

Scrub Lupine
(*Lupinus aridorum*)

5-Year Review:
Summary and Evaluation



Lake Meleod National Wildlife Refuge, Polk County. Photo by Todd Mecklenborg

U.S. Fish and Wildlife Service
North Florida Ecological Services Office
Southeast Region
Jacksonville, Florida

5-YEAR REVIEW
Species reviewed: Scrub Lupine (*Lupinus aridorum*)

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5-YEAR REVIEW

Scrub Lupine (*Lupinus aridorum*)

I. GENERAL INFORMATION

I.A. Methodology used to complete the review

This review is a synthesis of information found in the *Recovery Plan for Nineteen Florida Scrub and High Pineland Plant species* (1996), previous 5-year reviews, research project reports, peer reviewed scientific publications, unpublished field observations, and personal communications. A Federal Register (FR) notice announcing the review and requesting information was published on 23 September 2014 (79 FR 56821). Comments and suggestions from peer reviewers were incorporated as appropriate. No part of this review was contracted to an outside party. This review was completed by the U.S. Fish and Wildlife Service's (Service) species lead recovery biologist in the North Florida Ecological Services Office where the documents are on file.

I.B. Reviewers

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I.C. Background

I.C.1 FR Notice citation announcing initiation of this review: 79 FR 56821,
September 23, 2014

I.C.2. Species status: Declining. All of the existing locations are isolated from one another and occur in fragmented urban landscapes. Three natural populations occur on public lands with varying levels of conservation management. The remaining six natural populations are subject to development pressure since they are in private ownership. An additional three introduced populations from five total introduction efforts persist, but the long-term viability of these populations is uncertain.

I.C.3. Recovery achieved: 2 (26-50%) recovery objectives achieved), 2016
Recovery Data Call

I.C.4. Listing history:
Original Listing
FR notice: 52 FR 11172
Date Listed: April 7, 1987
Entity listed: Species
Classification: Endangered

I.C.5. Associated rulemaking: None

I.C.6. Review History: The Service conducted a 5-year review for *Lupinus aridorum* in 1991 (56 FR 56882). In this review, the statuses of many species were simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. No change in the species' listing classification was found to be warranted.

A second 5-year review was completed in 2007 (72 FR 20866). Summarizing the population trends from this review, the abundance and range-wide population trend of *L. aridorum* had continued to decline primarily from habitat loss. The review noted the only populations on public lands; one population in Polk County and two populations in Orange County. The Orange County populations occurred in parks and were not actively managed. This 5-year review effort in 2007 reported the number of known populations declined from a historical record of 40, to 19 in 1998 and 11 in 2003. Since 2003, three or four of these populations were extirpated leaving only six to seven populations. These reported findings differ from the current assessment.

Recovery Data Call - 1998, and every year since through 2016.

I.C.7. Species' Recovery Priority Number at start of review (48 FR 43098): 2C. The "2" indicates a high degree of threat and high recovery potential; the "C" reflects a degree of conflict with development and growth.

I.C.8. Recovery Plan:

Name of plan: South Florida Multi-Species Recovery Plan (identifies recovery contributions for the South Florida Ecological Service's Field Office area of responsibility)

Date issued: May 18, 1999

Name of plan: Recovery Plan for Nineteen Florida Scrub and High Pineland Plant Species

Date Issued: June 20, 1996

Date of previous plan: Original Plan - Recovery Plan for Eleven Florida Scrub Plant Species

Date Issued: January 29, 1990

II. REVIEW ANALYSIS

II.A. Application of the 1996 Distinct Population Segment (DPS) policy

II.A.1. Is the species under review listed as a DPS? No. The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish and wildlife. The definition limits listing DPS to vertebrate species of fish and wildlife and because this species is a plant, the DPS policy does not apply.

II.B. Recovery Criteria

II.B.1. Does the species have a final, approved recovery plan containing objective, measurable criteria? No, to prevent extinction the approved recovery plan (1996) identifies three recovery criteria: (1) protect sites in Polk and Highlands counties and establish a disturbance regime to create bare, sunny openings; (2) conduct demographic monitoring for the foreseeable future; and (3) manage and rehabilitate publicly-owned habitats in Orange County. As stated in the previous 5-year review, these criteria are not objective and measureable. Also, *L. aridorum* is not known to occur in Highlands County; criterion # 1 erroneously lists Highlands County instead of Orange County; therefore, this criterion cannot be met.

The South Florida Multi-Species Recovery Plan (1999) defined a recovery objective to prevent extinction and then stabilize. To consider the species stabilized the existing populations within the historic range would need to be adequately protected from further loss, degradation, and exotic plant invasion. The sites must also be managed to maintain openings. Five broad recovery actions were noted; however, no metrics were assigned. The intent of the plan was the South Florida's contribution (as part of the South Florida Ecosystem Restoration effort) toward increasing populations, preventing extinction, and stabilizing of populations.

II.B.2. Adequacy of recovery criteria.

II.B.2.a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No. Additional information is available on genetics, demography, habitat degradation, and the effects of drought.

II.B.2.b. Are the 5 listing factors that are relevant to this species addressed in the recovery criteria (and is there no new

information to consider regarding existing or new threats)?

No. Disease (Factor C) and drought and fire suppression (Factor E) are known to be current threats to the species and these factors are not currently addressed in the recovery criteria.

- II.B.3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information. For threats-related recovery criteria, please note which of the 5 listing factors are addressed by that criterion. If any of the 5-listing factors are not relevant to this species, please note that here.** *Protect sites in Polk and Highlands counties, and establish a disturbance regime to create bare, sunny openings. Conduct demographic monitoring for the foreseeable future. Manage and rehabilitate publicly-owned habitats in Orange County.*

The vague criteria attempts to address listing factor A (the present or threatened destruction, modification or curtailment of its habitat or range) and possibly listing factor E (other natural or manmade factors affecting its continued existence).

In the late 1990's one site was acquired by the U.S. Fish and Wildlife Service as part of the National Wildlife Refuge (NWR) System in Polk County. The Lake McLeod NWR tract is one of four tracts within the Lake Wales Ridge NWR complex and is managed for scrub endemics. This population has been monitored along with active research being conducted on *L. aridorum* since acquisition. Two sites in Orange County – Shadow Bay Park and Bill Fredrick Park – are also in public ownership with active but limited management to balance the multi-use occurring within their boundaries.

II.C. Updated Information and Current Species Status

II.C.1. Biology and Habitat

- II.C.1.a. Abundance, population trends, demographic features, or demographic trends:** Census data from the Florida Natural Areas Inventory's (FNAI) database indicate 45 Element of Occurrence (EOR) records along with a handful of other known locations not assigned an EOR number: roughly a total of 50 sites. Currently, there are nine natural populations remaining of which three occur on public lands with management benefitting the species. Five population introductions have occurred since 2008, of which three remain. The three remaining introduced populations appear to be declining but additional monitoring over the next several years will be required to accurately assess the population viability.

Life stage data indicate that the number of individuals present within a population can vary greatly from year to year. As short-

lived perennial with varying annual seedling recruitment, the number of plants present in a given year is not a reliable indicator of population size or status. For instance, the population at Lake McLeod NWR fluctuated from 702 to 318 to 599 individuals from 2011 through 2015 (Kordek 2015). However, with the exception of the three populations on managed public lands, populations on private lands in general appear to be declining.

Overall, the abundance and range-wide population trend of *L. aridorum* is declining primarily because of habitat loss and secondarily due to habitat degradation.

II.C.1.b. Genetics, genetic variation, or trends in genetic variation:

There is low overall diversity in this species. *L. aridorum* has low allelic richness and heterozygosity (Peterson 2016). Peterson noted the majority of the genetic variation was found to be within individuals (71%), among individuals within populations (23%), and among populations within the ridge systems (10%).

Bupp (2013) assessed *L. aridorum* populations using microsatellites for genetic variability and population structure. He found almost all populations of the species are significantly differentiated from one another but this was not attributed to geographic distances between populations or a biogeographic break between plants on different ridge systems. This indicates that the populations are experiencing genetic drift and may be progressing toward allelic fixation. His work concluded with the recovery implications that outbreeding depression is unlikely and future population introductions would most likely benefit if genetic variability is increased by utilizing seeds from multiple populations.

II.C.1.c. Taxonomic classification or changes in nomenclature: A

change has occurred in taxonomy from *Lupinus aridorum* (McFarlin ex Beckner) to *Lupinus westianus* var. *aridorum* (McFarlin ex Beckner) Isely. The Service will continue to reference the taxonomy as when the species was listed under the Endangered Species Act of 1973, as amended, per the Federal Register. The rationale is as follows.

When the Service published its review of plant taxa considered for listing as endangered or threatened in 1980, *L. aridorum* had not been named although it was considered a unique species by McFarlin in 1935. Becker described the morphological differences in *L. aridorum* and designated it as a unique species in 1982 (Palmer 2006). In 1984 and again in 1985, the Service's 12-month

finding determined that listing of *L. aridorum* was warranted. The Service published the proposed rule listing *L. aridorum* as endangered on 24 April 1986. During this same year, dissension among other taxonomists argued *L. aridorum* is a disjunct population of *L. westianus* having only flower color as the single morphological difference (Isely 1986). *Lupinus westianus* includes two allopatric groups: *L. westianus* var. *westianus* and *L. westianus* var. *aridorum*. The Service's final rule in 1987 listed the species as *L. aridorum*.

Recent genetic research revealed a close relationship among *Lupinus aridorum*, *L. westianus*, and *L. diffusus* (Bupp 2013). His distrust results indicate that *L. aridorum* and *L. westianus* are different genetically. Bupp noted the similarities between the two species could be the result of phenotypic plasticity from inhabiting similar upland scrub environments or retention of ancestral genotypes. Additionally, Internal Transcribed Spacer (ITS) sequence data (Bok Tower Gardens, unpub. data) showed taxonomic separation of *L. aridorum* and *L. westianus*, with *L. diffusus* suggested as a close congener of *L. aridorum* (Bupp et al. 2016).

II.C.1.d. Spatial distribution, trends in spatial distribution, or historic range: *Lupinus aridorum* is only found on two interior ridges in central Florida. There are two disjunct distributions. The southern distribution occurs on the Winter Haven Ridge in Polk County and the more northern distribution is found on the Mount Dora Ridge in Orange and Osceola counties. These two ridges are separated by the Lake Wales Ridge.

The species was first collected in 1900 in Orange County, Florida. It was not collected again until found in Polk County in 1928 and 1937. Survey efforts in the early 1970's and early 1980's increased the known occurrences in these counties. When listed in 1987, there were 16 known sites where plants still existed; 10 sites occurred in Orange County and 6 sites were located in Polk County.

Additional surveys post-listing increased the number of known sites. Two range-wide surveys were performed by FNAI in 1988 and The Nature Conservancy (TNC) in 1998. As part of a Master's Thesis, Sharon Kane reexamined the prior efforts performed by FNAI and TNC between 2002 and 2003.

The FNAI surveys in 1988 documented that, of the 35 historically known sites in Orange County, only 24 remained and of the 12

historically known sites in Polk County 6 sites remained occupied (30 sites total). The 1998 TNC surveys documented 18 sites in Orange County where the species was still present and 4 sites remained in Polk County. An additional site discovered in 1996 in Osceola County was also occupied during the TNC 1998 survey (23 sites total). Kane’s 2002 and 2003 surveys documented the number of extant populations declined from 23 in 1998 to 10 in 2003; 9 were present in Orange County, 1 site was occupied in Polk County and the Osceola County population was extirpated (10 sites total).

The most recent survey efforts have been accomplished by Bok Tower Garden’s (BTG) Rare Plant Conservation Program. Beginning in 2009 through 2014, BTG conducted surveys range-wide to document extant populations and collect germplasm for conservation efforts for *L. aridorum* recovery. Of the 10 remaining populations documented as late as 2003, 3 were recently “rediscovered” during these efforts. Plants had not been observed for several years at these sites but after vegetation clearing, plants germinated from the resilient seed bank remaining in the soils. The 10 populations included 8 sites in Orange County and 2 sites in Polk County (Peterson 2014). In 2016, their continuing research and conservation efforts for the species noted only eight remaining populations. Seven occur in Orange County and one in Polk County (Peterson 2016). However, in June of 2016 the Service’s species lead biologist discovered a new site in Polk County approximately 3 miles north/northwest of the Lake McLeod NWR site. Unfortunately, the property is in private ownership, occurs along a major roadway in a highly developed area near the city of Winter Haven, and is listed for sale. Currently, nine “natural” sites are known to occur range-wide as illustrated in Table 1 below.

Table 1. Number of sites per county reported during survey events

Survey Dates	Orange County	Polk County	Osceola County
1987	10	6	
1988	24	6	
1996			1
1998	18	4	1
2002-2003	9	1	extirpated
2009-2014	8	2	
2016	7	2	

Introduced Populations

As conservation measures to fulfill recovery objectives and criteria in recovery planning, the establishment and management of new populations was identified in the *Scrub Lupine Recovery Action Plan*. Population introduction efforts began in 2008 and continued through 2010. Five populations have been introduced on protected sites from these efforts. Three population introductions have occurred in Orange County and two introductions have taken place in Polk County. Two of the introductions were augmented after initial plantings. Of the five population introductions to date, three sites remain occupied with varying degrees of success; however, all introduced populations have declined in number of individuals present with low seedling recruitment occurring. Additional monitoring over the upcoming years will be required to accurately determine the viability of the introduced populations.

- II.C.1.e. Habitat or ecosystem conditions:** *Lupinus aridorum* occurs on sandy soils in Florida scrub and sandhill habitats. The soils are primarily white or occasionally yellow and are typically classified as excessively drained or well-drained (e.g. St. Lucie fine sands, Archbold fine sands, and Pomello fine sands). Within the habitat, the plants are normally observed growing in bare open areas similar to other well-drained soil gap specialists. However, Richardson et al. (2014) noted a tendency for the species to grow in areas closer to trees and shrubs, with lower soil moisture, and a greater mixture of detritus than would randomly be expected. These tendencies to be in closer proximity to other vegetation could be a result of microhabitat characteristics such as partial shading, soil characteristics, or the detrital layer. Vegetation frequently found growing in association with *L. aridorum* include *Pinus clausa*, *Quercus spp.*, *Ceratiola ericoides*, *Persea borbonia*, *Serenoa repens*, *Ximenia americana*, *Lyonia ferruginea*, *Opuntia humifusa*, *Pityopsis graminifolia*, *Polygonella myriophylla*, *Paronychia chartacea*, *Aristida spp.*, *Bonamia grandifolia*, and *Cladonia leporina*.
- II.C.1.f. Other:** Symbiotic associations between legumes and nitrogen-fixing soil microorganisms are known to be ecologically important worldwide (Hoque et al. 2011), and especially advantageous to plants growing in nutrient-poor soils, as nitrogen is often the limiting factor for plant growth and survival (Santi et al. 2013). Native soils for *L. aridorum* are likely nitrogen-limited for plant species, as they are characterized as nutrient-poor, and soils tests have shown low nitrogen levels adjacent to wild plants.

Species of both fungi (mycorrhizae) and bacteria (rhizobia) in the soil are associated with nitrogen and nutrient uptake for species of *Lupinus* (Sprent and James 2007). Some legume species can require specific types of soil fungi (Sprent and James 2007), and specific bacterial species have been associated with rare legumes (Tondello et al. 2011). Determining the fungal and bacterial species associated with *L. aridorum* may help determine factors limiting its habitat restriction, and therefore its rarity, and help in the assessment and management of population introduction sites.

Three projects are currently underway by BTG to explore soil-plant interactions in this species: a project to characterize the microbiome function and diversity in scrub habitat with St. Lucie series soil, a project to characterize microbiomes within the rhizosphere, phyllosphere and nodules of both *L. aridorum* and *L. diffusus*, and a project to compare and characterize root exudates produced by the two species.

Data analysis is currently underway to identify the soil species and find any associations between microbial species and plant species, and within and across upland systems.

II.C.2. Five-Factor Analysis

II.C.2.a. The present or threatened destruction, modification or curtailment of its habitat or range: Habitat destruction, modification, and degradation on private lands remain the primary threat range-wide to the species. Populations occurring on private lands remain subject to adverse human activity, predominately development. Additionally, lack of management – especially fire suppression – on private lands degrades the habitat over time resulting in less suitability to maintain population viability.

These human activities are no longer threats to populations on public conservation lands because of protection afforded and restricted use; however, budget constraints and prioritizing available resources may preclude proper, necessary management activities on conservation lands at times.

Only three natural populations occur on public lands with the majority of the populations in private ownership. Little opportunity exists for future protection or management opportunities on these lands because of the urban matrix where they occur.

II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes: Not known as a threat at the time of listing or present.

II.C.2.c. Disease or predation: Several species of fungus have been observed on *L. aridorum* plant tissues: charcoal root rot (*Macrophomina phaseolina*), black leaf spot (*Diplocarpon rosae*), and recently an unknown black fungus. Little is known about the unidentified black fungus that appears to be confined to the seed coat on *L. aridorum*. The seed pod looks totally normal but upon opening it the fungus is apparently just on the seeds. Examinations of seed development (Stout 2016) in 2014 at the Lake McLeod NWR documented seeds from 11 of 15 plants (73%) were lost due to this fungal growth. Ten of 20 plants (50%) examined in 2015 had seed loss from fungal sources. No evidence of fungal infested seeds was detected in 2016 (30 plants in sample).

A parallel study of seed status at Fenton Road, Orange County, revealed trends similar to those observed at Lake McLeod NWR (Stout 2016). In 2014, 16 of 17 plants (94%) lost most of the potential seed yield to fungal infestations. Seed loss to fungal growth was reduced to 7 of 20 plants (35%) in 2015. Thirty-one plants were examined in 2016 and no evidence of fungal interference was observed.

The three years of observations at two widely separated sites suggest further study may reveal one or more shared explanations for the seed losses due to fungal growth on seeds within apparently intact legumes (pods). The vector or vectors responsible for fungal contamination are unknown. A connection to rainfall patterns awaits further study.

Bacteria-induced wilt continues to be observed in *L. aridorum* populations. It is speculated that the bacteria blocks the conducting xylem tissue to the leaf. The sudden death of plants undergoing wilt may occur anytime during the year. Medium to large plants may be more subject to wilt than smaller recruits. Less than 5% of a population may die from this agent in a typical year.

The moth, *Uresiphita reversalis*, has been a source of mortality to the lupine populations (*L. aridorum*, *L. diffusus*) studied during the last 5 years (Stout 2016). Stout (2016) documented roughly 200 *L. diffuses* individuals devastated by the larvae in one population with no evidence of any insects preying on the moth larvae.

II.C.2.d. Inadequacy of existing regulatory mechanisms: Section 7(b) (4) and 7(o) (2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in violation of state law or regulation or in the course of any violation of a state criminal trespass law.

The Florida Administrative Code 5B-40 (Preservation of Native Flora of Florida) provides the Florida Department of Agriculture and Consumer Services (FDACS) limited authority to protect plants on State and private lands (primarily from the standpoint of illegal harvest). *Lupinus aridorum* is listed as an Endangered Plant under this statute, which requires anyone wishing to “willfully harvest, collect, pick, remove, injure, or destroy any plant listed as endangered growing on the private land of another or on any public land or water” to “obtain the written permission of the owner of the land or water or his legal representative” (FAC 5B-40.003(1)(a)). A permit is also required to transport “for the purpose of sale, selling, or offering for sale any plant contained on the endangered plant list which is harvested from such person’s own property” (FAC 5B-40.003(1)(c)).

Existing regulatory mechanisms are not inadequate for this species.

II.C.2.e. Other natural or manmade factors affecting its continued existence: The Service’s analyses under the Act include consideration of ongoing and projected changes in climate. The terms “climate” and “climate change” are defined by the Intergovernmental Panel on Climate Change (IPCC). “Climate” refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term “climate change” thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (IPCC 2007). In our analyses, we use our expert

judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change.

Estimates of the effects of climate change using available climate models lack the geographic precision needed to predict the magnitude of effects at a scale small enough to discretely apply to the range of *L. aridorum*. However, data on recent trends and predicted changes for the Southeast United States (Karl et al. 2009) provide some insight for evaluating the potential threat of climate change to the species. Since 1970, the average annual temperature of the region has increased by about 2 degrees Fahrenheit ($^{\circ}\text{F}$) (1.1 degrees Celsius [$^{\circ}\text{C}$]), with the greatest increases occurring during winter months. The geographic extent of areas in the Southeast Region affected by moderate to severe spring and summer drought has increased over the past three decades by 12 and 14 percent, respectively (Karl et al. 2009). These trends are expected to increase.

Predicted rates of warming may more than double in comparison to what the Southeast has experienced since 1975, with the greatest increases projected for summer months. Depending on the emissions scenario used for modeling change, average temperatures are expected to increase by 4.5 $^{\circ}\text{F}$ to 9 $^{\circ}\text{F}$ (2.5 $^{\circ}\text{C}$ to 5 $^{\circ}\text{C}$) by the 2080s (Karl et al. 2009). While there is considerable variability in rainfall predictions throughout the region, increases in evaporation of moisture from soils and loss of water by plants in response to warmer temperatures may contribute to the effect of these droughts (Karl et al. 2009).

The Service is not aware of any climate change information specific to the habits or habitat of *L. aridorum* that would indicate what potential effects climate change and increasing temperatures may have on this species. Predictions of increased drought frequency, intensity, and duration could result in plant losses due to prolonged drought conditions. However, this plant and other scrub species are relatively drought-resistant. The Service has no evidence that climate changes observed to date have had any adverse impact on the species, or its habitat nor is there information suggesting that the species, will not be able adapt to predicted changes in drought conditions.

Of the five listing factors; destruction, modification or curtailment of its habitat or range (Factor A) is the main threat to *L. aridorum*. Disease and predation (Factor C) is also a stressor but the magnitude and severity are not currently known. Factors B, D, and E are not considered threats at this time.

II.D. Synthesis

The approved recovery plan listed the following three recovery criteria to prevent extinction. Protect sites and establish a disturbance regime to create bare, sunny openings. Conduct demographic monitoring for the foreseeable future. Manage and rehabilitate publicly-owned habitats. These criteria are not objective and measureable.

The range-wide numbers of extant populations continue to decline. Nine natural populations exist with one population occurring at Lake McLeod NWR and two populations occurring at county parks. The remaining populations occur on private lands (Table 1). Three of the five introduced populations continue to support the species; however, they appear to be declining.

Little is known about the long-term adverse effects from fungus, wilt, or moth predation on *L. aridorum* populations. Continued research is warranted and measures are needed to address losses from disease and predation.

Recent genetic research has increased our knowledge of population diversity, variability, and structure. Currently, three projects are underway to explore soil-plant interactions in this species. These findings may aid future decisions with population management, increase fecundity, and decreasing mortality.

Summarizing, *Lupinus aridorum* remains in danger of extinction throughout its entire range; specifically habitat loss and degradation remain significant. Disease and climate change may also adversely affect populations. Permanent protection and management are necessary to conserve this species. Only one natural population is assured long-term management and protection. No change in the status of *L. aridorum* is recommended.

III. RESULTS

III.A. Recommended Classification:

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is Needed

III.B. New Recovery Priority Number: No change

III.C. If a reclassification is recommended, indicate the Listing and Reclassification Priority Number: N/A

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

1. Update and revise the recovery plan to improve and clarify the objective measurable criteria and better address the five factors.
2. Collaboration with conservation land managers to increase habitat suitability of occupied habitat.
3. Actively engage landowners to protect and manage occupied habitat.
4. Continued research on biology and ecology: genetics; seed germination (soil-microbial interactions); out planting techniques to reduce mortality; fungus and bacteria stressors.
5. Conduct research on different habitat management techniques and their effects in regards to maintaining or improving the residual seed bank for populations.
6. Increase existing monitoring efforts.

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5-YEAR REVIEW
Scrub Lupine (*Lupinus aridorum*)

Current Classification Endangered

Recommendation resulting from the 5-Year Review

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Appropriate Listing/Reclassification Priority Number, if applicable N/A

Review Conducted By: Todd Mecklenborg

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 11/10/2014
Jay B. Herrington

Cooperating Field Supervisor, Fish and Wildlife

Concur Do Not Concur

Signature  Date 11/30/14
Roxanna Hinzman

Lead Regional Director, Fish and Wildlife Service

Concur Do Not Concur

Signature _____ Date _____