to maintain viable populations with or without enhancement. For delisting, indicate how current distribution reflects the recovery of the species since its listing.

3. **ABUNDANCE**

Provide available historic and current population estimates/trends, densities, vigor, sex and age structures, and explain population changes relative to human-caused impacts or natural events. Compare current and historic abundance in terms of overall population size or size of occurrences, populations or portions of populations, as appropriate. Describe current population trends (with numbers and rate) and relate these to viable population numbers. Explain survey methodology used to arrive at numbers or estimates and what assumptions, if any, were involved.

4. **LIFE HISTORY (SPECIES DESCRIPTION, BIOLOGY, AND ECOLOGY)**

Include pertinent information that is available on species identification, taxonomy and systematics, seasonal activity or phenology, reproductive biology, mortality/natality, longevity, growth rate, growth form, food habits, habitat relationships and ecological niche or ecological attributes, interactions with other species or special habitat requirements that may increase vulnerability of the species to certain natural or human-caused adverse impacts (e.g., obligate wetland or riparian habitat species, low birthrate, colonial species).

5. **KIND OF HABITAT NECESSARY FOR SURVIVAL**

Describe habitat features that are thought to be important to the species' ability to maintain viable population levels. Any or all of the following features may be included, as appropriate:

> *Plant community; edaphic conditions; climate; light; topography/microtopography; natural disturbance; interactions with other plants or animals; associated species; elevation; migration or movement corridors; wintering habitat; breeding habitat; foraging habitat; other habitat features.*

For aquatic organisms, the following features may be included in addition to the above:

> *Water temperature; water flow patterns; stream gradient; water chemistry (dissolved oxygen, salinity, etc.); water depth; bottom type; cover type and availability; fish assemblage/community; aquatic plant abundance; other habitat features.*

6. **FACTORS AFFECTING ABILITY TO SURVIVE AND REPRODUCE**

Discuss the basis for the threats to the species or subspecies, or to each population, occurrence or portion of range (as appropriate) due to one or more of the following factors:

(1) present or threatened modification or destruction of its habitat;

(2) overexploitation;

(3) predation;

(4) competition;

(5) disease; or

(6) other natural events or human-related activities.

Identify the direct, indirect, and cumulative adverse impacts and discuss how these are contributing to the decline of the species. Indicate whether the species is vulnerable to random catastrophic events.

For delisting, state why any one or a combination of the aforementioned factors no longer threatens the existence of the species.

7. **DEGREE AND IMMEDIACY OF THREAT**

Indicate the immediacy of the threat and the magnitude of loss or rate of decline that has occurred to the present or is expected to occur without protective measures.

8. **IMPACT OF EXISTING MANAGEMENT EFFORTS**

Describe any ongoing protective measures or existing management plans for the species or its habitat. Information on species or land management activities that are impacting populations or portions of the range and information on proposed land-use changes should be included. This may be best accomplished by discussing populations or portions of the range. A chart may be useful.

Include available information on any or all of the following:

(1) property ownership/jurisdiction for known populations or portions of the range;

(2) current land use;

(3) protective measures being taken, if any, and effectiveness of current management activities;

(4) current research on the species;

(5) existing management/recovery plans and the extent of their implementation;

(6) proposed land-use changes (include knowledge of forthcoming California Environmental Quality Act documents that may or should address impacts, and lead agencies involved); or

(7) county general plans, federal and State agency plans/actions or other plans/actions that address or should address the species.

9. **SUGGESTIONS FOR FUTURE MANAGEMENT**

Describe activities that may be necessary to ensure future survival of the species after listing or delisting. Include recommendations for any or all of the following:

(1) activities that would protect existing populations (site maintenance, preserve design establishment, etc.);

(2) monitoring programs and studies;

(3) needed amendments to existing management and land-use plans, including county general plans;

(4) agencies/organizations that should be involved in planning and implementing management and recovery actions;

(5) other activities that would help protect existing habitat or ensure survival of the species;

(6) how other sensitive species (listed and unlisted) may benefit from protection of this species;

(7) how other species/habitats may be impacted by management and recovery activities for this species; or

(8) at what point this species would be considered stable and sustainable.

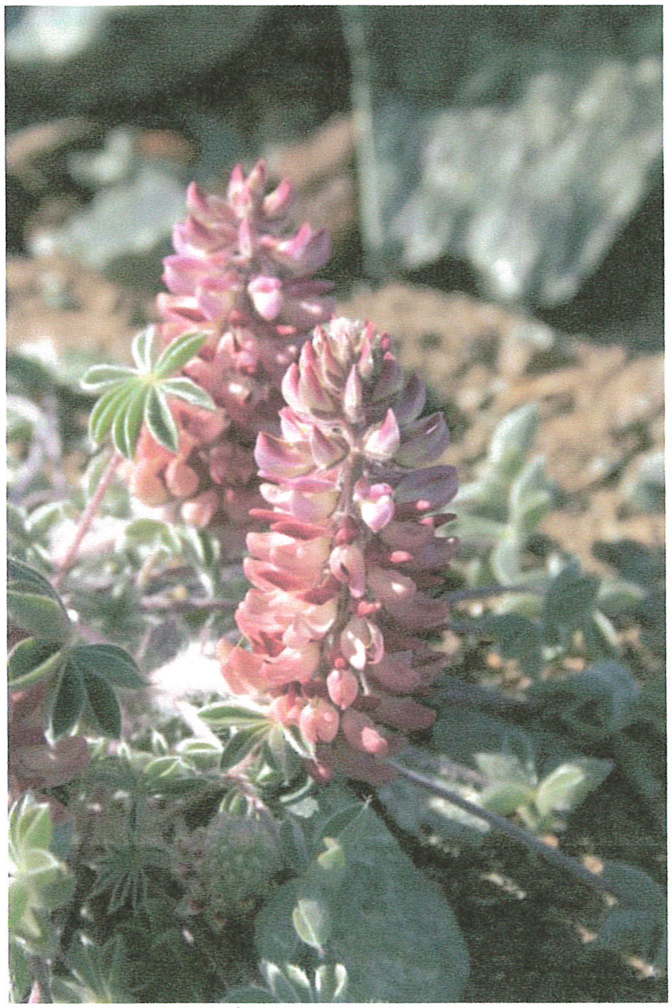
10. **AVAILABILITY AND SOURCES OF INFORMATION**

Cite literature, available specimen collection records, and other pertinent reference materials. Attach documents critical to the recommended action. Be sure to include recent status surveys. List names, addresses, and telephone numbers of persons providing unpublished information and list those supporting the recommended action.

11. **DETAILED DISTRIBUTION MAP**

Delineate on appropriate maps the historic and present distribution (estimated if not known). Include one map of California showing general distribution, and U.S. Geological Survey topographical maps (or equivalent) of appropriate scale, for more detailed distribution information, including locations of occurrences, populations or portions of populations, as appropriate. Include historic and current distribution as documented by literature, museum records, Natural Diversity Data Base and other Department of Fish and Game records, and testimony of knowledgeable individuals. All maps must be suitable for black and white reproduction and fully labeled, including borders, base map name, map scale and species name, and should not exceed 11" x 14" in size.

# PETITION TO THE STATE OF CALIFORNIA FISH AND GAME COMMISSION TO LIST THE LASSICS LUPINE (*LUPINUS CONSTANCEI*) AS ENDANGERED UNDER THE CALIFORNIA ENDANGERED SPECIES ACT



**JULY 14, 2016**

**DAVID IMPER**
**CENTER FOR BIOLOGICAL DIVERSITY**

**Notice of Petition**

For action pursuant to Section 670.1, Title 14, California Code of Regulations (CCR) and Sections 2072 and 2073 of the Fish and Game Code relating to listing and delisting endangered and threatened species of plants and animals.

I. SPECIES BEING PETITIONED:
Common Name: Lassics lupine
Scientific Name: *Lupinus constancei*

II. RECOMMENDED ACTION
To list as Endangered under the California Endangered Species Act

Dave Imper and the Center for Biological Diversity submit this petition to the California Fish and Game Commission to list the Lassics lupine (*Lupinus constancei*) as "endangered" in California, under the California Endangered Species Act (California Fish and Game Code §§ 2050 *et seq.*) ("CESA"). This petition demonstrates that the Lassics lupine clearly warrants listing under CESA based on factors specified in the statute. We look forward to the Commission's response to this petition and processing of it pursuant to the procedures and timelines established at California Fish and Game Code §§ 2073 *et seq.*

III. AUTHORS OF PETITION


Name: Dave Imper
Address:
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Name: Cynthia Elkins
Center for Biological Diversity
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Email: celkins@biologicaldiversity.org


I hereby certify that, to the best of my knowledge, all statements made in this petition are true and complete.

Date: July 14, 2016

Signature: /s/ David Imper
David Imper, M.Sc.,

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## EXECUTIVE SUMMARY

The Lassics lupine (*Lupinus constancei*) is an herbaceous perennial flowering member of the legume family (Fabaceae) endemic to the Lassics mountain range of Humboldt and Trinity counties, in northwestern California. This attractive lupine exhibits striking pink-rose tinged flowers above white-silver foliage, in contrast to the surrounding black or reddish barren slopes. Its total global range consists of less than four acres of mostly barren, shallow serpentine-influenced soils, with a scattered assemblage of shrubs and forbs. Only two occurrences of Lassics lupine have been documented since it was described in 1983, both located above 5,000 feet elevation on the slopes of Mt. Lassic and Red Lassic, within Six Rivers National Forest (SRNF). Both sites were negatively impacted by the Lassics Fire in July and August of 2015. Extensive monitoring and research over the past 13 years indicated the species is trending toward extinction. Events over the past two years have significantly increased that concern.

The Lassics lupine is threatened by four general factors, and thus warrants state protection. The species is threatened with significant curtailment of habitat, as a result of climate change, forest encroachment, and the recent fire. It is also threatened by predation; a very high rate of seed predation and herbivory by wildlife has caused a high rate of mortality, significantly impairing its reproductive potential. Regulatory mechanisms are inadequate to protect the species. The Lassics lupine is classified a Sensitive species by the Forest Service. However, that status and other State and Federal regulations have been ineffective. SRNF has been slow in implementing measures necessary to counter the imminent threats, in part because the majority of the species distribution occurs within designated wilderness. Finally, the species is threatened by other factors; recent and severe mortality related to climate extremes, representative of longer term regional climate trends, indicate if the species is to survive, a greater proportion of the population must occupy habitat more immune to climate extremes. Such habitat formerly occupied by the species has succumbed to forest encroachment over the past 60 years. The SRNF has not pursued the necessary restoration. Without protection under CESA, and the enhanced status, agency prioritization, urgency, and hopefully, funding, that formal listing will facilitate, all available evidence indicates the species is in immediate danger of extinction.

Currently there are no regulatory mechanisms to protect the Lassics lupine from extinction. The petitioners have petitioned the U.S. Fish and Wildlife Service to protect the Lassics lupine under the Endangered Species Act and it is currently under federal status review.

## INTRODUCTION

There is no more appropriate icon symbolizing the beauty and exceptional floristic diversity associated with the Lassics Mountain Range than the Lassics lupine. Named after the Athabascan Lassik tribe, forcibly removed from the region in 1862 (Carothers 2008), the mountain range and its unique lupine have been, and hopefully will continue to be, a permanent memorial to the original occupants of this truly exceptional landscape.

The Lassics lupine is likely the rarest, and based on a recent population viability analysis (PVA), arguably the most threatened plant species in northwestern California. It is substantially more imperiled than any of the six plant species listed as endangered under the ESA within the jurisdiction of the U.S. Fish and Wildlife Service (USFWS) Arcata Field Office (Carothers 2015a, 2015b; Imper 2015; Kurkjian 2012).

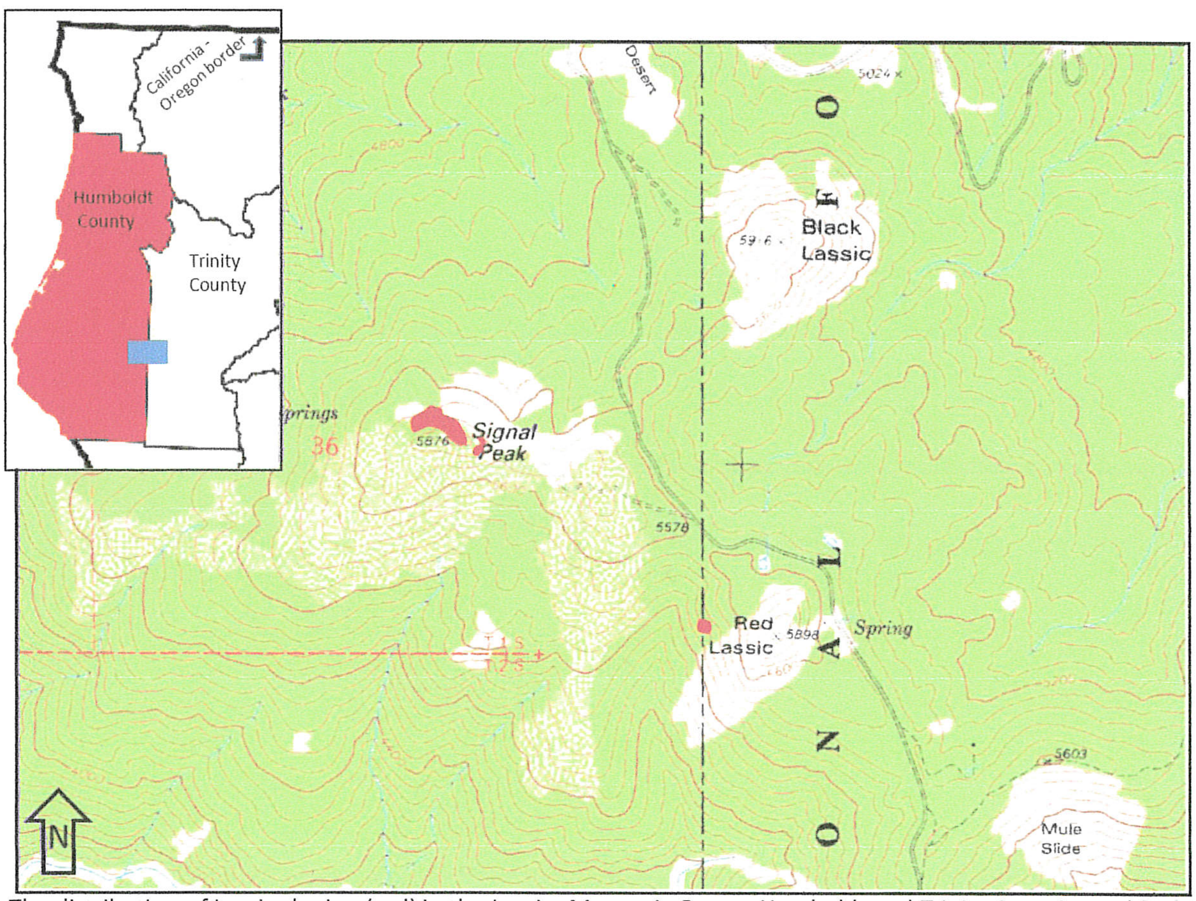
The Lassics lupine PVA (Kurkjian 2012a), which was based on nearly a decade of monitoring and research data, indicated that in the absence of aggressive protection and management measures, the species has a greater than 50 percent risk of going extinct within 50 years.

Lassics lupine at Mt. Lassic

The decline predicted by that analysis was primarily driven by a high rate of seed mortality due to predation by small mammals (Kirkjian 2012). The PVA model did not account for three additional factors threating the population (Imper 2012): 1) occupied habitat at Mt. Lassic is shrinking rapidly due to forest encroachment, 2) prolonged climate extremes, and 3) the Red Lassic colony, one of the two existing colonies, is threatened with extirpation as a result of the loss of shading provided by nearby trees, which subsequently burned in the 2015 Lassic fire (Imper 2012, 2015, 2016).

## RANGE AND DISTRIBUTION

The Lassics Mountain Range is located approximately 80 miles southeast of Eureka, on the Mad River Ranger District, and includes three principle peaks: Mt. Lassic, Red Lassic, and Black Lassic, straddling the Humboldt/Trinity County line (see map below). The Lassics lupine is endemic to Mt. Lassic and Red Lassic, at elevations between 5,200 and 5,700 feet. The largest colony is located near the top of the westernmost of three peaks comprising Mt. Lassic (referred to hereafter as Signal Peak), and on the adjacent saddle (i.e, the lower west-facing slope of the second peak of the three. A second colony, occupying less than 2,500 square feet, is located on the west slope of Red Lassic, approximately 3,000 feet southeast of the Mt. Lassic colony. Various targeted surveys of potential habitat within the Lassics since 1991 have failed to identify any additional sites (Imper 2015). In their description of the species, Nelson and Nelson (1983) cite a voucher specimen collected in 1972 by Nelson (#1017) from "Mt. Lassic and the two smaller peaks to the east." As the name Mt. Lassic is interpreted here, that would suggest the lupine may have previously occurred on the easternmost peak of the three making up Mt. Lassic. However, Imper (2015) did not observe the lupine growing on the easternmost peak in 1982, nor has anyone reported it since. That peak does exhibit a small area of unique soil type on its north face that is identical to that supporting the lupine on Signal Peak, and which has not been documented anywhere else in the Lassics (Alexander 2008). Therefore, it is conceivable the lupine occurred there historically. Several lupine individuals also occurred at the top of the second peak of Mt. Lassic between 2005 and 2012, although these are no longer extent.




The distribution of Lassics lupine (red) in the Lassics Mountain Range, Humboldt and Trinity Counties, California (USGS Black Lassic quadrangle; no scale). Inset map indicates the regional proximity.

Based on annual monitoring, the total area occupied by the species was under four acres in 2014, but has since declined somewhat after four years of drought, coupled with absence of snowpack in 2014, extreme winter and summer conditions in 2015, and to lesser extent, the Lassic Fire of 2015 (Imper 2015). The current occupied range has rebounded temporarily after recent germination of seed in the natural seed bank, but will likely recede again by late summer, 2016, due to a very high mortality rate affecting new seedlings.

## LAND OWNERSHIP AND MANAGEMENT DIRECTION

The distribution of Lassics lupine lies entirely within the Lassics Botanical and Geologic Special Interest Area (SIA) of SRNF. The Mt. Lassic colony is also located within the Lassics Wilderness, designated in 2006.

The Lassics lupine is listed as "Sensitive" by the Forest Service, and as such, the agency is responsible to ensure its viability and to preclude trends toward endangerment that would result in the need for Federal listing as a result of agency actions (Forest Service Manual [FSM] Chapter 2670: Threatened, Endangered and Sensitive Plants and Animals, September 2005).

As a part of the Northern California Coastal Wild Heritage Wilderness Act, approximately 7,000 acres (11 square miles) of the Mt. Lassic Range was incorporated into the Mt. Lassic Wilderness. The orientation of the 2006 Act is in keeping with the earlier wilderness bills to preserve wild and natural features of the landscapes, protect the diverse array of ecosystems (plants, animals, geologic/hydrologic structures), retain and enhance scientific research and promote the recovery of Threatened and Endangered Species (SRNF 2012a).

A portion of Lassics lupine habitat is considered early successional, and very likely was maintained historically by fire (see Habitat – Mt. Lassic – Fire section). The wilderness area is bordered by private lands to the west and north, and National Forest timber lands to the south and east. Political and economic considerations severely limit the feasibility of allowing lightning-caused fires that ignite outside the wilderness to burn, and the likelihood is small for ignition within such a small wilderness. After decades of fire suppression, it is clear that some level of manual treatment, followed by routine prescribed fire is necessary to restore and maintain a portion of Lassics lupine habitat. Unfortunately that same portion of its habitat happens to offer the species the best available refuge from climate extremes.

Abundant Forest Service guidance is available to justify the necessary habitat restoration, caging efforts, and other intervention needed to conserve the species. Specific to designated wilderness areas, FSM 2300 Recreation, Wilderness and Related Resource Management, under Chapter 2320 Wilderness Management, 2323.32 Policy, the agency shall apply the Policies and Guidelines for Fish and Wildlife Management in Wilderness and Primitive Areas, developed jointly by the Forest Service, Bureau of Land Management, and the International Association of Fish and Wildlife Agencies in a practical, reasonable, and uniform manner in all National Forest wilderness units (Association of Fish and Wildlife Agencies 2006). Those policies include a specific process for undertaking habitat restoration needed to conserve endangered species (formal listing is not technically necessary) within wilderness (including mechanical use and tree removal), to wit: "*actions necessary to conserve or recover threatened or endangered* *species, including habitat manipulation and special conservation measures, that involve uses generally prohibited under Section 4 (c) of the Wilderness Act, will be considered and may be authorized by the Federal administering agency through application of the MRDP as outlined in Section E., General Policy*." Relevant to state listing, the Association of Fish and Wildlife Agencies Policies and Guidelines clearly recognizes the state's authority to manage fish and wildlife resources in wilderness areas, and also provides a framework for cooperation upon which fish and wildlife projects and management are implemented by the state and federal agencies for future generations.

Forest Service manual policy states the agency shall "manage wilderness to protect known populations of federally listed threatened or endangered species where necessary for their perpetuation and aid in their recovery in areas of previous habitation." Yet, the SRNF has not implemented habitat restoration to benefit the lupine, nor has it been aggressive in pursuing recovery actions. U.S. Fish and Wildlife (USFWS) staff repeatedly urged SRNF to give higher priority to recovery of the species for more than a decade, in order that Federal listing might be precluded. The reasons given for the agency's inaction generally included: conflicts with Wilderness values or other administrative roadblocks, lack of funding and staff, and conflicting Forest priorities (Carothers 2005; SRNF 2012b; Imper 2015). Maintenance of wilderness values was also cited by the Forest Supervisor in his 2012 decision requiring removal of cages protecting the lupine, *within months after* a PVA (Kurkjian 2012a) indicated that to do so would very likely lead to extinction of the species (Imper 2015).

## CHRONOLOGY OF PAST INVESTIGATION

2002 – Initiation of Lassics lupine demographic monitoring.
2003 – Lassics lupine pollination study (Crawford and Ross 2003); Initiation of seasonal caging at Red Lassic to preclude browsing; first *in situ* lupine seed germination trials, expanded in 2005, 2009; boulder placement to block vehicle access.
2004 - Draft conservation strategy for the botanical area (Carothers 2004); Forest closure order to preclude OHV use; trail relocation to reduce pedestrian impacts; genetics study; first *ex situ* seed germination study (Gile 2004); plant cage design modified to prevent seed loss to rodents and cages installed at Mt. Lassic.
2005 – Lupine seed stored in seed bank at Berry Botanic Garden (currently the Rae Selling Berry Seed Bank, Portland, Oregon; habitat, soils and micro-climate studies initiated; initial population introduction efforts, expanded in 2008, 2012, 2014; small mammal monitoring initiated.
2006 - Lassics Wilderness designated.
2007 – Second germination study (Guerrant 2007).
2008 - Buried seed study to assess seed bank longevity; expanded soil survey and chemical analysis to characterize Lassics lupine soils and identify potential introduction sites (Imper 2012); vegetation study to assess historical vegetation dynamics and fire history (Carothers 2008).
2010/2011 – Multiple-year lupine seed predation and production studies initiated, and seed production model developed (Kurkjian 2010; 2011; 2012b).
2012 – Population viability analysis completed (Kurkjian 2012a).
2013 – Humboldt State University wildlife studies initiated, focused on identifying principle seed predators and relationships between seed predation rate and vegetation encroachment.

## CONSERVATION STATUS AND MANAGEMENT EFFORTS

### Regulatory

Lassics lupine is included on California Rare Plant Rank 1B.1, of the California Native Plant Society (CNPS) Inventory of Rare, Threatened, and Endangered Plants of California, maintained by the California Natural Diversity Database and California Native Plant Society, indicating it is rare, threatened, or endangered (CNPS 2015). The species is covered under the California Environmental Quality Act (14 Cal. Code Reg. §15380). It is not listed under the California Endangered Species Act. Lassics lupine is included on the Sensitive Plant list maintained by SRNF. The California Natural Diversity Database (2015) and NatureServe (2015) rank Lassics lupine as critically imperiled (G1/S1).

The Lassics lupine was proposed by SRNF staff (1995) for Federal candidate status in 1995, based primarily on Factor A (destruction of habitat) and Factor C (inadequacy of regulatory mechanisms). The major threats cited were cattle grazing, recreational use (primarily hunters), and inadequate funding by the Forest Service to control those impacts. The petition was denied by the USFWS, citing insufficient information (Fuller 1995).

### Draft conservation strategy

A draft conservation agreement was developed in 2012 between the USFS and USFWS to define near-term conservation measures, research needs and timeline, and the respective responsibilities of agencies and other partners involved in the conservation effort (USFWS 2014). Among other tasks, the strategy calls for seasonal caging of plants as an interim measure, continuation of ongoing research, and experimental vegetation manipulation. Reintroduction of disturbance is needed to 1) counter conifer succession, which has reduced habitat suitability for Lassics lupine and potentially attracted small mammals and, 2) counter increased chaparral cover which provides habitat for small mammals. Proposed research would focus on discerning the extent to which chaparral adjacent to lupine areas affects seed predation. Research outcomes would help guide management aimed at reducing the impacts of seed predation on Lassics lupine viability. The strategy has not been finalized by the two agencies at this time.

### Past conservation efforts

***Plant caging:*** In response to observations of high rates of predation on nearly-mature lupine seeds, approximately 20 wire mesh cages were placed on lupine individuals at Red Lassic in 2003. The effort was expanded in 2004 to include roughly 60 cages at Mt. Lassic. The simple capped tube cage design was ineffective at excluding small mammals, resulting in loss of virtually all seed produced that year. Based on an experimental program, the cage was redesigned in 2005 to include both an upper and lower fabric bonnet extending out from the central barrel. When installed properly, the cages are usually 100 percent effective (Kurkjian 2012c).

***Population viability analysis:*** The PVA (Kurkjian 2012a) was conducted to help identify the most critical life transition stages for the lupine and to assess the species' risk of extinction. The model was based on nine years of demographic data from three monitoring transects and related research, and predicted the annual population growth rate (lambda) under various conditions. The results indicated that if all reproductive plants were left uncaged and exposed to a constant 95 percent seed predation rate, the probability of quasi-extinction (defined as 10 adult plants or fewer remaining) within the next 50 years would range between 68.4 and 100 percent across the three monitoring transects. If all reproductive plants were caged, and therefore protected from seed predation, the probability of quasi-extinction in the next 50 years across all sites dropped to between 0 and 1.8 percent. Even with the current caging effort, the model suggests that stochastic events over the next decade will move the species closer to extinction.

***Population expansion:*** Three attempts have been made to introduce Lassics lupine to new locations isolated from the existing colonies. Based on soils analysis conducted within and adjacent to the two lupine colonies, 44 unscarified seed were planted at four new locations in 2005 (Imper 2012). Weather stations were also installed at the sites. Three of the four sites exhibited germination, but only one site retained live lupine plants after June 2007. This site was on the north side of the easternmost peak of Mt. Lassic (i.e., ML Peak#1). Additional research on potential introduction sites was conducted, this time taking into account physical site factors that may help to mitigate a drier and warmer climate. A total of 310 unscarified seed were planted at five locations in October 2012 (Imper 2012). The cumulative germination rate as of June 2014 for those sites ranged 3-18 percent. In November 2014 additional seed were planted at the two sites that had yielded the best germination and survival in the previous effort (Lower Mule Ridge and ML Peak#1). However, other than the ML Peak#1 site, plant survival for more than one year was negligible at all sites.

The results for the ML Peak #1 site were encouraging. Other than the north slope of Signal Peak, approximately 1,000 feet west of ML Peak #1 (supports a large proportion of the lupine population), this site was the only location within Alexander's (2008) study area in which he mapped the presence of the CM map unit soil (i.e. clastics mixed with serpentine; see Geology and soils section). The similarity was supported by laboratory analysis. That and its location on a north-faced slope suggested it offered the best opportunity for introduction of the lupine population. Indeed, the seeding effort as of June 2014 appeared to have succeeded; the 311 seed planted there since 2005 had produced a colony consisting of four reproductive plants, which had produced four juveniles and three new seedlings. Regrettably, following the warm and largely snow-free winter of 2014-15 (see Habitat – Climate section), all of the reproductive plants died and only two juvenile plants remained as of June. The near extirpation of this colony is not surprising, given the severe losses suffered by the lupine population in general, but it does emphasize the urgent need to restore existing habitat, or locate new habitat that provides greater refuge from climate extremes.

## POPULATION TRENDS AND ABUNDANCE

### Demographics

***Seed bank:*** The Lassics lupine produces a relatively large thick-coated seed, and maintaining a reserve of dormant seed in the soil (i.e., seed bank) appears to be an important strategy for the species. A buried seed bag study conducted between 2008 and 2013 (Carothers 2013a, 2013b) indicated an early decline in the percentage of dormant seed in the soil. Approximately 50 percent of the initial seed remained intact and viable after 1 year, 25 percent after 2 years, and an average of 22 percent for each of the succeeding 3 years of the study. The missing seed each year either germinated or died due to other causes.

***Germination and early survival:*** Under optimum conditions germination of well-formed Lassics lupine seed can approach 100 percent. A greenhouse propagation study by Guerrant (2007) resulted in 98 percent germination when seed were scarified (5 percent germination without scarification). Multiple *in situ* germination trials conducted since 2003 using mostly unscarified seed generally yielded a relatively low rate of germination and early survival, with a maximum 20 percent germination rate observed after 7 years, and as high as 8 percent survival at 6 years for those seed that did germinate. In most cases the germination rate was much lower, and fell dramatically after the first year or two (Carothers 2013a; Imper 2015).

Based on the monitoring transects, new seedlings generally comprise 20-50 percent of total plants (Kurkjian 2012c), but that likely is an overestimate due to the enhanced seed productivity and survival due to the caging effort. Both monitoring data and anecdotal evidence suggest that much or all of the increase in lupine population observed during the 5 years prior to 2014 was the result of caging reproductive plants (Figure 1).

***Mortality:*** Loss of seed to predation by small mammals during most years since 2003 has been very high, in many years approaching 100 percent of seed produced. Kurkjian (2010) observed an 86 percent predation rate of fruit in uncaged plants, compared to 5 percent for caged plants. In addition, Kurkjian (2010) noted the occurrence of small mammals collecting lupine seed from the soil surface after dispersal, also noted by Imper (2015), with an unknown rate of loss.

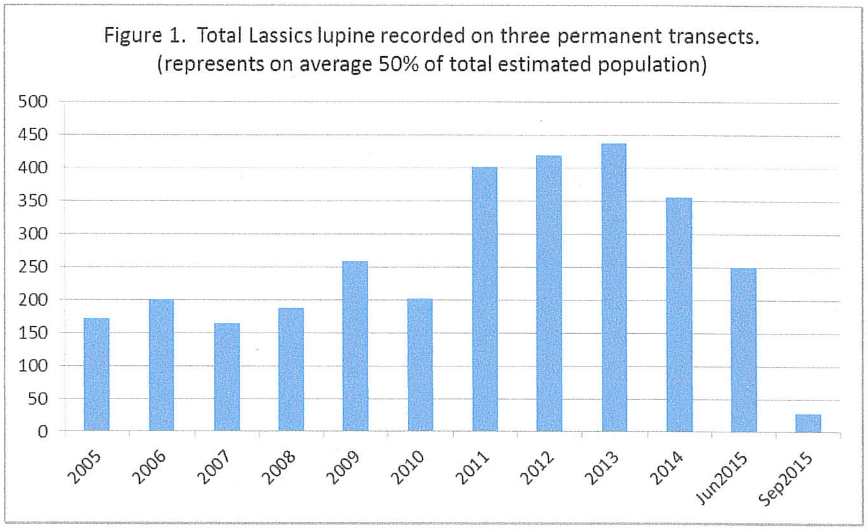
Annual mortality rates for the lupine are quite variable, but are normally high. Between 2003 and 2011, August to August adult mortality averaged 26 percent (range 10-50 percent) for the three transects. Annual seedling mortality was higher, ranging 48-64 percent (Imper 2015). The relationship between climate and lupine mortality has not been straight forward, and clearly is confounded by other factors such as wildlife browsing. Nevertheless, monitoring has indicated that climate-induced lupine mortality is most closely associated with lack of summer rainfall, in combination with high summer temperatures, the effects of both being exacerbated by early snowmelt dates. For example, lupine mortality in the Mt. Lassic colony was extremely high in 2015, a year in which winter and summer temperatures were near record highs, and winter snowpack was negligible. In contrast, lupine mortality in 2005 was very low during the growing season, when summer rainfall appeared to be the most plentiful observed since 2000, and served to replenish summertime soil moisture readings to saturated levels (Imper 2012). The snowpack that year also extended well into May, and the June-August mean temperature was the coolest recorded since 2000. The combination of these factors appears to have been optimal for the lupine. The degree to which site conditions mitigate for summer climate extremes undoubtedly explains much of the difference in lupine mortality, plant density and reproductive vigor observed across the site in any one year (Imper 2012).

In summary, multiple factors contribute to the generally low reproductive potential of the lupine. These include: relatively high mortality rates due to desiccation, animal browsing and excavation around the rootstock; severe seed predation combined with predation from the soil surface after dispersal; typically low *in situ* germination rates, and apparent rapid decline in seed longevity in the seedbank.

**Population Record**

Demographic monitoring of the Lassics lupine has been conducted annually along 2 permanent transects since 2003; one transect encompasses the entire colony at Red Lassic and a second transect encompasses most of the plants on the saddle between Signal Peak and the second peak of Mt. Lassic. A third permanent transect was established in 2005 in the forest habitat on the lower slope of Signal Peak. Location in reference to the transect tape, life stage, plant size, number of inflorescences, number of fruits, evidence of herbivory and/or seed predation, predation intensity, and whether the plant is caged are recorded for each plant during each monitoring period.

The three transects along which Lassics lupine demographic data and location coordinates are recorded are estimated to represent roughly half of the entire population. Total population has been variously estimated at between 500 and 1,000 plants over the past 12 years. The majority of the north slope of Signal Peak itself is too steep to traverse without damage to the soil, and surveys of the lupine there have generally been limited to counts of adult plants from a trail bisecting the colony, using binoculars. With the exception of a relatively small flat near the summit, which exhibits robust and dense lupine plants, the average density across the slope is relatively low.




At the time the PVA was completed, the lupine population was estimated on the order of 800 total plants with fewer than 400 reproductive plants (Kurkjian 2012a; Carothers 2014). In June 2015, following two very warm winters and virtually no winter snow accumulation, monitoring indicated the overall population had fallen to some 390 plants, including an estimated 103 reproductive plants (Carothers 2015a; Carothers 2014; Imper 2015). At that time the mortality since the previous year was approximately 48 percent (Carothers 2015a). In late July and August 2015, the Lassic Fire burned a portion of the Mt. Lassic colony, and burned through the entire Red Lassic colony with stand-replacing severity. In addition, unusually dry and warm conditions continued through the summer. As a result, monitoring conducted in late September suggested as much as 80 percent mortality had occurred ***just since the June 2015 sampling*** (Carothers 2015b), potentially reducing the population of Lassics lupine to as few as 60 individuals ***(i.e., 7% of the estimated population when the PVA was completed)*** (Figure 1). Inventory data are not available yet, but initial assessments conducted in May 2016 indicate the population may have declined even more than that projection (Imper 2016). No adult plants appear to have survived at the Red Lassic site, and survival in at least a portion of the Mt. Lassic population appears worse than expected.

## LIFE HISTORY

### Taxonomy and Genetics

The Lassics lupine is a member of the caespitose lupine complex of western North America, and was described in 1983 based on specimens from Mt. Lassic (Nelson and Nelson 1983)(Integrated Taxonomic

Information System Taxonomic Serial Number [TSN] 503578). The Lassics lupine appears most closely related, but bears little obvious resemblance to the more widespread *L. sellulus* var. *ursinus* (Nelson and Nelson 1983). The species was briefly reduced to a variety of L. lepidus (*L. l.* var. *constancei* [T.W. Nelson & J.P. Nelson] Isely) by Isely (1998) but was maintained as *L. constancei* in the 2012 Jepson manual (Baldwin *et al.* 2012). No closely related lupines with which the Lassics lupine may be confused occur in the vicinity of the Lassics.

Isozyme analysis was used to assess the amount of genetic differentiation between the two Lassics lupine colonies at Mt. Lassic and Red Lassic (Wilson and Hipkins 2004). Overall genetic diversity within the species was judged to be very low, and differentiation between the colonies was a small component of total variation observed.

**Species Description**

The species is easily distinguished from other members of the caespitose lupine complex by its short erect stem, short thick inflorescence, white and pink-rose bicolored flowers, glabrous keel, and several other characteristics (Nelson 1980; Nelson and Nelson 1983). The Lassics lupine is a short-lived perennial, although individual plants have been observed to live up to 12 years. Plants are tap rooted with a woody caudex, grow close to the ground in a matted habit, and may reach a diameter of 12 inches or more. A mature plant growing under optimal conditions may produce 20 or more inflorescences (flowering stalks); more typical is one to three inflorescences (LUCO database - Kurkjian 2012c). A single flowering stalk can produce up to 20 or more fruits (legumes) per stalk, but usually fewer, each containing from one to four seeds (Carothers 2012, Kurkjian 2012a). At maturity, the fruits split along the suture and seeds have been observed to be projected to a distance of four feet or more away (Imper 2015).

**Habitat**

***Red Lassic:*** Although soil characteristics and geology are similar between the Red Lassic and Mt. Lassic lupine sites, the lupine habitat at Red Lassic is an anomaly. In contrast to the Mt. Lassic colony, generally confined to a north slope, the Red Lassic colony is situated on a southwest aspect at the crest of a slope, and appears entirely dependent on two potentially temporary conditions: overstory shading and snowmelt. Large Jeffrey pines (*Pinus jeffreyi*) provide partial shelter from the south and southeast. In addition, a topographic depression formed by a mass failure on the lower slope of Red Lassic is located adjacent to the colony, and during normal years retains snow or water into the early summer. The combination of those two factors appears to mitigate what otherwise would be conditions too hot and dry to sustain the lupine (Imper 2012). Species typically associated with the lupine include Jeffrey pine, pinemat manzanita (*Arctostaphylos nevadensis*), sandwort (*Minuartia nuttalii*) wintergreen (*Pyrola picta*) and a few others (Carothers 2004).

The distribution of Lassics lupine at Red Lassic surrounds a core area where the lupine is absent, and which is more exposed than the surrounding area due to the lack of tree cover. An investigation was conducted from 2007-2009 on the relationship between solar radiation, soil temperature, and distribution of the lupine. Soil temperatures were recorded across a grid encompassing the lupine distribution. Vertical 180 degree photographs taken at the same grid points were analyzed with Winscanopy software to calculate mean daily understory radiation. As expected, the understory radiation levels for June, July and August were significantly correlated with monthly mean and maximum soil temperatures. The results also indicated levels of light and soil temperature rose dramatically within the central area that is devoid of lupines. When one of the six pine trees providing shelter to the lupine colony was removed digitally from the images, the results suggested that August maximum soil temperatures in occupied lupine habitat would rise on the order of 10 degrees F., sufficient to eliminate the lupine (Imper 2012). All six trees were charred in the 2015 Lassic fire and their viability is not yet known.

***Mt. Lassic:*** Lassics lupine habitat at Mt. Lassic in general is open, with scattered buckbrush (*Ceanothus cuneatus*), whitethorn (*C. cordulatus*), stunted Jeffrey pine and incense cedar (*Calocedrus decurrens*) trees, and a variety of herbs including *Allium hoffmani, A. falcifolium, Phacelia corymbosa,* and *Galium grayanum* (Carothers 2004). Slope angle ranges from nearly flat on the saddle east of Signal Peak, to 80 percent or more on the north slope of Signal Peak. The habitat may be divided into three basic types, with ramifications for lupine density, reproductive vigor and mortality. These general habitats include: steep barren slopes, barren flats, and Jeffrey-pine forest. The majority of plants occur on moderate to steep north or west-faced slopes, with a large proportion of gravel or cobble at the surface, high insolation and no litter layer. Snow tends to melt earlier, and soils tend to dry out earlier than in the other occupied habitat. In this habitat the lupine generally exhibits low density, and intermediate growth and reproductive vigor (Imper 2012).

Two areas of what appears to be optimum habitat for the lupine occur on flat to moderate slopes, in micro-sites that in normal years hold snow later in the season, and as a result retain soil moisture near the surface later into the summer. These sites include: 1) a bench near the top of Signal Peak, and 2) the east side of the Mt. Lassic saddle just as it breaks onto a northerly aspect. Though open, these sites also receive a relatively high degree of orographic shading, and exhibit intermediate soil temperatures compared with other lupine habitat (Imper 2012). The lupine here occurs in greater density, and is the most robust with respect to size and reproductive vigor.

The least favorable habitat for the lupine, from the standpoint of reproductive vigor and growth rate, is found lower on the slope at the edge or within the Jeffrey pine/incense cedar forest. At Mt. Lassic, this habitat generally is intermediate with respect to soil moisture retention in late spring and summer, but exhibits distinctly lower insolation and soil temperatures in summer (Imper 2012). Based on the unprecedented lupine mortality observed following the warm, dry winter of 2014-15, this habitat appears to provide some degree of refuge from climate extremes; lupine mortality was somewhat lower in the forest than on the open slopes (Carothers 2015a; Imper 2015).

The forested lupine habitat occurs in two areas: 1) a monitoring transect located on the northwest side below Signal Peak, with a relatively small concentration of Lassics lupine, and 2) an area of forest encroachment to the northeast below Signal Peak and north of the saddle area. The latter area supports a small number of lupine under a relatively closed canopy of Jeffrey pine, and among mats of prostrate buckbrush (*Ceanothus prostratus).* This area is the focus of future habitat restoration efforts involving tree removal or girdling (see Factor A).

***Solar radiation:*** Similar to the study described above for Red Lassic, an analysis was conducted to determine how average daily radiation levels in June vary around the lupine distribution perimeter (Imper 2012). The radiation levels ranged from less than 40 moles per meter squared per day (mol/m2/day), on the northern slope within the forest canopy, to 63.3 mol/m2/day in the open at the south boundary. The maximum theoretical June radiation for this location (calculated for a due south aspect at about 40 percent slope) is 64 mol/m2/day, suggesting that June radiation (and likely soil temperatures) probably is not a major factor limiting the lupine. Average daily radiation was then recalculated for the colony perimeter photo-points for the month of August, and compared with the maximum theoretical input (62 mol/m2/day). Radiation levels at or within the lupine distributions did not rise above 53.1 mol/m2/day, suggesting that late summer radiation levels (i.e., soil temperatures) after the soils had dried out may be a critical determining factor, at least for the southern boundary of the colony.

***Fire:*** While fire suppression records date back to 1910 on SRNF, aggressive suppression of fires in remote areas of the Forest did not begin until the end of World War II. Prior to 2015, only three natural fires have been recorded in the vicinity of the Lassics peaks themselves, all in 1953. Of course fires further from the Lassics could well have spread into lupine habitat, were it not for fire suppression. Estimated fire intervals range from 13-20 years for most of the Mad River District (Carothers 2008) but may be longer for open habitat with low understory fuels. The Lassics were within the territory of the Athabascan Lassik tribe, and it is likely that they periodically burned to keep forests clear of undergrowth for hunting and travel (Carothers 2008). Such fires would have been understory burns that consumed the duff and young trees that characterize the forest today.

Past fire suppression is considered to be the most likely factor leading to the forest encroachment observed on the lower face of Signal Peak, and which is currently degrading Lassics lupine habitat. The supporting evidence includes the complete absence of stumps or other evidence of a previous stand in this habitat, and the frequent presence of fire scars on old-growth trees near and below the young stand.

**Pollination**

Crawford and Ross (2003) investigated pollination of the Lassics lupine, and in the process incidentally made the first observation of the very extreme level of seed predation suffered by the lupine. The majority of lupine pollination was by two widespread bumble bee species, *Bombus vosnesenskii,* and *Bombus melanopygus.* The rate of pollinator visitation was high, and the three most frequent bee species appear to be effective pollinators, as they are large enough to trigger the mechanism that releases pollen and presents the stigma.

**Small mammals**

Based on small mammal trapping conducted since 2005, small mammal fauna within and near the lupine habitat is dominated by two species of deer mice (*Peromyscus boylii* and *P. maniculatus*), and two species of chipmunk (*Tamias senex*, and *T. sonomae*) (Falxa 2015). Small mammal abundance estimates have varied substantially among years, and are generally highest in the chaparral type, which on average has small mammal abundance 1.6 times greater than in the open habitat, and more than twice the abundance found in forest on the north slope of Signal Peak. The trap data also indicates that late spring precipitation (April-June total) is negatively correlated with small mammal abundance in general, and in particular, in the open habitat type. The regression RSQD (0.70) using precipitation to predict open trap rate is highly significant (F statistic P value < 0.005) if the atypical weather years 2014 and 2015 are excluded, and still significant (P value < 0.05) when they are included (Imper 2015).

**Geology and Soils**
Alexander (2008) described soil map units in detail over an area of approximately 250 hectares, comprising the majority of exposed serpentinized peridotite, and colluvium predominantly composed of serpentinized peridotite, within a six square mile area enclosing the Lassics. Non-serpentine soils were not included, except one unique map unit (clastic sedimentary rock-based soil), which supports a portion of the Lassics lupine population. The majority of the Lassics lupine occurs on soils (map unit CS) described by Alexander (2008) as barren/very shallow Entisols/clastic metasedimentary rock colluvium over serpentinite, with moderately steep slopes (12-30 percent). The distribution of this soil is primarily limited to a portion of the north slope of Mt. Lassic. A second soil type (map unit CM), supports perhaps 20 percent of the aerial extent of the population, and also is limited to the north slope of Mt. Lassic. Alexander described this soil as rocky, very shallow Entisols/clastic sedimentary rocks, with very steep slopes (60-75 percent), with sparse conifer trees and deciduous shrubs. The remainder of the lupine population was mapped on a widespread soil type (map unit SD), described as moderately deep Hyampom variant, cold, and deep to very deep Hungry family complex/serpentinite, with steep slopes (25-60 percent) and open forest. Only a very small portion of this soil type actually supports the lupine.

Mineralogical and physical analysis of soils appeared to distinguish those areas supporting the lupine from the map unit in general.Macro- and micronutrient and heavy metal concentrations, and other parameters were characterized in soils collected across the range of ultramafic-soils, and selected other soils present in the Lassics between 2005 and 2009 (Imper 2012). The initial investigation was designed to distinguish Lassics lupine soils from the immediate surrounding habitat. With little exception, the soils supporting the lupine were similar in several key indicators, particularly soil texture; also carbon, nitrogen, magnesium, lead and nickel concentrations, compared to adjacent habitat not occupied by the lupine. Further soils analysis beginning in 2009 focused on identification of potential sites for lupine introduction. The results were analyzed with Principal Component Analysis (PCA) to select the variables that best characterized soils supporting the lupine. Among the 52 samples collected, pH and sand content were generally intermediate in soils supporting the lupine, with pH ranging 5.7-6.8 and sand content ranging 81-91 percent. The totally barren, green-gray serpentine soils typical of much of Mt. Lassic were similar in many respects, but differed from lupine soils in higher sand content and pH, and also lower lead levels.

PCA and polynomial multiple regression were then used to rank the different collection sites for lupine suitability (Imper 2012). Several suitable locations were indicated on the north slope of Mt. Lassic below the existing lupine distribution, as well as on the easternmost peak of Mt. Lassic, Mule Ridge, and near Red Lassic. From those, five sites that appeared to offer greater refuge from warming temperatures, such as northerly aspects, were planted with lupine seed in late fall 2012 (see Conservation Status - Past conservation efforts section).

**Climate**
***Regional:*** The Zenia Forest Service Guard Station is the closest formal weather station to the Lassics, located at 4,000 feet elevation, 8 miles south and approximately 1,500-1,700 feet lower than the distribution of Lassics lupine. Precipitation and air temperature data have been recorded there since 2000 (California Data Exchange Center 2015a). Average annual precipitation for the 16-year period is 71 inches (range 32 – 102 inches). The coldest and wettest month at Zenia over the record period was

December, with a daily temperature mean of 40.5 degrees F. (range 35.8 - 44.5), and total December precipitation average of 18.0 inches (range 1.27 – 38.9 inches). The hottest month was consistently July; average daily temperature for the recorded period was 69.3 degrees F. (range 64.0 – 72.6), with average precipitation for the month at 0.3 inches (range 0 – 2.5 inches).

While annual and monthly precipitation at Zenia in 2014 was generally average for the record period, data for 2015 indicate near record lows for January, March and May. As a result, the total January-April precipitation was third lowest in the 16-year period, and precipitation for those months exhibit a distinct drying trend over the period, as does December and January precipitation (Figure 2). Temperature data for Zenia also exhibit strong warming trends. Mean temperature for the period January-March, and June-August of 2015, as well as June-August of 2014 were among the two warmest during the 16-year period (Figures 3 and 4).

In order to determine if the 16-year climate record for Zenia reflects localized, short term trends or more widespread, longer term trends, temperature data for the Big Flat weather station approximately 60 miles to the northeast in the Trinity Alps, were compared. Weather data at Big Flat, 5,100 feet elevation, have been collected since 1985 (California Data Exchange Center 2015b). Although monthly averages range up

Figure 2. Total December and January monthly rainfall
Zenia CDEC weather station, 2000-2015

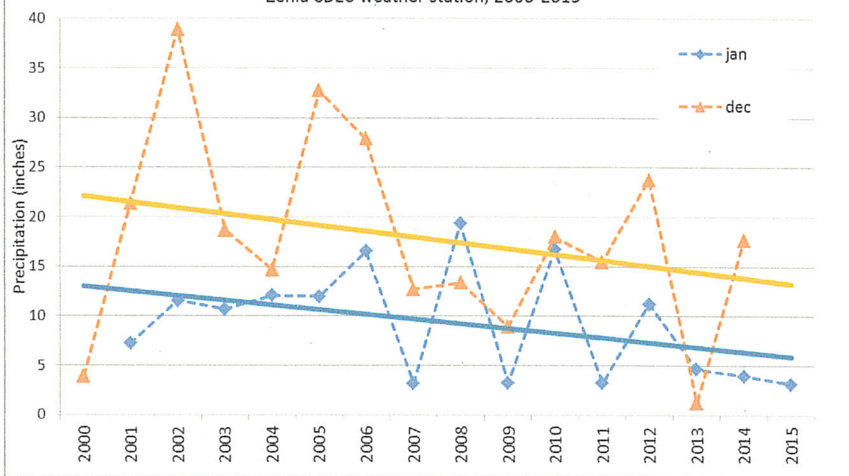



Figure 3. Mean January-March monthly temperatures
Big Flat (BFT) & Zenia (ZEN) CDEC weather stns, 1985-2015

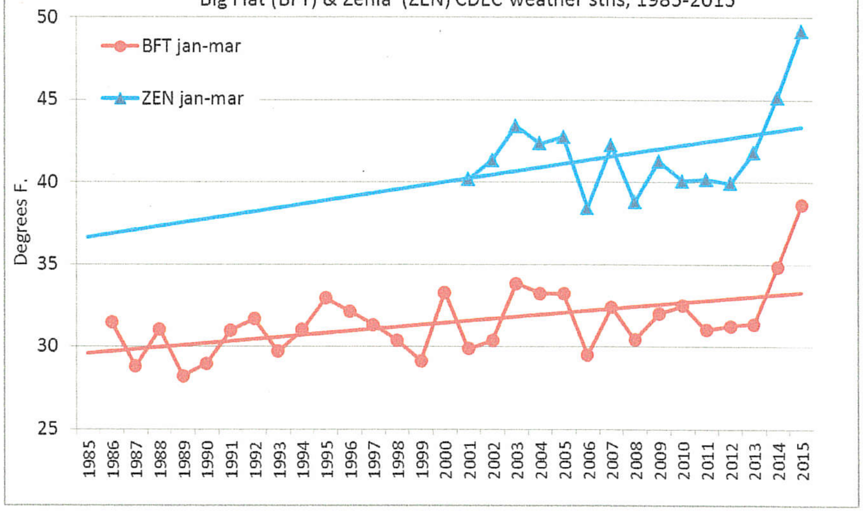
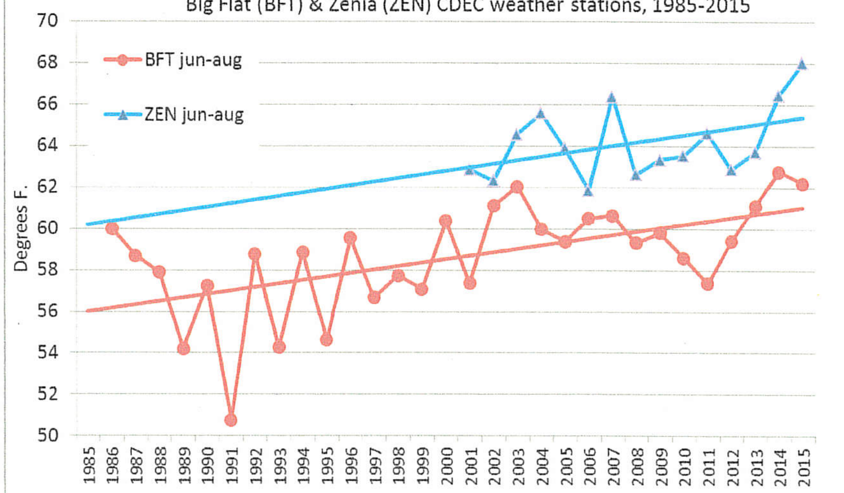



Figure 4. Mean June-August monthly temperatures
Big Flat (BFT) & Zenia (ZEN) CDEC weather stations, 1985-2015



to 10 degrees F. lower in winter compared to Zenia, the data are likely more representative of conditions on Mt. Lassic, and the monthly fluctuations observed over the 16-year overlap period are remarkably similar (Figures 3 and 4). Similar to Zenia, mean temperature from January-March of 2015 was the warmest of the 31-year record, and for June-August of both 2014 and 2015 was among the warmest on record. The strong correlation between Zenia and the longer record period suggests the recent climate extremes experienced at Mt. Lassic are indicative of longer term trends.

***Climate at Mt. Lassic:*** In such an extreme environment as the summit of Mt. Lassic, which is under snow for up to 8 months a year, subject to hot, dry summers, extreme soil temperatures, and soils that are well-drained, infertile and potentially toxic, it is not surprising that climate factors (both above and below-ground) play an important role in the distribution and life history of the Lassics lupine.

The combination of snowmelt date, summer precipitation, late summer temperatures and specialized soils characteristics, all appear to be critical factors affecting the Lassics lupine distribution, mortality, reproduction and recruitment. Weather data recorded at Zenia in many cases are good indicators of spring conditions in Lassics lupine habitat, particularly the date of average snowmelt. Those data were also correlated with lupine mortality rates, particularly summer temperatures and rainfall (Imper 2012).

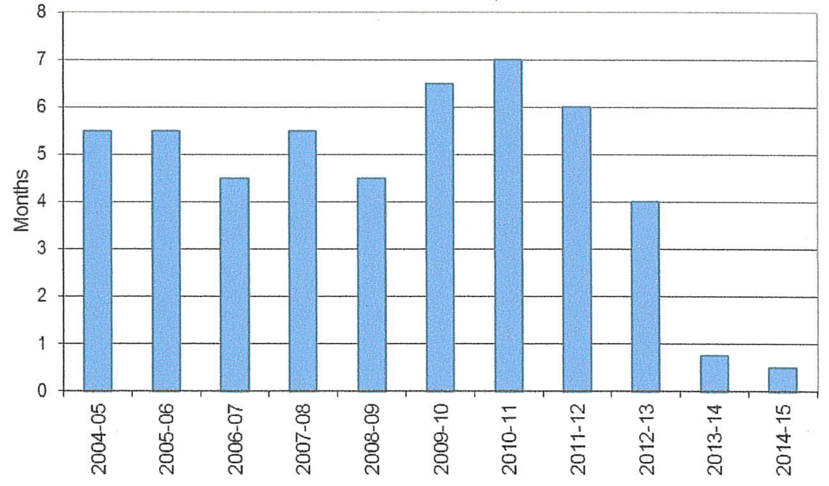
Above and below ground climate conditions were investigated within lupine habitat between 2005 and 2012 to assess: 1) spatial and seasonal variability in date of snowmelt, and ways to predict it remotely; 2) spatial and seasonal variability in soil temperature and moisture, and how it influences Lassics lupine distribution and demographics; and 3) how spatial variability in solar radiation is moderated by canopy, topographic shading, aspect, and slope; and how those factors are related to Lassics lupine mortality.

Soil temperature, available soil moisture, and solar radiation measured as photosynthetically active radiation (PAR), were recorded for various periods at 14 sites within and near Lassics lupine habitat between 2005 and 2012. The influence of solar radiation on lupine demographics and distribution was also investigated using Winscanopy software, similar to the Red Lassic study. In this case, the primary focus was on late spring and summer radiation levels, in order to investigate the influence of radiation inputs on the snowmelt date, and its influence on heat and soil moisture stress and how those factors influence the south boundary of the lupine.

A rain recorder was also installed at the top of Mt. Lassic between October 2009 and June 2012. Monthly totals averaged 61 percent of that recorded at Zenia over the entire period (Zenia recorded 241 inches over the three full winters the recorder was installed at Mt. Lassics). The discrepancy in recorded precipitation was undoubtedly influenced by the much higher proportion falling as snow at Mt. Lassic (except 2013 and 2014), for the most part not recorded by the rain recorder. The total June-September precipitation was as much as 0.7 inches less than recorded at Zenia, and was 3.4 and 2.3 inches in 2010 and 2011, respectively. Both the stations recorded rain on about 37 percent of the days between October 2009 and June2012, with about 70 percent of those days in common between the two recorders. The commonality increased to nearly 80 percent for the summer months.

The duration of snowpack was (and continues to be) monitored with Onset Hobo temperature loggers buried at four inches in the soil, which exhibit an abrupt rise in temperature above freezing within a few days following snowmelt. The accuracy of this method for determining snowpack duration is in good accordance with fluctuation in solar radiation readings (PAR sensors placed 12 inches above the ground), which provided a second direct indication of snow cover. An index of snowmelt date was derived from the average of four Hobo sensors buried within Lassic lupine habitat on Mt. Lassic and Red Lassic (Imper 2003). Between 2005 and 2013, the index of snow pack duration ranged from 4 to 7 months (mean 5.5 months); snow was virtually absent in 2014 and 2015 (intermittent snow covered the ground surface less than 2 weeks total throughout the winter. Data for the coldest site of the four monitored, on the north side of the Mt. Lassic saddle, are shown in Figure 5. The date of snowmelt varied somewhat among different lupine habitats, with the Red Lassic and top of the saddle at Mt. Lassic melting earliest, followed by open areas on the north slope, and finally the forested habitat (Imper 2012).

Figure 5. Estimated winter snowpack duration North Saddle of Mt. Lassic; 2004-2015.




Until 2014 and 2015, when winter snowpack was negligible, April and May average temperatures, and March-April total precipitation recorded at Zenia were able to predict the date of annual snowmelt to within a few days each year (regression RSQD 0.93).

## FACTORS AFFECTING THE LUPINE'S ABILITY TO SURVIVE AND REPRODUCE

The Lassics lupine is vulnerable to a wide variety of threats. Seed predation and browsing by wildlife severely limit reproductive capability. Forest encroachment into lupine habitat is eliminating plants and, more importantly, is reducing the availability of habitat most resistant to climate extremes. Finally, recent extreme climate conditions have resulted in both loss of habitat and a severe decline in the population. Added to this, wilderness designation in 2006 has made it extremely difficult to implement urgently needed recovery actions in a timely manner. Because of its severely limited range, recent population declines, and the high magnitude and imminent nature of the threats it faces, the Lassics lupine is in danger of becoming extinct in the foreseeable future.

### Modification or curtailment of habitat or range

Habitat loss and modification is a primary and urgent threat to the survival of Lassics lupine.

***Range contraction of the Mt. Lassic colony:*** The canopy analysis using Winscanopy software indicated the south and east boundaries of the Mt. Lassic colony are limited by a maximum level of solar radiation in August (Imper 2012), which is mitigated in more exposed areas of the habitat by orographic shading and/or tree canopy. Above a maximum level of solar radiation, the lupine cannot survive due to heat and/or moisture stress. Population monitoring began at the Mt. Lassic saddle transect in 2002. By 2005, with the exception of only a few plants, the southern boundary of the lupine distribution on the saddle east of Signal Peak had moved roughly 20 feet northward, and by 2011 had contracted another 12 feet (Figure 6). By June 2015 the boundary was roughly 100 feet north of the 2002 boundary. Much of the area vacated by the lupine during the first 10 years appeared to receive solar radiation in August in excess of the maximum generally associated with the boundary elsewhere in occupied habitat (Imper 2012). The unprecedented (i.e., since 2001) virtual snow-free winters of 2014 and 2015, and record temperatures undoubtedly exacerbated the effects of radiation. While "climate change" may or not be the ultimate factor involved (see Threats section), the fact remains that lupine habitat has been significantly curtailed by extreme climate conditions, and those conditions appear to reflect a continuation of a trend ongoing for at least the past 30 years. The best available recovery option would seem to be immediate establishment of a significant proportion of the population in habitat that is less susceptible to climate extremes.

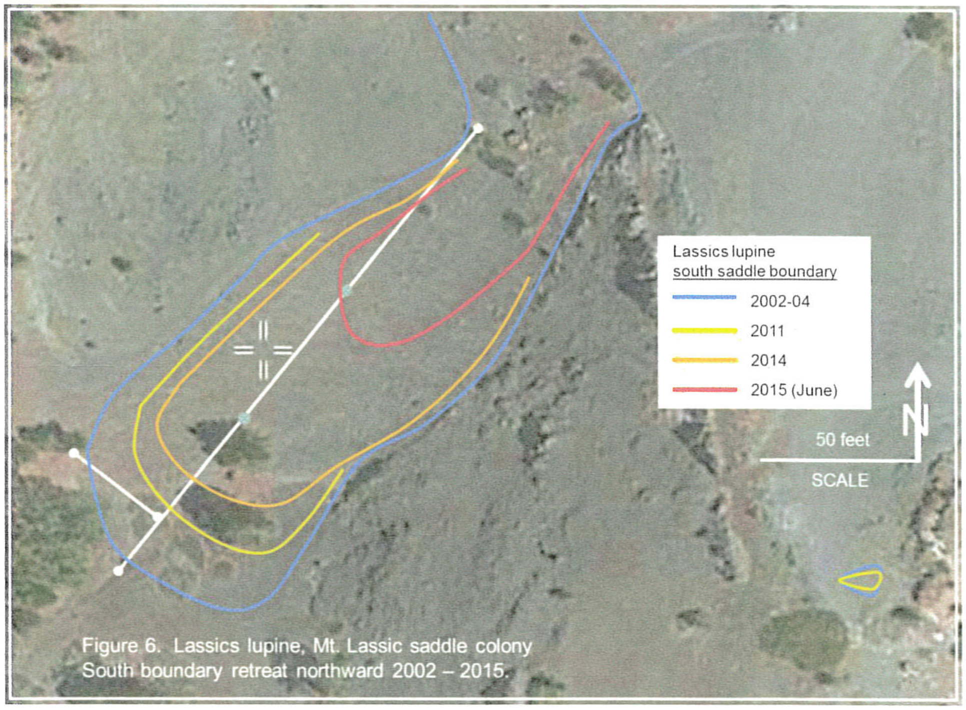


Figure 6. Lassics lupine, Mt. Lassic saddle colony
South boundary retreat northward 2002 – 2015.

***Forest encroachment:*** Carothers (2008) documented the rapid advancement of forest up the north face of Signal Peak over the past 50-60 years, in some areas on the order of 300 feet or more. A smaller area immediately below and north of the saddle area has also been encroached upon, with similar impacts on the lupine. Based on soils data, the portion of the affected habitat that exhibits the clastic/serpentine soil type suitable for the lupine encompasses between 2 and 3 acres, or roughly 30-40 percent of the total suitable habitat for the lupine at Mt. Lassic (Imper 2012). The encroachment by both forest and chaparral vegetation likely also served to stimulate foraging behavior out in the barren landscape, which 60 years ago offered neither abundant food nor cover for escape, as well as reduce seed production by the lupine. Kurkjian (2011) concluded that forest canopy cover and proximity to forest cover have a strong (negative) influence on plant size and number of inflorescences, which themselves are the best predictors of seed output. In general, forest cover leads to a decline in reproductive vigor, and unsuitable growing conditions through deepening litter, canopy closure and reduced light. Carothers (2008) noted that lupine habitat beneath Jeffrey pine that does not undergo periodic burning accumulates deep litter layers, producing an environment that (especially when coupled with overstory shading) results in lower lupine plant density, reduced size and lower reproductive vigor, and reduced seedling germination (Carothers 2008; Imper 2012).

The majority of the encroachment is Jeffrey pine ranging from 5-15 inches diameter at breast height (dbh), 10-50 feet tall, and based on increment cores in 2008, was relatively even-aged at about 45 years. Incense cedar is scattered in the understory ranging up to 3 inches dbh, and 15 feet tall.

***2015 Lassic fire:*** The Lassic fire of July and August 2015 appears to have significantly curtailed Lassics lupine habitat. The fire burned approximately 18,200 acres, centered roughly on Mt. Lassic. Many Lassics lupine individuals in the lower northern reach of the Mt. Lassic colony and all but a few of the individuals at the Red Lassic colony may have been killed. The fire severity was not adequate within lupine habitat at Mt. Lassic to kill a significant number of trees, and scorching of the litter layer was spotty, and thus did not appear to materially improve the forest habitat for the lupine, beyond the short-term benefit from a nutrient flush. In contrast, the fire burned exceedingly hot over the entire Red Lassic colony, eliminating the protective litter layer and burning 40 feet or more up into the pine trees. Research on the influence of canopy shading on lupine distribution at Red Lassic, described in the Habitat section, suggests the loss of just one tree there likely would lead to significant mortality in what was already a very small (perhaps now extirpated) colony (Imper 2012).

***The impacts of past Forest management on the lupine:*** The available evidence indicates that historical fire suppression is the most important anthropogenic factor, if not the only factor contributing to expansion of chaparral and forest vegetation, both reducing the distribution of the lupine, and likely increasing small mammal densities in close proximity to the lupine (see Habitat section). At 11 square miles, the Mt. Lassic Wilderness is far too small to maintain anything close to a natural fire regime by itself, given that it is surrounded by Forest matrix lands which are managed for timber production to the east and south, and private lands to the west and north.

Past indifference by SRNF management to the plight of the lupine is discussed under Regulatory threats.

***Off-road vehicles and recreation:*** Off-road vehicle use historically impacted the Mt. Lassic colony of Lassics lupine, as recently as 2003 (Carothers 2004). In order to reduce both vehicle and pedestrian impacts to the lupine, a formal trail was built that bypasses the colony, and a forest closure order was implemented in 2004 prohibiting vehicle use within the area. Designation as wilderness in 2006 permanently eliminated the use of vehicles. Current impacts from recreational use are relatively minor compared to the other threats cited.

**Overutilization**

Illegal removal for horticultural purposes is not known to be a threat to the Lassics lupine.

**Disease and predation**

The Lassics lupine does not appear to be threatened by disease.

Predation is a primary threat to the species. Severe pre-dispersal (prior to fruits dehiscing) seed predation has been observed in most years since 2003, when virtually the entire seed crop was taken (Crawford and Ross 2003; Imper 2015). It is considered unlikely, and there is no evidence available indicating, that lupine seed predated by small mammals are cached or otherwise survive. In addition, the lupine is subject to frequent deer and/or rabbit herbivory and in some cases excavation of the root crown, resulting in loss of reproductive capability or death. Carothers (2015b) reported a severe rate of seed predation, as well as foliar browsing leading to death at the Mt. Lassic colony in 2015. While caging is generally quite effective in reducing seed predation, it is labor intensive, and careful installation is necessary to avoid failure. Carothers (2015b) noted a high rate of cage failure in 2015, which allowed predation even on the caged plants.

The magnitude of the threat posed by seed predation shown by the PVA would suggest that habitat features that lead to increased seed predation pressure must have changed dramatically in the recent past, or the species would not have survived. The most likely change, consistent with small mammal trapping conducted since 2005, is that pressure from seed predation has risen as a consequence of forest and chaparral encroachment within and close to lupine habitat. Small mammal abundance varies between years, but on average, potential seed predators are 40 percent less abundant in the open lupine habitat compared to adjacent chaparral (Falxa 2015). California ground squirrels (*Spermophilus beecheyi*) appear to have expanded in the lupine area since 2005, and because of their large size (compared to mice and chipmunks), a few individuals can take many seeds. The link between seed predation and vegetation encroachment was also made by Kurkjian (2010), in her investigation of seed predation within and near Lassics lupine habitat, using surrogate species. Seeds of *Vicia* sp. were predated at a greater rate from screens set within or near chaparral, compared to forest, and rates were highest close to the vegetation edge.

**Existing regulatory mechanisms**

Existing regulatory mechanisms are not adequate to ensure the continued existence of Lassics lupine. The lupine is classified as a Sensitive species by the U.S. Forest Service. The only protection provided by classification as a Sensitive species is that the Forest Service is required to assess, and if warranted, mitigate impacts to Sensitive species as part of the planning process for agency projects, but this does not abate the current threats to the lupine.

Various Forest Service policies both allow and require the agency to maintain viable populations and preclude a species trend toward Federal listing, even within designated wilderness. In this case, actions taken by SRNF have been treated as discretionary and been given low priority, in regards to proactively safeguarding the lupine.

As a California Rare Plant Rank 1B species, Lassics lupine is covered under the California Environmental Quality Act, but that offers no protection, since the current threats are not due to projects under which CEQA, or its Federal equivalent, the National Environmental Policy Act (NEPA), apply. Designation of the Lassics Wilderness in 2005, a factor contributing to the current threats to this species, was a congressional action, and therefore not subject to analysis under NEPA. It is primarily natural processes (seed predation, vegetation succession and its effects on habitat loss and potentially seed predation, and climate extremes), in absence of historical disturbance regimes and adequate human intervention, that are the primary threats. In part, the agency may have been slow to recognize the need for immediate actions due to the principle threats being largely insidious and until recently, relatively chronic in nature.

If nothing else, the mere fact that the Forest Supervisor in 2012 was able to order the removal of all protective cages, within months following completion of a PVA indicating that the caging was critical to maintain the species, illustrates the inadequacy of current regulatory mechanisms to protect even a species as threatened as the Lassics lupine.

Lassics lupine warrants protection under both the CESA and Federal ESA because it is at high risk of becoming extinct in the foreseeable future from high magnitude, imminent threats to its continued existence and there are no regulatory mechanisms that ensure its continued existence in the face of these threats.

**Other factors (climate change)**

Climate change is a primary threat to the Lassics lupine. Although some specifics about how global climate change will affect the Lassics are as yet unknown, the general consensus is for warmer winter temperatures, diminished snowpack, and drier summer and autumn seasons (Wilkinson and Rounds 1998). In particular, the enhanced risk of extinction for mountaintop species related to climate change is well recognized (Cochran 2011). Such species tend to be more susceptible to warming temperatures, shortened snowpack duration and earlier snowmelt than the environments and their biota found at lower elevations, through altered phenology, energy balance, exposure to predators and numerous other ramifications. Notably, species such as the Lassics lupine, relatively unsuited for long distance dispersal (heavy, unwinged seed), and already situated at the highest elevations of suitable terrain in the Lassics, have no place to migrate upwards. Thus they are largely dependent on fortuitous escape to suitable micro-climates nearby, or assisted migration in order to escape extinction.

The high sensitivity of the Lassics lupine to climate extremes has been described (see Conservation status - Population expansion; Habitat - Red Lassic and Solar radiation; and Curtailment of habitat sections), clearly illustrated by the dramatic die-off in 2015. Climate data most applicable to the Lassics only date to 2000, but a strong correlation was demonstrated with the 30-year record available for the Big Flat CDEC weather station (see Climate section), suggesting the recent climate extremes (30-year record high temperatures and shortened snowpacks) may become more frequent in the future. It is reasonable to conclude that long term regional climate changes present a significant threat to the lupine.

Due to the current small population of Lassics lupine, even prior to the recent severe mortality (less than 1,000 plants), loss of genetic diversity due to inbreeding and/or random genetic drift are potential significant threats to the species. No assessment has been made of the minimum population necessary to avoid these effects. However, given the restricted amount of habitat available to the species, at least within the Lassics, the population likely has not been substantially larger than that for some time. At the current population level (on the order of 60 plants), environmental stochasticity poses an imminent threat to the species.

## DEGREE AND IMMEDIACY OF THREAT

The PVA by Kurkjian (2012a) indicated the Lassics lupine is trending toward extinction. Without any protection of reproductive plants, and at the current rate of seed predation, the PVA predicted a greater than 68 percent chance of species extinction within 50 years. Even with the current caging effort (approximately 60-80 reproductive plants annually), the model suggested that stochastic events over the next decade would move the species closer to extinction.

The PVA did not account for several major threats:
The smaller of the two colonies of Lassics lupine, located at the western base of Red Lassic, was severely burned during the 2015 Lassic Fire (Imper 2015). That colony may have been extirpated, or may be extirpated in the near future, either due to incineration of the majority of plants, or death of one or more of the pine trees that provide critical shade to the colony (Imper 2012).

The larger lupine colony, at Mt. Lassic, has been severely impacted by several years of extreme warm temperatures, declining snowpack, and the recent fire. A portion of the southern boundary of the colony has retreated northward as much as 100 feet over the past 12 years. At the same time forest dominated by Jeffrey pine and incense-cedar has encroached southward on the Mt. Lassic site over the past 60 years, eliminating the lupine from habitat believed to be more sheltered from the effects of drought conditions. As a result, the lupine has nowhere to escape warming and drying conditions. The species already occurs on the uppermost extent of suitable soils on the north slope of Mt. Lassic, and currently is prevented from moving further down slope into a more favorable microclimate due to encroachment on that habitat by conifers.

While past efforts to enhance the population through protective caging were successful, most noticeably between 2010 and 2013 (Figure 1), the gains appear to have been negated over the past two years. Efforts to introduce the lupine to new sites, begun in 2003 had limited success until 2015, when all but a few of the new plants died.

As a result of the above factors, the current population of Lassics lupine is estimated to be fewer than 60 adults ***(7 percent of the estimated population when the PVA was completed).*** While some of the plants that appeared to have died as of early spring 2016 may re-sprout, the situation will not likely change significantly for the better. Although portions of the Lassics did retain snow until early April this year, if summer conditions are again warm and dry, the population surviving into 2017 may well be on the verge of extinction.

There is an immediate need for prioritization of Lassics lupine conservation by the SRNF, and infusion of resources to implement management actions within the wilderness aimed at reducing threats and increasing the lupine population. State listing as endangered will help it gain the attention it needs. To survive, the lupine needs both short and long-term agency attention. Both of the SRNF staff botanists will soon be retiring, and the USFWS Arcata field office has not, nor does it intend to, refill the plant recovery position vacated in 2012, which carried out a significant portion of the past investigation and recovery efforts for this species. Therefore, in addition to other critical needs, federal and state listing will help ensure that this species will not fall off the regulatory radar, and that both agencies will continue to focus attention on the plight of this species.

We believe the information provided in this petition indicates beyond question that the Lassics lupine warrants protection under the California Endangered Species Act.

## RECOMMENDED MANAGEMENT AND RECOVERY ACTIONS

There are multiple urgent, specific actions available and needed to ensure the long-term survival of this species. Given the past inability of SRNF to accomplish certain of these tasks, we anticipate State and Federal listing will facilitate their implementation in a more timely manner.

While the caging effort appeared, at least until 2015, effective at forestalling a trend toward extinction of the lupine, it is only effective at mitigating the threat of seed predation and wildlife browsing. It was an emergency measure necessary to provide seed to maintain and perhaps expand the lupine population, and buy critical time for research on the various threats to the species. The recent curtailment of occupied habitat and the population as a result of climate extremes, and to lesser extent, forest encroachment, pose their own significant threats for the species, and point directly to the urgent need to restore habitat lost to forest encroachment, grow the population, and establish a significant portion of the population in habitat where the species as a whole is able to survive prolonged climate extremes such as occurred in 2014 and 2015.

Evidence described by Imper (2012) indicated that between two and three acres of forested habitat (Figure 7, Area 1 primarily) suitable for the lupine are located downslope from the lupine on Mt. Lassic. We know this habitat was formerly open (Carothers 2008), but it has been encroached upon by Jeffrey pine and incense cedar over the past 60 years, resulting in a thick litter layer, and in areas, relatively dense canopy. Climate and soils data collected by Imper (2012, 2015) indicate that at least in portions of this habitat, seasonal fluctuation in soil temperature and moisture are more conducive to growth of the lupine than the more exposed locations of its current occupied habitat. The major difference between the forested habitat and its current habitat is that light levels in the forested habitat are generally 40 - 50 percent less.

Due to its close proximity to the main concentration of Lassics lupine and scattered residual lupine individuals, Area 1, and to lesser extent Area 2, represent the best opportunity to expand the population through partial removal of the tree canopy and litter layer (Figure 7). The restoration effort there could be approached in two ways:

<u>Experimental approach</u>:
The western portion of Area 1 (Figure 7) below Signal Peak and west of the saddle measures approximately 260 feet (up-downslope) by 320 feet across slope, or approximately two acres in size. One or more test plots would be treated, measuring 60 feet across slope by 200 feet downslope from the current tree line, each of which would involve removal (either manual removal or by girdling) of an estimated 40-50 trees ranging 3-15 inches dbh, along with many small incense-cedar trees. Trees larger than 15 inches dbh would be retained. The litter layer would be partially removed. Lupine seed and/or

transplants would be introduced, and a monitoring program implemented, including soils and climate variables, and lupine response, both in the planted material and any natural recruitment. No old-growth trees are present in this area. The approach in the east portion of Area 1 (Figure 7) would differ slightly. This area is smaller, measuring roughly 75 by 160 feet, and contains scattered old growth pine and cedar exceeding 24 inches dbh and 150 years old, along with the encroaching pine and numerous small incense cedar trees. The treatment here would include removal of the smallest incense and pine trees aged 60 years or less throughout the area.

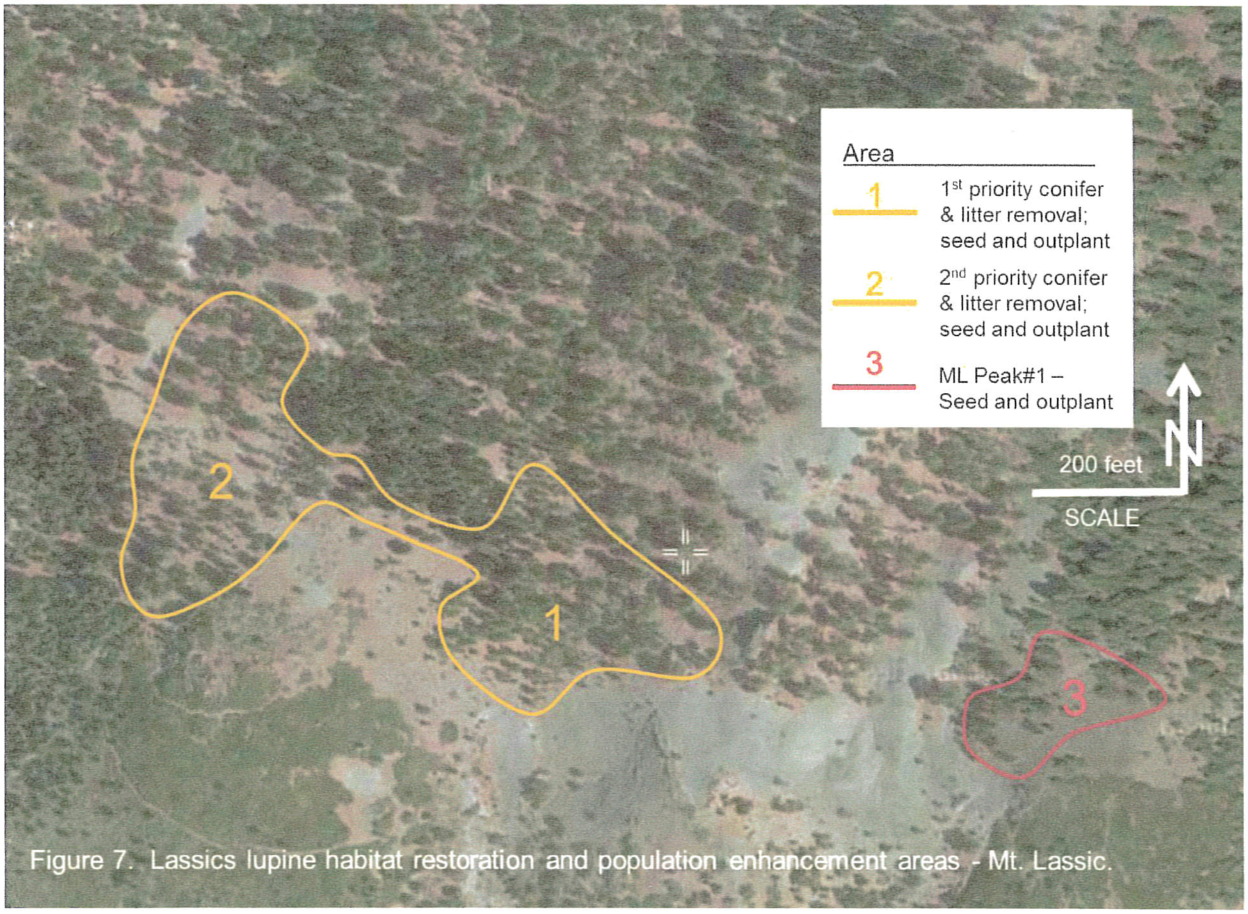


Figure 7. Lassics lupine habitat restoration and population enhancement areas - Mt. Lassic.

Full project approach:

Alternatively, there is good argument to proceed with the entire restoration of Area 1 initially:

1) This habitat was open 60 years ago;
2) The lupine is suppressed along the edge, and virtually absent within this forested habitat;
3) There is good evidence to suggest that if the lupine can be established, it will be more immune from climate extremes than in the open habitat farther upslope;
4) Given the imminent threat of extinction for the species, there is a great deal to be gained if the introduction is successful;
5) There is relatively little to lose if it fails, other than setting back forest succession temporarily.

Area 2 (Figure 7) is not considered to be as high priority as Area 1 due to the appearance of less suitable soils for the lupine (map unit ST = higher proportion of serpentine), as opposed to the clastics mixed with serpentine soils of Area 1 (map unit CS), throughout much of the area. Area 2 does exhibit tree encroachment and thick litter, which if removed would undoubtedly support more than the few lupine there now, but the degree to which the lupine density may be increased is considered more limited than in Area 1.

Imper (2012) identified numerous locations isolated from the existing population that exhibited soils similar to those occupied by the lupine, and which were situated on northerly aspects that might meet the other ecological requirements of the species. The most promising of those was ML Peak#1, located east of Signal Peak (Figure 7, Area 3). The initial results of seed out-planting were encouraging, but the extreme climate conditions between 2013 and 2015 eliminated all but a few of the surviving lupine. A renewed search for suitable transplant sites in locations more protected from climate extremes should be pursued as soon as possible.

Of course any experimental introduction efforts entail inherent risk from removing seed from the current colonies. Therefore, efforts should be implemented immediately to propagate Lassics lupine, both for producing seed and to experimentally test methods for growing planting stock *ex situ*, to be available for the population introduction efforts. Although attempts to establish colonies elsewhere in the Lassics (or beyond) or immediately downslope from Signal Peak in what appears to be suitable habitat may fail, the effort may be the only good recovery option available at this time to maintain a native population of Lassics lupine in the Lassics.

A checklist of suggested immediate specific recovery actions, in order of priority, includes the following:

**Priority Category 1: Tasks needed to avoid imminent species extinction**

1) Initiate all planning efforts needed to proceed with implementation of habitat restoration in the high priority area (Area 1, Figure 7) on the north face of Signal Peak as soon as possible.

2) Until the immediate threat of extinction subsides, expand the caging effort to include protection of all accessible Lassics lupine adult plants and as many seedlings as feasible at both colonies.

3) In 2016 and until the immediate threat of extinction subsides, capture a significant proportion of the annual lupine seed production and allocate to: a) shallow burial in order to augment the seed bank in optimal lupine habitat, and b) focused out-planting in optimal lupine habitat, combined with subsequent caging protection and monitoring of germinants. Maximizing the rate of seed recruitment into the population may be crucial to saving the species, given the demonstrated high mortality of naturally dispersed seed.

4) Initiate further investigation (along the lines of that conducted by Imper 2012) to locate suitable habitat for the lupine, in locations less susceptible to mortality from extreme climate conditions. Additional detailed soils inventory by a soils scientist, with greater focus on specific soils characteristics favored by the lupine than Alexander (2008) was, would greatly assist in the effort. Early installation of soil moisture sensors in potential out-planting sites will help confirm whether they are suitable for the lupine, prior to significant investment of lupine seed to the effort. Implement

plant introduction efforts in conjunction with routine monitoring and caging as soon as adequate seed are available.

5) Continue and expand both *in situ*, and *ex situ* propagation of the lupine. Offsite propagation is needed to provide both planting stock and seed available for augmentation of the existing colonies, and introduction to new sites. Virtual year-round protection (except during snowpack) from browsing and seed predation by caging will be needed to protect any resulting plants until the critical threat of extinction is mitigated.

**Priority Category 2: Tasks needed to maintain a viable population**

6) As a pre-emptive measure, reduce the extent of chaparral vegetation surrounding and within lupine habitat on Mt. Lassic, based on the logical premise that clearing will reduce the resident small mammal populations and their seed predation impacts.

7) Continue research in order to confirm whether or not the encroaching chaparral increases the risk of seed predation for lupine plants.

8) Continue the small mammal monitoring trapping effort, providing the baseline abundance data for interpreting the results of item 7.

9) Continue to (a) monitor snowpack duration and melt date (e.g., the current four Hobo sensors used as a snowmelt index), (b) monitor climate data for the Zenia weather station, and (c) explore relationships with the trapping results from item 8. As described (Natural history - Small mammals section), total spring rainfall at Zenia since 2005 is negatively correlated with the small mammal abundance data from monitoring. That relationship, or other environmental indicators, should be investigated for their ability to predict small mammal populations prior to the field season. The caging effort is labor intensive, costly and unsustainable in the long term. A reliable method for predicting the threat from seed predation during the approaching season, if such exists, would be invaluable if it enabled suspension of caging during low-threat years.

10) Continue the seed predation monitoring and research to further document the relationship between the primary seed predators and vegetation encroachment; initiate research to identify the primary lupine browser species; investigate their relationship to encroaching vegetation; and quantify impacts on the lupine. Unless it is feasible to utilize a surrogate attractant species in lieu of exposing Lassics lupine, this research must be delayed until the immediate threat of lupine extinction subsides.

11) Continue the demographic-based monitoring of Lassics lupine at the three existing monitoring sites.

12) Add to the offsite conservation seed bank as appropriate.

13) Update and maintain the Lassics lupine database, commissioned by SRNF, but not updated since 2011.

**INFORMATION SOURCES**

See the Literature Cited section below for a list of references cited in this petition and persons providing unpublished information. Copies of references are also being provided to the Commission in electronic format on a disk.

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