

Assessing the status and extent of *Lupinus lepidus* var. *cusickii* in Denny Flat, Baker County, Oregon



2014

Report to the Bureau of Land Management, Vale District

Report prepared by Erin C. Gray, Denise E.L. Giles-Johnson, and Matt A. Bahm
Institute for Applied Ecology



PREFACE

This report is the result of an agreement between the Institute for Applied Ecology (IAE) and the Bureau of Land Management (BLM). IAE is a non-profit organization dedicated to natural resource conservation, research, and education. Our aim is to provide a service to public and private agencies and individuals by developing and communicating information on ecosystems, species, and effective management strategies and by conducting research, monitoring, and experiments. IAE offers educational opportunities through 3-4 month internships. Our current activities are concentrated on rare and endangered plants and invasive species.



Questions regarding this report or IAE should be directed to:

Matt Bahm

Institute for Applied Ecology

PO Box 2855

Corvallis, Oregon 97339-2855

phone: 541-753-3099

fax: 541-753-3098

email: mattab@appliedeco.org

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Cover photograph: Cusick's lupine habitat at ORV Hill. Inset: Cusick's lupine seedling (*Lupinus lepidus* var. *cusickii*).

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Assessing the status and extent of *Lupinus lepidus* var. *cusickii* in Denny Flat, Baker County, Oregon

REPORT TO THE BUREAU OF LAND MANAGEMENT, VALE DISTRICT

INTRODUCTION

Lupinus lepidus var. *cusickii*, Cusick's lupine, is a BLM special status species. In addition, it is listed as endangered by the Oregon Department of Agriculture, and it is considered a Species of Concern by the U.S. Fish and Wildlife Service. The Oregon Biodiversity Information Center (ORBIC) considers *L. lepidus* var. *cusickii* to be threatened or endangered throughout its range (ORBIC 2010). *Lupinus lepidus* var. *cusickii* (Figure 1) is a narrow endemic, restricted to only five small populations in Baker County, Oregon (Meinke et al. 1990). These populations are located southeast of the Blue Mountain foothills within Denny Flat, near the town of Unity, Oregon. *Lupinus lepidus* var. *cusickii* is part of the *Lupinus caespitosus*-*lepidus* complex, a polymorphic species group which is widely distributed throughout western North America (Broich and Morrison 1995). *Lupinus* populations with the epithet *cusickii* have been treated in a variety of ways including as a subspecies, a variety, or a synonym for *Lupinus lepidus* (Broic and Morrison 1995, ODA 2010); we refer to Cusick's lupine as *L. lepidus* var. *cusickii*, consistent with the treatment of Broich (1989) and others (Broich and Morrison 1995, Oregon Flora Project, ODA 2010, ORBIC 2010).



Figure 1. *Lupinus lepidus* var. *cusickii* (Cusick's lupine) in fruit.

The flowers of *L. lepidus* var. *cusickii*, which bloom in July, are potentially cross-pollinated by a variety of visitors, primarily bumblebees and small solitary bees (Meinke et al. 1990). It is not known if *L. lepidus* var. *cusickii* is genetically self-compatible, and no asexual reproduction via vegetative means occurs in the species. The production of large crops of seed may be dependent on well-timed summer rainfall to support ovule development (Meinke et al. 1990). No studies have been performed on germination ecology or seed longevity, but it is suspected that seeds germinate in the winter or spring if seed coat scarification has occurred. Seedlings are present at least as early as May (observed during a preliminary spring visit to sites). As there is no vegetative reproduction in this species, seed production is vital for population maintenance and growth.

Known *L. lepidus* var. *cusickii* populations are found on eroding, tuffaceous hillsides at elevations around 4000 feet. *Lupinus lepidus* var. *cusickii* occurs in areas of sparse vegetation, but is generally associated with occasional junipers and low-growing perennials such as *Eriogonum* spp., *Allium* spp., and *Lomatium* spp. Associated annual species include *Mimulus nanus*, *Phacelia lutea*, *Spraguea umbellata*, and *Camissonia* sp. (Meinke et al. 1990). Other species sometimes observed with *L. lepidus* var. *cusickii* include *Artemisia tridentata*, *Astragalus* sp., *Phlox* sp., and *Silene* sp. (Broich 1989). The average annual precipitation in the area is 30-40 cm. All populations of the species fall within the Blue Mountains physiographic province (Franklin and Dyrness 1984).

Although *L. lepidus* var. *cusickii* was first located in Oregon in 1886, relatively little is known about the species (Meinke et al. 1990). Despite previous studies, which have identified taxonomic problems (Broich 1989, Broich and Morrison 1995), inventoried for additional populations, and described natural history of the species (Meinke et al. 1990), we are only now beginning to gain an understanding of the species' population dynamics and long-term trends. Population monitoring was initiated by the Institute for Applied Ecology (IAE) in 1993 and conducted annually until 1998, and in 2009 and 2012. Monitoring was initiated to determine impacts of OHV traffic and livestock grazing to Cusick's lupine. Monitoring conducted in 2009 and 2012 was used to update current information on the status of the species and assess any possible long-term impacts of OHV and/or livestock use on the taxon's populations. Though these plots have documented long-term impacts of OHV and/or livestock use, there is increased need to expand the long-term population monitoring to incorporate un-sampled subpopulations to yield a more representative understanding of long-term trends across the entire population.

In addition to monitoring long-term plots, IAE has worked with the BLM to conduct surveys to gain understanding of the current status and extent of the species. In 1990 and 1992, surveys were conducted of approximately 2500 acres near Unity Reservoir and Denny Flat and 1500 acres in the vicinity of Stinkingwater Creek. In 2010, our activities focused on determining the distribution of *L. lepidus* var. *cusickii* populations in the Denny Flat region of Baker County, estimating the size of populations, and determining potential threats to these populations. In 2010 surveys, a partial census was completed as the area in the vicinity of permanent monitoring transects was not surveyed. In 2014, we resurveyed extant subpopulations in Denny Flat (those surveyed in 2010), to yield updated information on the status and extent of this population. In total, approximately 152 acres of *L. lepidus* var. *cusickii* habitat were surveyed. Surveyed areas included sites with and without long-term monitoring plots, conducting a complete census at all sites. This information will be used to prioritize areas for placement of long-term monitoring plots focused on capturing large-scale population dynamics, occurring in 2015. In addition, we visited one previously un-surveyed site, Happy Camp, which had been prioritized due to its potential habitat. This information will provide the BLM with important information to assess management plans for the conservation of this sensitive species.

METHODS

Field surveys were conducted July 7-10, 2014. Sites were identified using information gathered from 2010 and in previous surveys, where potential habitat was identified using aerial photos and topographic maps. Seven sites were surveyed using the Intuitive Controlled survey method (Whiteaker et al. 1998) to document sub-populations of *L. lepidus* var. *cusickii* within potential habitat. Sites included Elms Reservoir 1, Denny Flat East 1, Denny Flat East 2, Denny Flat West, Amphitheater East and West, ORV Hill 1 & 2, and Elms Reservoir 2 (Figure 3). On each site, areas likely to have *L. lepidus* var. *cusickii* were identified through a combination of topography and soil color. Tuffaceous soil, the primary component of *L. lepidus* var. *cusickii* habitat, is very light in color and found mainly on eroding hillsides. With these characteristics in mind, additional areas were identified over the course of the surveys and



Figure 2. Small reproductive *L. lepidus* var. *cusickii*

were extended in any case that potential habitat was found. A complete census of *L. lepidus* var. *cusickii* was conducted within these sites. We counted individuals in the following categories: reproductive, vegetative, seedling (less than 5 cm diameter if not reproductive), and dead (only if we could confirm that it had been *L. lepidus* var. *cusickii*). Dead plants were likely underestimated, as there were many dead plants present that we were unable to confirm as *L. lepidus* var. *cusickii*. Reproductive plants were in fruit and flower simultaneously and many were extremely small but still producing flowers (Figure 2). Locations were documented using a navigation grade GPS unit, recording a GPS point in areas of high plant abundance. The extent of surveys was determined using GPS tracks uploaded in GIS. These routes were delineated on USGS 7.5' topographic quadrangles (Appendix A and Appendix B). Sighting report forms were completed for each occurrence noting potential causes of disturbance, geology, plant community

composition, presence of exotic species, and physical characteristics of the site.

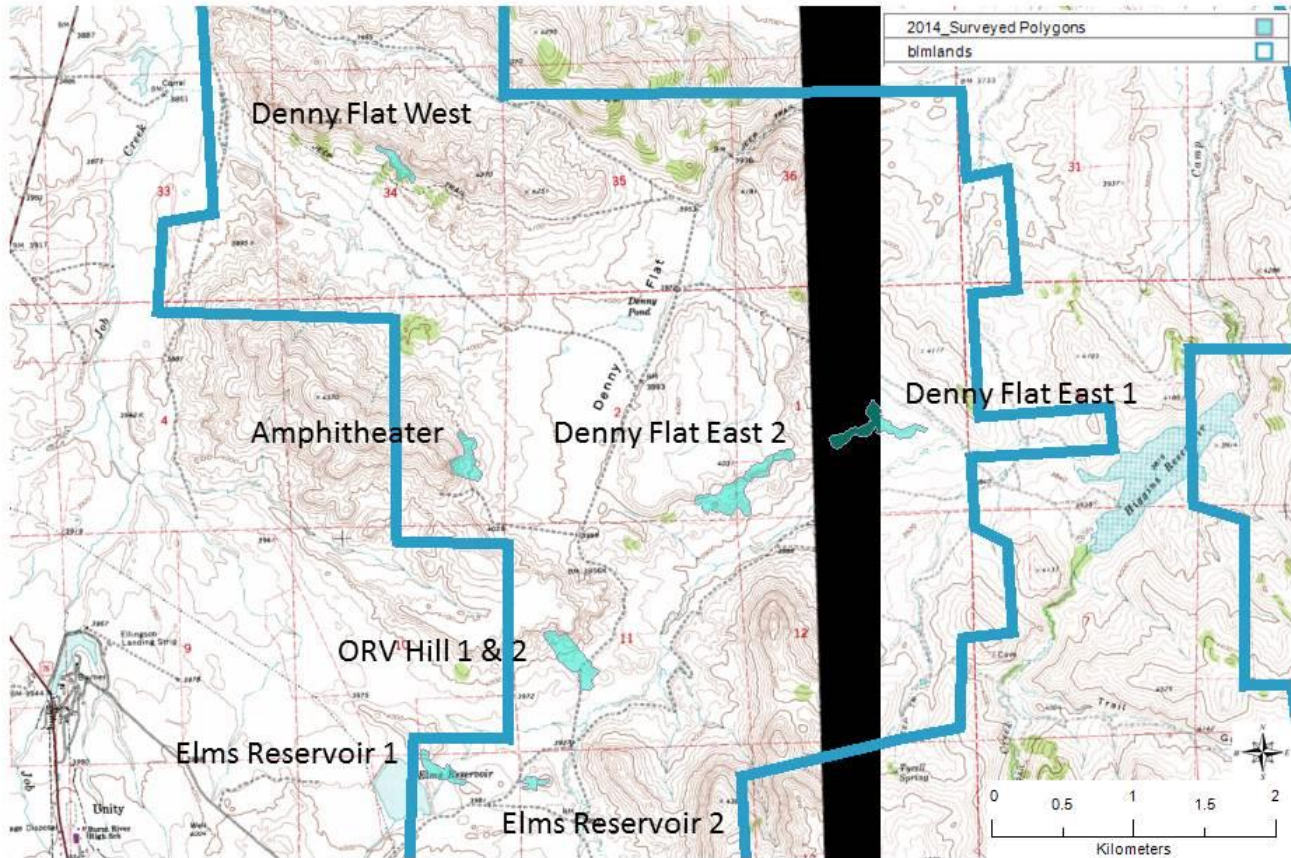


Figure 3. Overview of *Lupinus lepidus* var. *cusickii* occurrences surveyed in 2014 at Denny Flat. Areas surveyed are in light blue, with the BLM boundary in darker blue.

RESULTS

Surveys of previously known occurrences

During the 2014 field season, approximately 152 acres in the Denny Flat area of Baker County were surveyed for *L. lepidus* var. *cusickii*, including the areas where permanent monitoring transects are located. Seven occurrences were observed, including extensions of previously known ones (Table 1, Appendix A). In 2014 we separated Elms Reservoir 1 and 2 and Denny Flat East 1 and 2 into two sites due to their distance from each other. Similar to in 2010, we considered Amphitheater East and West as one site, along with ORV Hill 1 and 2 due to their close proximity to each other. Surveys in 2014 covered more area than those conducted in 2010 because they also included the area surrounding the long-term monitoring transects (Newton and Thorpe 2010, Appendix A). Therefore, direct comparisons cannot be

made for the populations that have long-term monitoring plots (Table 1). Surveys were conducted in a similar fashion in 2010 and 2014 at Denny Flat West and Denny Flat East 1 and 2, so direct comparisons could be made at these sites only. At Denny Flat West we saw a decline of *L. lepidus* var. *cusickii* from 1634 plants in 2010 to 497 plants in 2014. In 2010, 1330 individuals were noted in Denny Flat East 1 and 2, whereas in 2014 we saw a total of 1370 plants, a slight increase. Despite surveying more ground in 2014, we still saw decreases in *L. lepidus* var. *cusickii* from 2010 to 2014 at Amphitheater (2806 and 1041, respectively) and ORV Hill 1 and 2 (1592 and 842, respectively). While these numbers can't be compared directly, it is compelling that despite surveying more area in 2014, we still observed fewer *L. lepidus* var. *cusickii* than in the past.

Lupinus lepidus var. *cusickii* was somewhat uncommon throughout the entire area, but when encountered, formed dense patches. Although there was a noticeable amount of dead adults, this was counterbalanced by a high rate of recruitment (Figure 2). The proportion of seedlings to the rest of the population varied from 20% for the ORV Hills to 87% for the Denny Flat West. Though the presence of tuffaceous soil and a lack of other vegetation were characteristics of occupied habitat, we often encountered areas that appeared appropriate but did not support *L. lepidus* var. *cusickii*. The largest sub-populations were found on steep, eroding hillsides with little vegetation (cover photo). Plants also inhabited flat areas with greater soil stability and higher shrub cover.

Table 1. Characteristics of populations of *L. lepidus* var. *cusickii* surveyed in 2014.

Site	Date Surveyed	Total live plants 2010	Acres Surveyed	Seedling 2014s	Vegetative 2014	Reproductive 2014	Dead 2014	Total Live Plants 2014
*Elm's Reservoir 1	7/7/2014	4924	7.2	430	74	1735	26	2239
*Elm's Reservoir 2	7/9/2014		2.9	1831	69	1338	17	3238
Denny Flat East 1	7/8/2014	1330	14.6	414	82	345	85	841
Denny Flat East 2	7/8/2014		21.8	278	59	192	117	529
Denny Flat West	7/9/2014	1634	5.5	436	4	57	5	497
*ORV Hill 1 & 2	7/8/2014	1592	16.3	580	25	237	48	842
*Amphitheater East & West	7/9/2014	2806	10.1	540	28	473	361	1041

*2014 surveys included areas not surveyed in 2010

Lupinus lepidus var. *cusickii* was most commonly associated with open spaces with very low competition on highly erodible tuffaceous soil. The plant community was dominated by desert shrubs, including the natives *Chrysothamnus viscidiflorus*, *Artemisia tridentata*, *Eriogonum sphaerocephalum*, and *Ericameria nauseosa*. Groves of *Juniperus occidentalis* dotted the landscape, along with the occasional *Pinus ponderosa*. Other natives included *Eriogonum* spp., *Elymus elymoides*, *Erigeron pumilus*, *Calochortus macrocarpa*, *Cordylanthus ramosus*, *Machaeranthera canescens*, *Poa secunda*, *Silene* sp., and *Mimulus nanus*. Invasive community members included *Bromus tectorum*, *Sisymbrium altissimum*, and *Lepidium perfoliatum*. Also present at many of our sites was a larger perennial lupine and an annual lupine, but they were easy to differentiate from *L. lepidus* var. *cusickii*.

Disturbances and potential threats were observed at each occurrence and were mainly limited to presence of invasive species in surrounding areas and human disturbance. Several areas in Denny Flat show evidence of off-road vehicle (ORV) use and illegal dumping of household appliances and car parts. While few of the populations were in immediate danger, continued use of the area by humans could easily expand into *L. lepidus* var. *cusickii* populations. Elms Reservoir 1 and 2 both had evidence of illegal dumping, with the population at Elms Reservoir 2 expanding along a well-travelled jeep track. These areas should be monitored closely in the future. Invasive species were present along roadsides and in close proximity to some populations of *L. lepidus* var. *cusickii*, however occupied habitat overall is native dominated.

Surveys of potential habitat

We surveyed Happy Camp, a site that had been identified as potential habitat to support *L. lepidus* var. *cusickii*, on July 10, 2014. This site had been identified as potential habitat in collaboration with the BLM and looking over aerial photos for evidence of tuffaceous soils. We surveyed areas of the site using the same method as the others, surveying approximately 73 acres. The site had several patches of soil that looked like they could potentially support *L. lepidus* var. *cusickii*, but upon closer inspection the soils were darker in color and rockier. We noted some areas with similar associated species, including *Eriogonum sphaerocephalum*, *Juniperus occidentalis*, *Artemisia tridentata*, *Ericameria nauseosa*, *Chrysothamnus viscidiflorus*, *Comandra umbellata*, *Poa secunda*, *Achnatherum hymenoides*, and *Linanthus pungens*, along with a high abundance of the annual lupine. Grazing was prevalent at this site and the general plant community did not seem to have the diversity that the other sites housed.

FUTURE ACTIVITIES

The surveys conducted in 2014 enabled us to understand the current status and extent of *L. lepidus* var. *cusickii*. Utilizing information gathered in surveys in 2014, we plan to implement long-term monitoring plots in these areas to incorporate un-sampled subpopulations to yield a more representative understanding of long-term trends across the entire population. As part of these long-term permanent monitoring plots, we will collect detailed information on *L. lepidus* var. *cusickii* individuals including seedling numbers to give us an idea of recruitment rates into the population. We will also monitor the associated plant community to provide data on long-term changes and potential interactions with invasive species. We plan to add a number of long-term monitoring plots (at least two per subpopulation) to

yield a representative understanding of population trends as a whole. Monitoring of these permanent monitoring plots in subsequent years will provide data to determine population trends for *L. lepidus* var. *cusickii*.

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APPENDIX A. SUMMARIES FOR *LUPINUS LEPIDUS* VAR. *CUSICKII* SURVEYS

Amphitheater East and West

Survey Date: July 9, 2014

Observers: Erin Gray, Tara Callaway, Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. T13S R37E SE1/4 S3. USGS 7.5' quad: Unity. About 2.5 miles northeast of Unity, OR. Follow US-26 east from Unity approximately 2.75 miles, and turn north onto a dirt two-track. Follow this road just past 2.2 miles, then turn west onto another two-track. Follow this road approximately .6 miles. Plants were located approximately 500 ft from the road. UTM: 11T 407922E, 4923924N, Nad83.

Occurrence information: The Amphitheater area has one of the largest occurrences of *Lupinus lepidus* var. *cusickii* in the Denny Flat area (Figure 4). We found a total of 1081 live plant (540 seedlings, 28 vegetative, and 473 reproductive). In addition, we counted 361 dead plants. This census includes the area surveyed in 2010 along with the area surrounding long-term monitoring transects. While these numbers cannot be directly comparable to results found in 2010, some inferences can be made. In 2010, IAE did not monitor the area surrounding the long-term transects, yet the total number of plants was much greater than that seen in 2014 (2806 live plants). This indicates that the number of plants at this site has declined, though by exactly how much is unknown. In both years of surveyed, this site had a high number of large dead plants. We counted 361 in 2014 and 598 in 2010.

Survey information: This area was selected for surveying based on aerial photographs and the existence of a population in the immediate vicinity. In 2014 we surveyed approximately 10 acres of potential habitat for *L. lepidus* var. *cusickii*, which was an extension of that surveyed in 2010 (Figure 4). *L. lepidus* var. *cusickii* was found in high density on lower and middle areas of the hillside, and in the flat areas at the bottom of the hill, both within and outside of the grazing enclosure. Few individuals were found in Amphitheater East relative to Amphitheater West, and the two sections were considered one as they were located less than 100 m in distance.

Habitat Information: The Amphitheater area is so named for the large eroding hillside of tuffaceous deposits. Vegetative cover on this hillside is sparse, namely because of the steep slopes and loose soil. Species found among *L. lepidus* var. *cusickii* include *Eriogonum* spp., *Silene* sp., *Ericameria nauseosa*, *Linanthus pungens*, and *Chrysothamnus viscidiflorus*. Towards the bottom of the hill, the slope is less steep, and affords greater stability for other species, including *Bromus tectorum*, *Artemisia tridentata* ssp. *wyomingensis*, *Grayia spinosa*, *Juniperus occidentalis* ., and *Pinus ponderosa*.

Disturbance and threat information: The habitat at Amphitheater was very steep and there are little threats to the steep mid-slopes which house large numbers of *L. lepidus* var. *cusickii*. However, in the flat areas surrounding the long-term monitoring plots invasive species and cattle grazing are a threat. We noted several patches of invasive species (including *Bromus tectorum*) in the flats at the bottom of the hill, these are in close proximity to some large patches of *L. lepidus* var. *cusickii*. There was lots of evidence of cattle which could negatively impact the steep hillsides of this sensitive habitat.

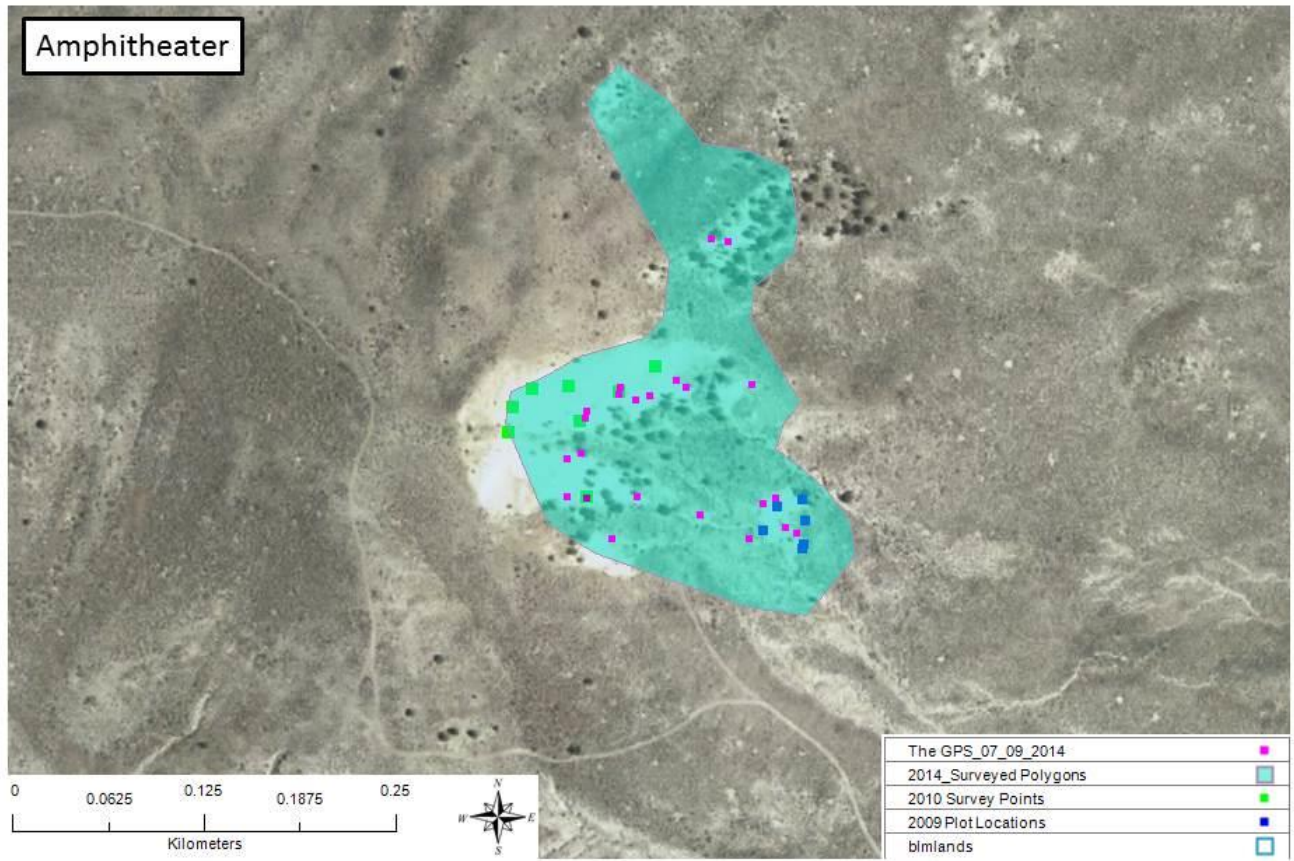


Figure 4. Area surveyed in 2014 at Amphitheater. Pink dots indicate 2014 survey points, green dots indicate 2010 survey points, and blue dots indicate long-term monitoring transects.



Figure 5. *Lupinus lepidus* var. *cusickii* habitat in the upper portion of Amphitheater (above). Pointing out areas to survey in the lower portion of Amphitheater that houses the long-term monitoring transects (below).

Denny Flat East 1

Survey Date: July 8, 2014

Observers: Erin Gray, Roger Ferriel (BLM), Tara Callaway, and Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. T13S R37E SW1/4 S1, SE1/16 SE1/4 S2. USGS 7.5' quad: Unity. Follow US-26 east from Unity approximately 2.75 miles, and turn north onto a dirt two-track. Follow this road approximately 3.2 miles, and turn right. Follow this road for another 1.3 miles. Park on the side of the road and hike across a small draw and over a hill to Denny Flat East 1. Use this site to access Denny Flat 2 overland.

Occurrence information: In 2010 Denny Flat East 1 and 2 were reported as one continuous occurrence. Given that there was more than a 100 m gap between them, we will discuss them separately in 2014. Site access is the same for both. The total area surveyed for Denny Flat East 1 was about 15 acres (Figure 6). In 2014, we found *L. lepidus* var. *cusickii* in areas where it was not noted before. We found a moderately sized population of 841 individuals (414 seedlings, 82 vegetative, and 345 reproductive), with 85 dead plants at this location. Denny Flat East 1 & 2 were reported together in 2010, and the total number of plants found was similar to that found in 2014 (1330 and 1370, respectively).

Survey information: This area was selected for surveying based on aerial photographs. It is located in close proximity to Denny Flat East 2 which corresponds with ORBIC EO# PDFAB2B193.6. Although we investigated several areas with suitable habitat (presence of tuffaceous soil, low shrub cover), *Lupinus lepidus* var. *cusickii* was present in patches.

Habitat Information: At Denny Flat East 1, small patches of *L. lepidus* var. *cusickii* were found tucked away in small washes among high shrub cover including *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Artemisia tridentata*, and *Eriogonum sphaerocephalum*. Other common species included *Poa secunda*, *Mimulus nanus*, *Eriogonum microthecum*, *Hesperostipa comata*, *Linanthus pungens*, *Elymus elymoides*, *Allium* sp., *Cordylanthus ramosus*, and *Astragalus pumilus*.

Disturbance and threat information: There is little evidence of threats at this population. The area is relatively secluded; we did not see any evidence of ORV use or human impacts. While there was some evidence of cattle grazing, its effects seemed light and the plant community had all signs of being very healthy.

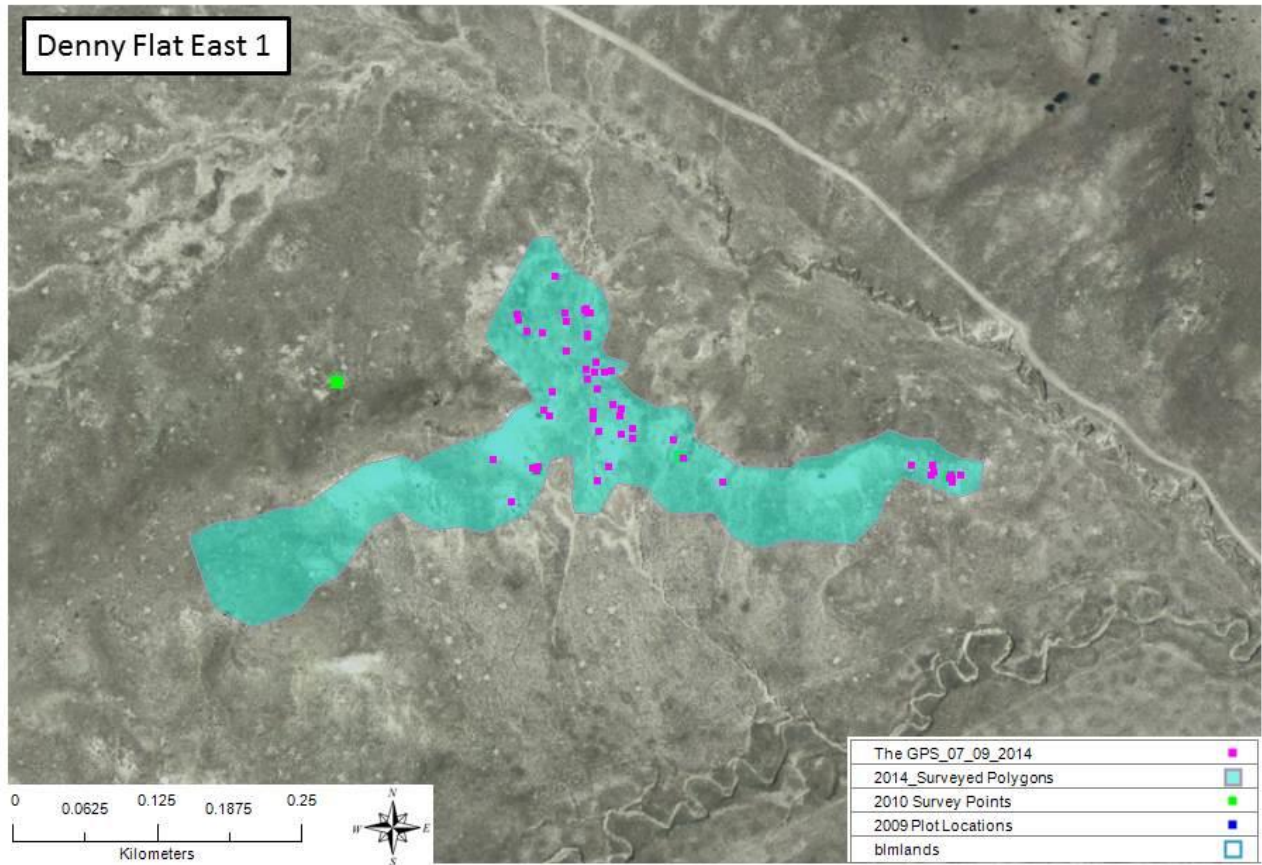


Figure 6. Area surveyed in 2014 at Denny Flat East 1. Pink dots indicate 2014 survey points and green dots indicate 2010 survey points.



Figure 7. IAE intern Suzanne Joh surveys for *Lupinus lepidus* var. *cusickii* at Denny Flat East 1.

Denny Flat East 2

Survey Date: July 8, 2014

Observers: Erin Gray, Roger Ferriel (BLM), Tara Callaway, and Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. T13S R37E SW1/4 S1, SE1/16 SE1/4 S2. USGS 7.5' quad: Unity. Follow US-26 east from Unity approximately 2.75 miles, and turn north onto a dirt two-track. Follow this road approximately 3.2 miles, and turn right. Follow this road for another 1.3 miles. Park on the side of the road and hike across a small draw and over a hill to Denny Flat East 1. Use this site to access Denny Flat 2 overland.

Occurrence information: In 2010 these populations were considered one continuous occurrence, however in 2014 we observed a greater than 100 m gap between them (Figure 8). We will discuss them separately. The total area surveyed for Denny Flat East 2 was approximately 22 acres (Figure 8). In 2014 we noted individuals in areas far outside what was noted in 2010. We found a moderately sized occurrence of 529 individuals (278 seedlings, 59 vegetative, and 192 reproductive), with 117 dead plants in 2014. Denny Flat East 1 & 2 were reported together in 2010, and the total number of plants found was similar to that found in 2014 (1330 and 1370, respectively).

Survey information: This area was selected for surveying based on aerial photographs. Denny Flat East 2 corresponds with ORBIC EO# PDFAB2B193.6. Although we investigated several areas with suitable habitat (presence of tuffaceous soil, low shrub cover), *L. lepidus* var. *cusickii* was not reliably present. There was no immediately tangible reason for the presence of *L. lepidus* var. *cusickii* in some areas and absence in others.

Habitat Information: At Denny Flat East 2, small patches of *L. lepidus* var. *cusickii* were found tucked away in small washes among high shrub cover and on eroding hillsides of tuffaceous soil and low vegetative cover. Species found here include *Eriogonum sphaerocephalum*, *Artemisia tridentata*, *Erigeron pumilus*, *Poa secunda*, *Eriogonum microthecum*, *Elymus elymoides*, *Calochortus macrocarpus*, and *Cordylanthus ramosus*. *L. lepidus* var. *cusickii* was common along washes and areas of slight annual disturbance.

Disturbance and threat information: This area had few signs of disturbance. Threats from invasive species are low, and evidence of cattle grazing was light. The greatest threat appears to be erosion on some of the steep slopes.

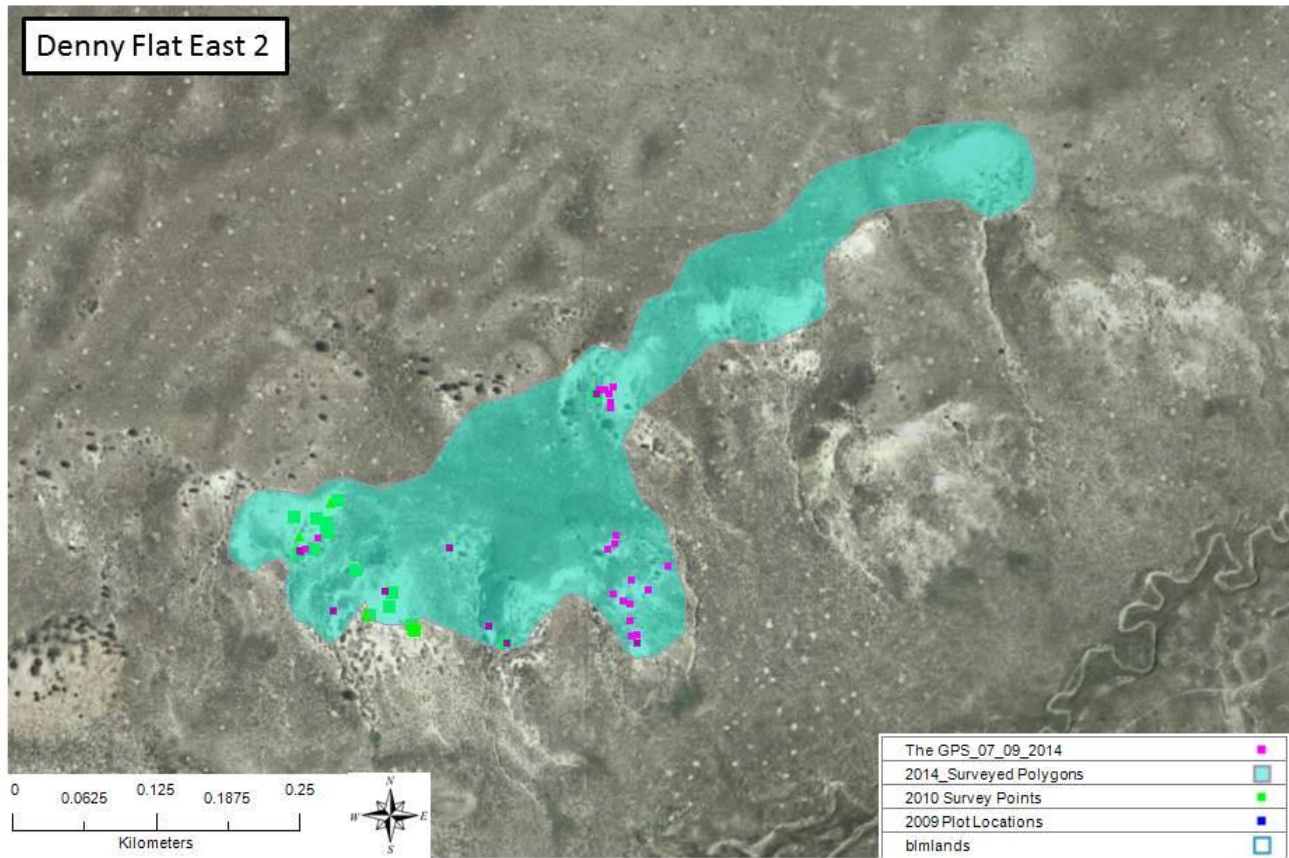


Figure 8. Area surveyed in 2014 at Denny Flat East 2. Pink dots indicate 2014 survey points and green dots indicate 2010 survey points.



Figure 9. Surveying for *Lupinus lepidus* var. *cusickii* at Denny Flat East 2.

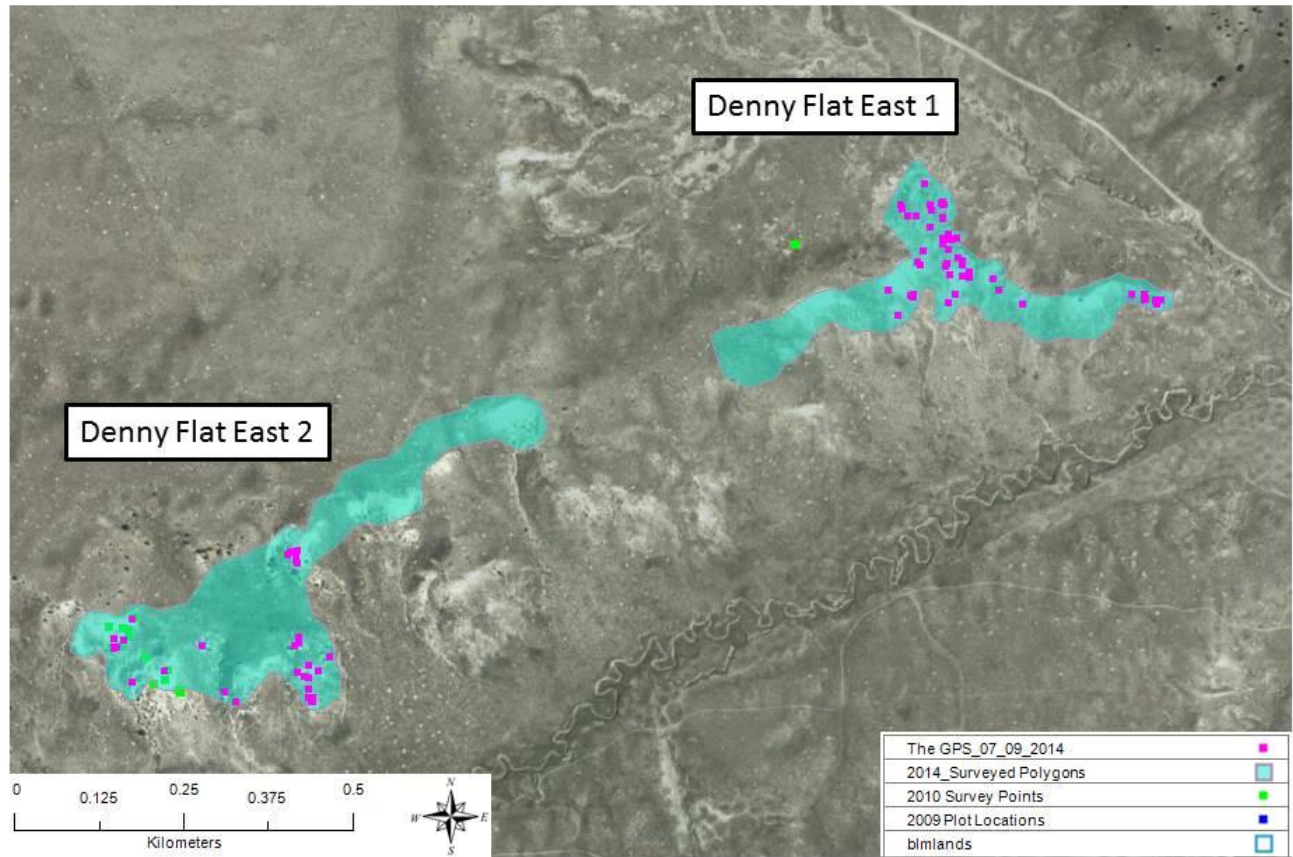


Figure 10. Denny Flat East 1 and 2 occurrences surveyed in 2014. Pink dots indicate 2014 survey points and green dots indicate 2010 survey points.

Denny Flat West

Survey Date: July 9, 2014

Observers: Erin Gray, Tara Callaway, Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. T12S R37E 1/64SW 1/16SW 1/4NW S34. USGS 7.5' quad: Unity. About 3.2 miles north-northeast of Unity, OR. Follow US-26 east from Unity approximately 2.75 miles, and turn north onto a dirt two-track. Follow this road about 3.6 miles, then turn left (west). Continue on this road approximately 1.1 miles. Park and hike south-west up and over the ridge then continue west along the ridgeline until you reach the occurrence (see Appendix B) UTM: 11T 407634E, 4926024N, Nad83.

Occurrence information: The occurrence we surveyed covered an area approximately 6 acres in size (Figure 11). In 2014, the individuals noted were within the boundaries seen in 2010, and areas noted as having plants in 2010 were lacking, suggesting a reduction in abundance since 2010. The population contained a total of 497 plants (436 seedlings, 4 vegetative, and 57 reproductive). In addition we noted 5 dead plants. This was a decline from the 1634 individuals (779 seedling, 628 vegetative, and 227 reproductive) seen in 2010. In 2010 we also found an additional 6 dead plants.

Survey information: This area was chosen for surveying based on aerial photographs and recommendations from botanists familiar with the area. We investigated several hilly areas with light-colored, presumably tuffaceous soil. Most areas had high cover of trees and bunchgrasses, suggesting a soil stability that is contraindicative for *Lupinus lepidus* var. *cusickii*.

Habitat Information: The greater area of Denny Flat West supports several tree species (*Pinus ponderosa* and *Juniperus occidentalis*) and native bunchgrasses including *Achnatherum hymenoides*, *Poa secunda*, *Elymus elymoides*. Other members of the plant community include *Eriogonum* sp., *Erigeron pumilus*, *Linanthus pungens*, *Grayia spinosa*, *Machaeranthera canescens*, and *Bromus tectorum*. The soil has relatively high rock content, and pine litter is abundant. We saw many seedlings growing in the pine litter, which was unique when compared to other sites (Figure 12). *Lupinus lepidus* var. *cusickii* at this site was very patchy, and often inhabits locally barren areas of eroding soil, and was noticeably absent from more stable soil patches.

Disturbance and threat information: This area had few signs of disturbance, and invasive species, though present, pose little threat. There is evidence of a jeep trail nearby, but not impacting the area occupied by *L. lepidus* var. *cusickii*. This population's isolation from other *L. lepidus* var. *cusickii* populations at Denny Flat may play a larger role in its persistence.

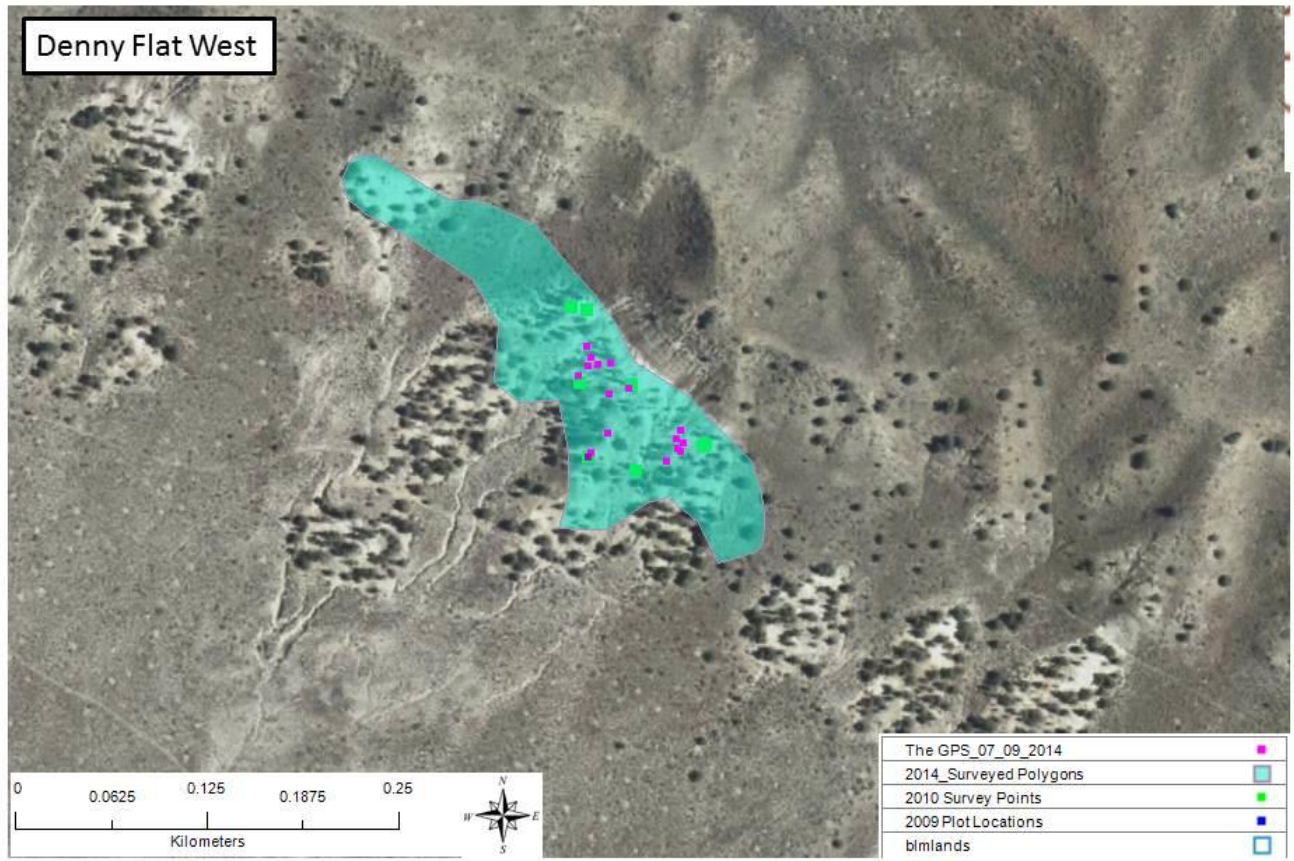


Figure 11. Area surveyed in 2014 at Denny Flat West. Pink dots indicate 2014 survey points and green dots indicate 2010 survey points.



Figure 12. *Lupinus lepidus* var. *cusickii* seedlings growing in pine litter (left). Surveying for *L. lepidus* var. *cusickii* at Denny Flat West in 2014, note the darker substrate and pine litter present (right).

ORV Hill 1 and 2

Survey Date: July 8, 2014

Observers: Erin Gray, Tara Callaway, and Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. T13S R37E SW1/4 S11. USGS 7.5' quad: Unity. About 2.3 miles northeast of Unity, OR. Follow US-26 east from Unity approximately 2.75 miles, and turn north onto a dirt two-track. Follow this road north about 1.5 miles. The ORV Hill 2 population is on the east side of the road. Follow the main road another .15 mile to find the ORV Hill 1 population about 400 feet off the road to the west. UTM: 11T 408641E, 4922533N, Nad83.

Occurrence information: In 2014 we found a total of 842 live plants (580 seedlings, 25 vegetative, and 237 reproductive). We found 48 dead plants in 2010. While we cannot compare numbers from surveys in 2010 directly, there were fewer plants found in 2014, with monitoring being more extensive. In 2014 we noted plants in areas not documented in 2010. In 2010 1592 plants were found not including the areas surrounding long-term monitoring plots. While we do not know by how much the plants have declined, we know that they have. The total area surveyed encompasses approximately 16 acres (Figure 13).

Survey information: This area was selected for surveying based on aerial photographs and the information collected in previous years. These populations extend down the hillside across the main two-track road, presumably washed there by rain. They also extend onto the eastern side of the road over a small bluff that houses the long-term monitoring plots

Habitat Information: This *Lupinus lepidus* var. *cusickii* population occupies south- to southwest-facing slopes with highly erodible tuffaceous soil (Figure 14). Vegetative cover is locally sparse, and consists of *Mimulus nanus*, *Eriogonum* spp., *Silene* sp., and *Ericameria nauseosa*. Also present were *Juniperus occidentalis*, *Chrysothamnus viscidiflorus*, *Poa secunda*, *Eriogonum sphaerocephalum*. The population extends across the road to an area with high grass cover (*Pseudoroegneria spicata*, *Elymus elymoides*, *Bromus tectorum*, and *Bromus hordeaceus*). This area is lower than the road and may receive extra moisture due to drainage from the road. The east side of the road had high shrub and grass cover in lowlands and *L. lepidus* var. *cusickii* is mostly present on the open hillside with exposed soil.

Disturbance and threat information: Invasive species are present at the site and are located in close proximity to the road. There is evidence of grazing at the site, particularly in areas with *Juniperus occidentalis*. The site has lots of ORV tracks that could impact the population and create erosion in this sensitive habitat.

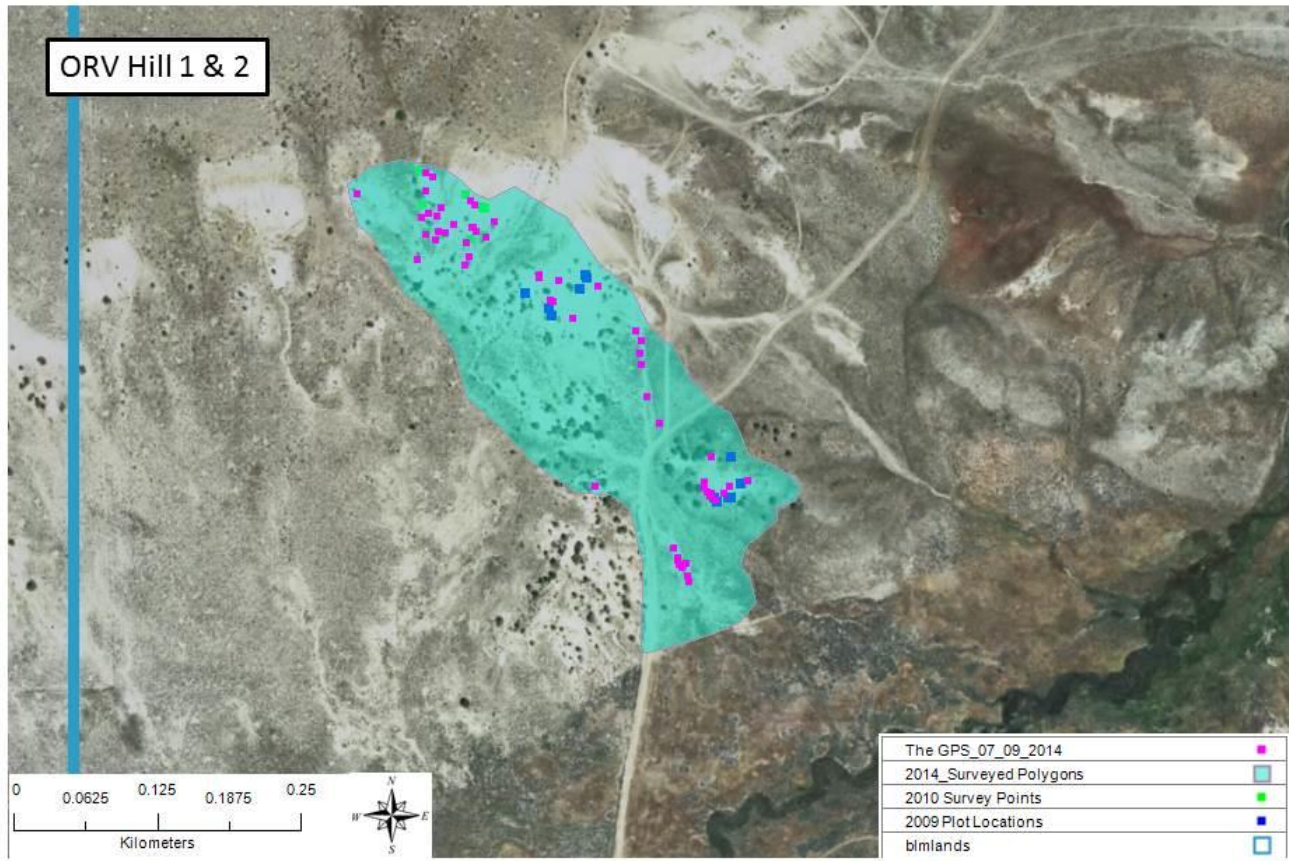


Figure 13. Area surveyed in 2014 at ORV Hill 1 and 2. Pink dots indicate 2014 survey points, green dots indicate 2010 survey points, and blue dots indicate long-term monitoring transects.



Figure 14. *Lupinus lepidus* var. *cusickii* habitat at ORV Hill 1. Note the very steep slopes with exposed tuffaceous soils.

Elms Reservoir 1

Survey Date: July 7, 2014

Observers: Erin Gray, Tara Callaway, and Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. T13S R37E NW1/16 NE1/4 S15, NW1/16 NW1/4 S14. USGS 7.5' quad: Unity. About 1.6 miles northeast of Unity, OR. Follow US-26 east from Unity approximately 2.75 miles, and turn north onto a dirt two-track. Follow this road approximately 0.4 miles, then turn left and follow for another 0.2 miles. Park next to the large Juniper, to the north of the reservoir. Plants are located on both sides of the road. UTM's: (Elms 1) 407656E, 4921837N; 11T Nad83.

Occurrence information: We will discuss Elms Reservoir 1 and 2 separately, given that they were separated by a distance greater than 100m. The Elms Reservoir 1 population is the largest found in the Denny Flat area. In 2014, a total of 2239 live individuals were found (430 seedlings, 74 vegetative, 1735 reproductive). In addition, we found 26 dead plants. The total population area encompasses about 7.2 acres (Figure 15). In 2014 we found plants in areas outside of that noted in 2010.

Survey information: This area was selected for surveying based on aerial photographs and the existence of a population in the immediate vicinity. Surveys targeted the area monitored in long-term transects as well as the surrounding appropriate habitat.

Habitat Information: At Elms Reservoir 1, *Lupinus lepidus* var. *cusickii* was found on a slight hillside and a small bowl of eroding tuff. Other members of the plant community include *Artemisia tridentata*, *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Linanthus pungens*, *Poa secunda*, *Silene* sp., *Chaenactis douglasii*, and *Achillea millefolium*

Disturbance and threat information: Threats observed for this population include human impacts given the proximity to the highway. The site is impacted by human litter and illegal dumping. There is also lots of evidence of large mammal herbivory on plants. Despite these threats, this remains one of the most robust populations in the Denny Flat area.

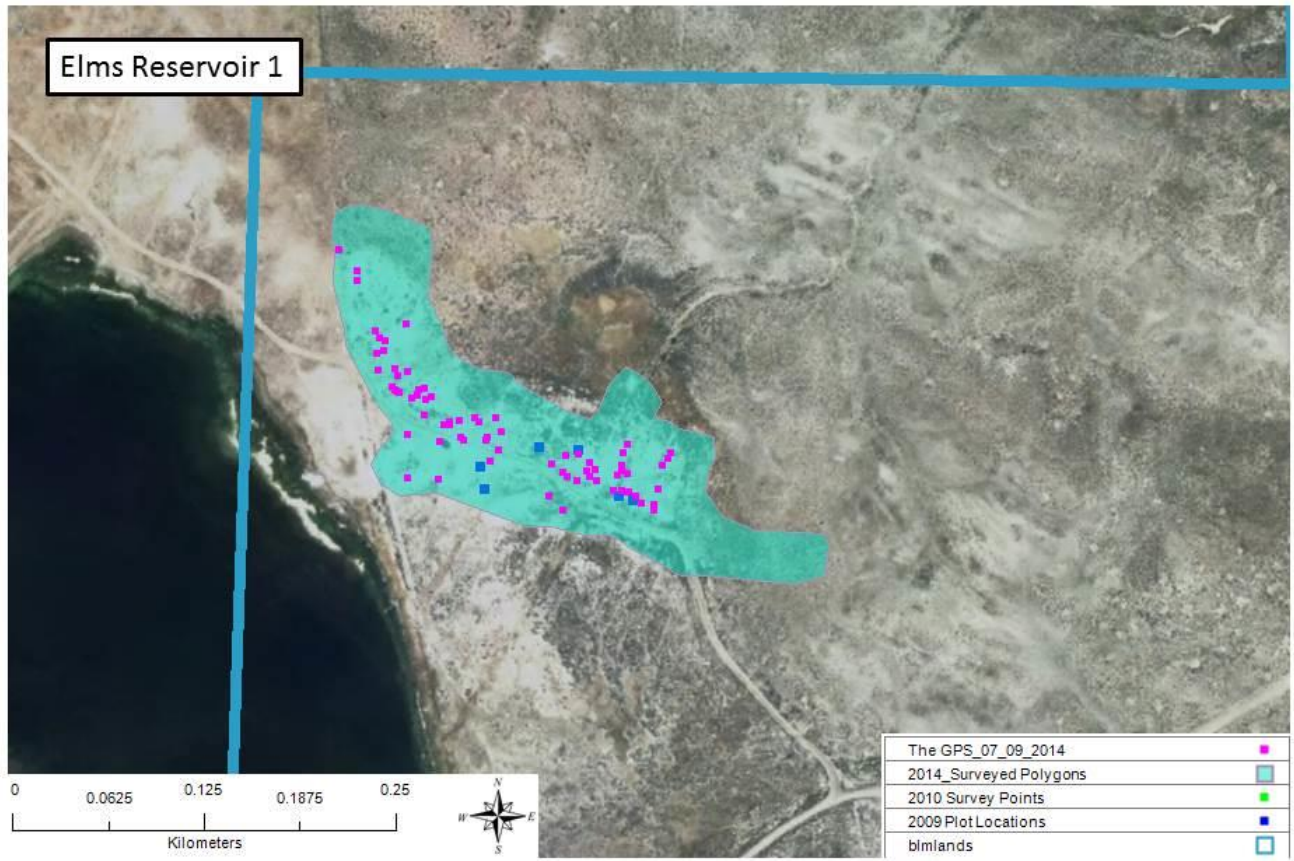


Figure 15. Area surveyed in 2014 at Elms Reservoir 1. Pink dots indicate 2014 survey points, green dots indicate 2010 survey points, and blue dots indicate long-term monitoring transects.



Figure 16. *Lupinus lepidus* var. *cusickii* habitat at Elm's Reservoir 1.

Elms Reservoir 2

Survey Date: July 9, 2014

Observers: Erin Gray, Tara Callaway, and Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. T13S R37E NW1/16 NE1/4 S15, NW1/16 NW1/4 S14. USGS 7.5' quad: Unity. About 1.6 miles northeast of Unity, OR. Follow US-26 east from Unity approximately 2.75 miles, and turn north onto a dirt two-track. Follow this road about 0.7 miles and park on the side of the road. Plants are located along the jeep track that continues east up the small butte. UTM: (Elms 2) 407720E, 4921683N; 11T Nad83.

Occurrence information: We will discuss Elms Reservoir 1 and 2 separately, given that they were separated by a distance greater than 100m. Elms Reservoir 2 is one of the largest occurrences found in the Denny Flat area. A total of 3238 live individuals were found during the 2014 census (1831 seedling, 69 vegetative, and 1338 reproductive). We found an additional 17 dead plants. The total population area encompasses about 2.9 acres (Figure 17).

Survey information: This area was selected for surveying based on aerial photographs and the existence of a population in the immediate vicinity. It was also visited in 2010 surveys.

Habitat Information: At Elms Reservoir 2, *Lupinus lepidus* var. *cusickii* was found on a flat area along a highly disturbed jeep road leading to the top of a small butte (Figure 18). Other members of the plant community include *Artemisia tridentata*, *Ericameria nauseosa*, *Erigeron pumilus*, *Eriogonum* sp., *Silene* sp., *Chrysothamnus viscidiflorus*, *Agropyron cristatum*, *Linanthus pungens*, *Poa secunda*, and *Bromus tectorum*.

Disturbance and threat information: This site is heavily disturbed. The occurrence follows a jeep road and extends onto a flat area in the immediate vicinity. Garbage dumping here is common and shotgun shells were present (Figure 18).

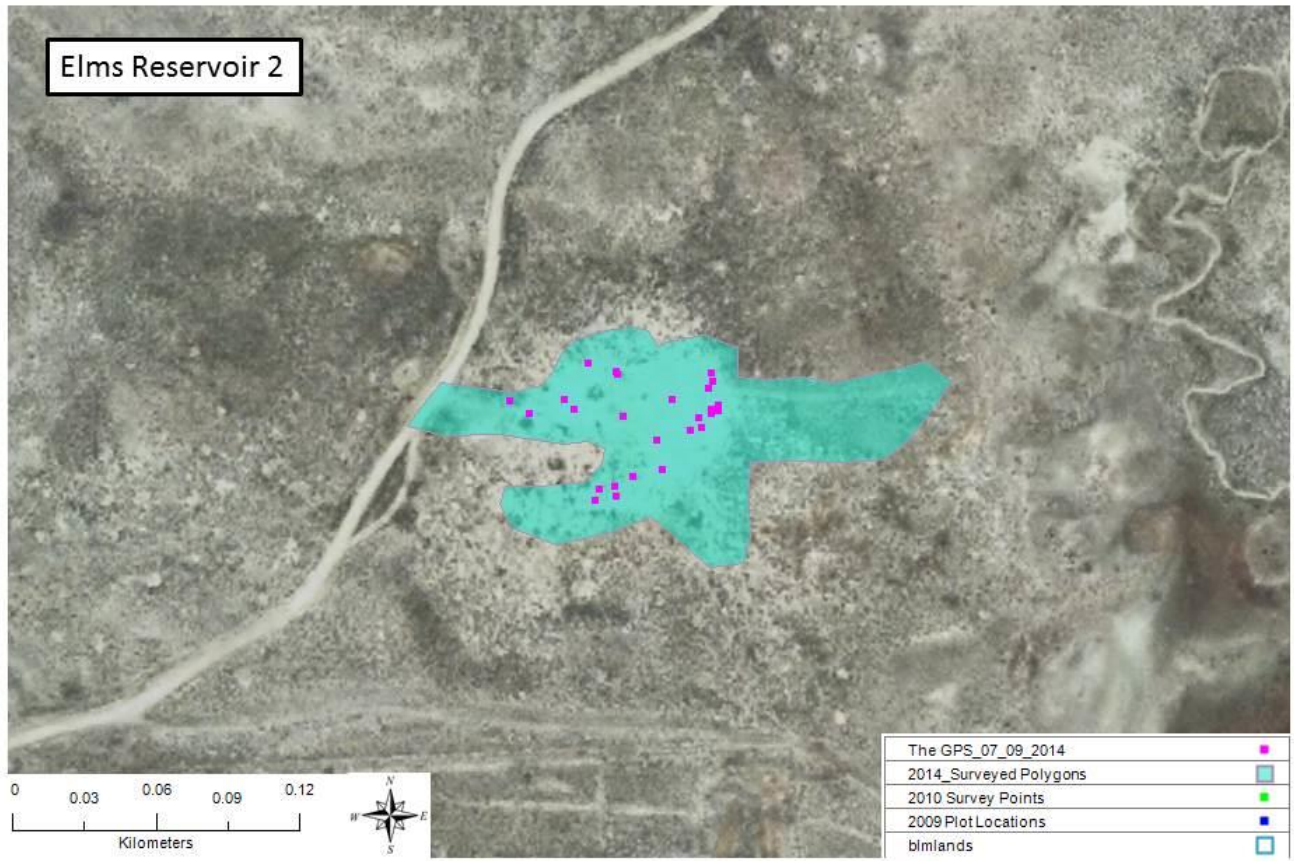


Figure 17. Area surveyed in 2014 at Elms Reservoir 2. Pink dots indicate 2014 survey points and green dots indicate 2010 survey points.



Figure 18. *Lupinus lepidus* var. *cusickii* population growing along a jeep track at Elms Reservoir 2 (above), and small plant growing next to garbage (below).

Happy Camp

Survey Date: July 9, 2014

Observers: Erin Gray, Tara Callaway, and Suzanne Joh
Institute for Applied Ecology
POB 2855
Corvallis, OR 97339-2855

Location information: Denny Flat, Baker County. Zero out odometer at the Unity Market/Gas Station. Turn east off Highway 26 at 4.6 miles, take a left into a driveway through a gate and zero out the odometer. Follow the road past the private residence and past the barn complex (at 0.1 and 0.2 miles respectively). The road continues for a total of ~1.2 miles. At this point, the road will turn north (to the left). After traveling for approximate 0.5 miles you will be on BLM land. The road is very sandy, beware!
UTMs: 413524E, 4918821N; 11T Nad83.

Occurrence information: We found no individuals at Happy Camp.

Survey information: This area was selected for surveying based on aerial photographs and from conversations with BLM staff. The total area surveyed was 73.4 acres (Figure 19).

Habitat Information: Despite the habitat looking promising, we found no *Lupinus lepidus* var. *cusickii* at Happy Camp. The site had some areas with associated species though the soils were much more compacted. Species present included *Eriogonum sphaerocephalum*, *Juniperus occidentalis*, *Artemisia tridentata*, *Poa secunda*, *Allium* sp., *Chrysothamnus viscidiflorus*, *Ericameria nauseosa*, *Comandra umbellata*, *Achnatherum hymenoides*, *Linanthus pungens*, *Calochortus macrocarpa*, *Erigeron pumilus*, *Machaeranthera canescens*, *Achillea millefolium*, *Cordylanthus ramosus*, and *Astragalus pumilus*.

Disturbance and threat information: Happy Camp had extensive evidence of grazing throughout the site with cattle tracks and many bunchgrasses impacted by grazing. The soils appeared to be more compacted than other sites, with different texture.

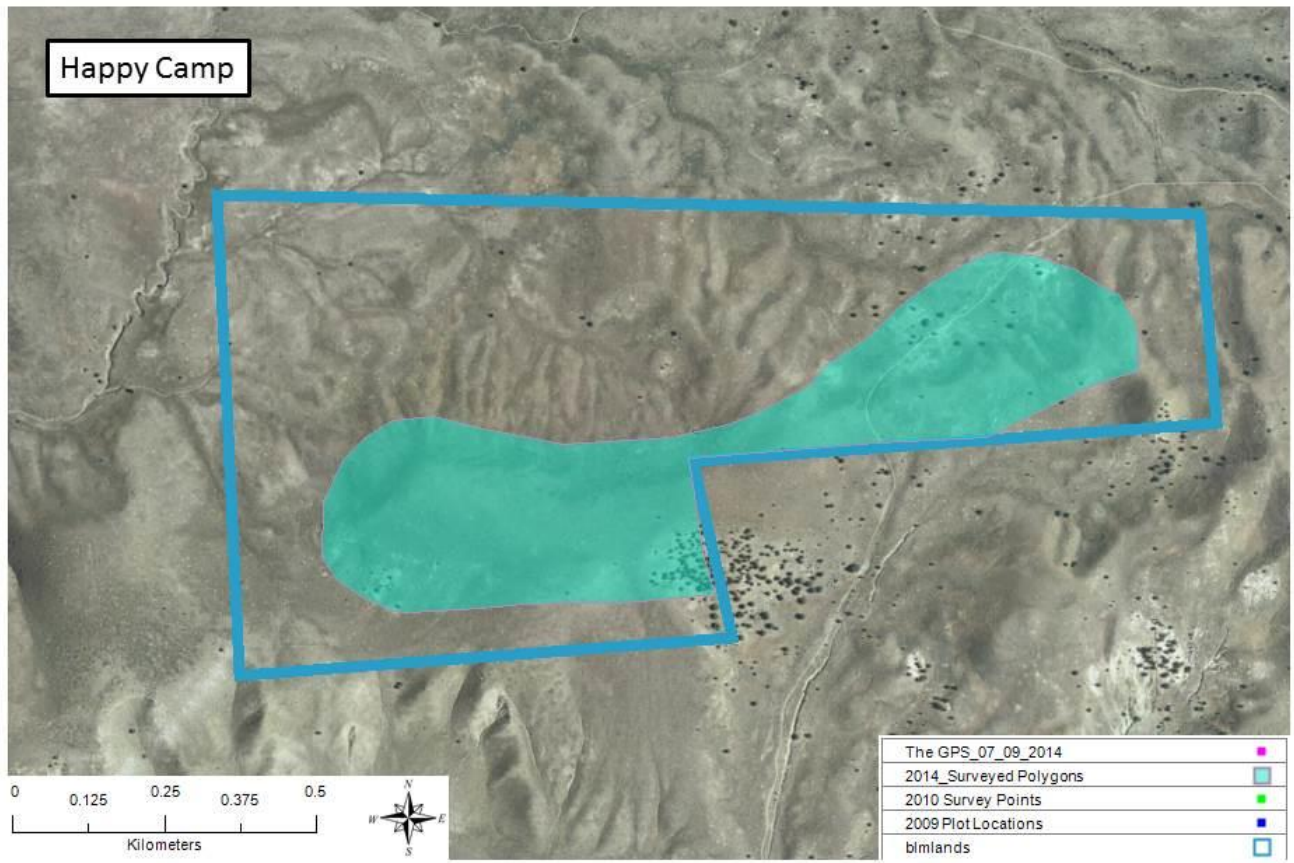


Figure 19. Area surveyed in 2014 at Happy Camp. No *Lupinus lepidus* var. *cusickii* were present.

APPENDIX B. OVERVIEW MAPS FOR DENNY FLAT

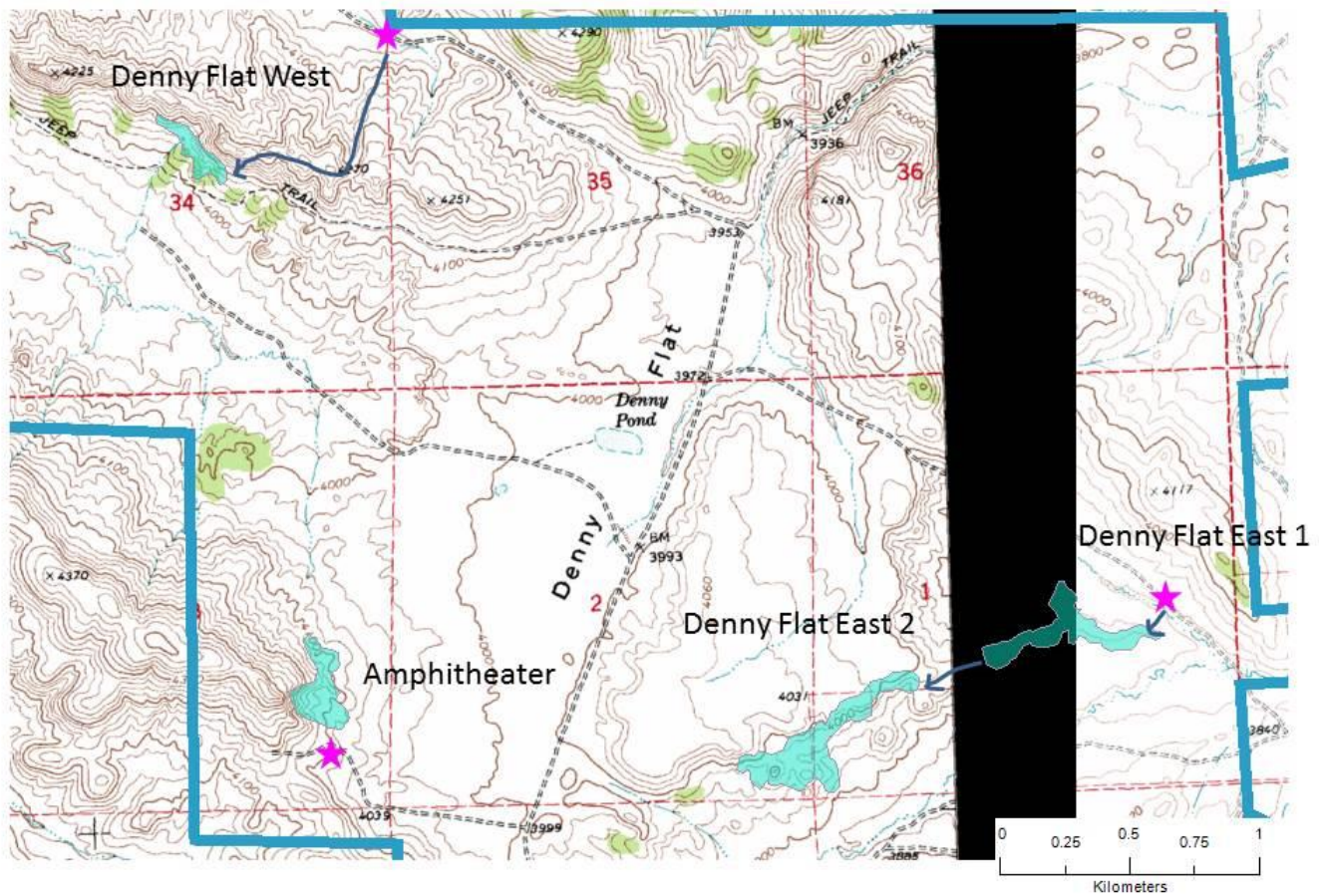


Figure 20. Overview of northern section of Denny Flat. Pink stars indicate areas to park, and grey arrows indicate the direction to hike for site access.

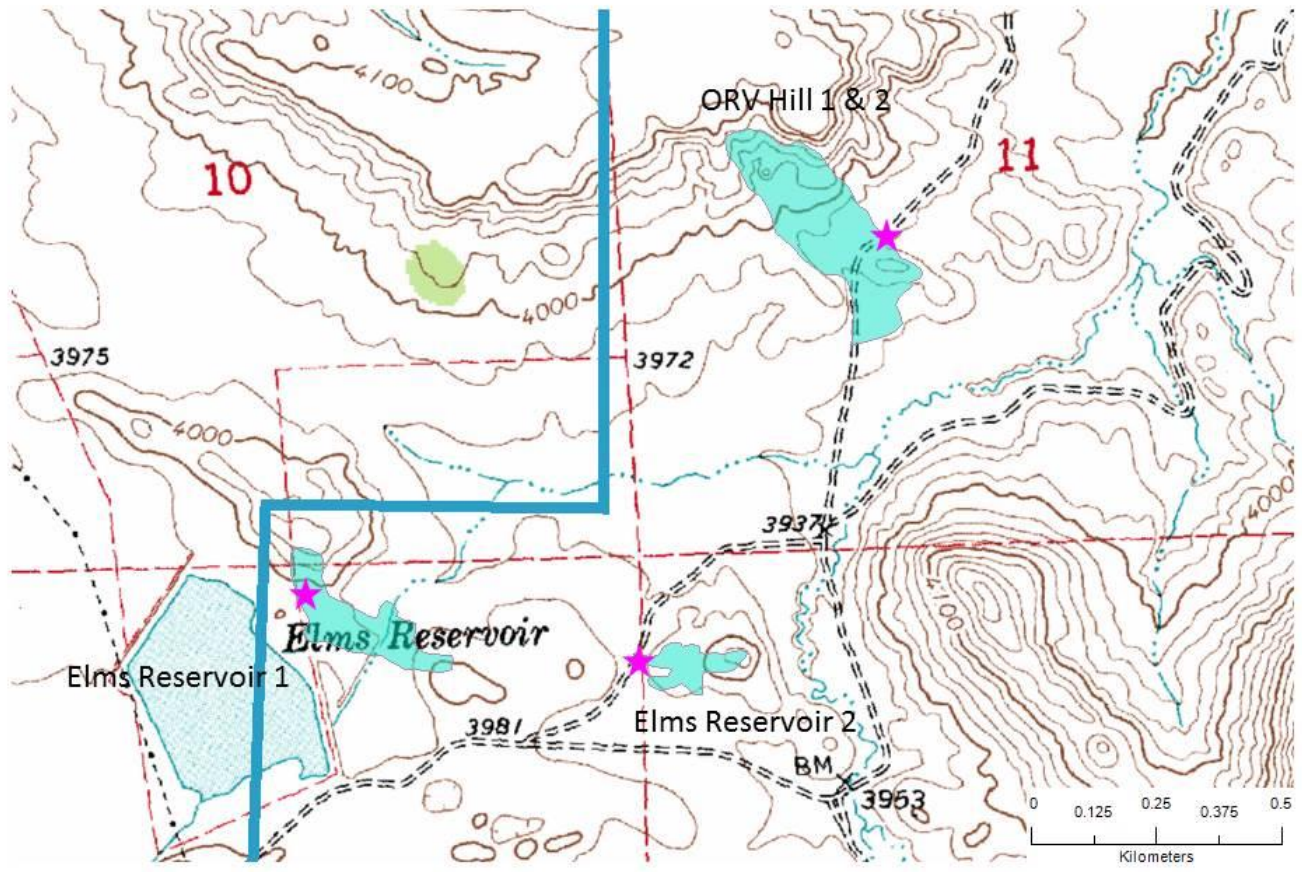


Figure 21. Overview of southern section of Denny Flat. Pink stars indicate areas to park for site access.