

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



2016

Report to the Bureau of Land Management, Vale
District

Report prepared by Meaghan I. Petix, Matt A.
Bahm, and Erin C. Gray
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

Conservation Research Program Director

Institute for Applied Ecology

563 SW Jefferson Avenue

Corvallis, Oregon 97333

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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EXECUTIVE SUMMARY

We conducted a full census of *Lupinus lepidus* var. *cusickii* subpopulations in Denny Flat on land managed by the Vale District of the Bureau of Land Management. In 2016, we monitored permanent monitoring transects to examine plant community and *L. lepidus* var. *cusickii* population trends. This species can have high annual variability and our 2014, 2015, and 2016 surveys found similar patterns. In 2016, all sites had higher plant counts than in 2015. Several sites that had shown decreases between the 2010 and 2014 surveys had higher plant numbers in both 2015 and 2016 compared to 2010.

- A total of 10,771 *L. lepidus* var. *cusickii* plants were counted in 2016 at Elms Reservoir 1.
 - Elms Reservoir 1 had the greatest increase in plants from 2015 to 2016, with 6746 more individuals counted in 2016.
- A total of 7144 plants were counted in 2016 at Elms Reservoir 2.
 - Elms Reservoir 2 had the greatest proportion of seedlings (81%) among the total population as well as the highest mean number of seedlings per m² in the monitoring transects.
- A total of 7112 plants were counted in 2016 at Denny Flat East 1.
- A total of 5112 plants were counted in 2016 at Denny Flat East 2.
- A total of 3442 plants were counted in 2016 at Denny Flat West.
 - Denny Flat West had the highest percent cover of *L. lepidus* var. *cusickii* in the monitoring transects.
- A total of 10,737 plants were counted in 2016 at ORV Hill 1&2.
 - ORV Hill 2 had the highest percent cover of exotic plant species in the monitoring transects.
- A total of 6883 plants were counted in 2016 at Amphitheater.

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 (ODA), and it is considered a Species of Concern by the U.S. Fish and Wildlife Service (USFWS). The Oregon Biodiversity Information Center (ORBIC) considers *L. lepidus* var. *cusickii* to be threatened or endangered throughout its range (ORBIC 2010). *L. lepidus* var. *cusickii* (Figure 1) is a narrow endemic, whose global distribution consists of a single metapopulation centered around Denny Flat, covering an area with a 2.5 miles radius in Baker County, Oregon (R. Ferriell, BLM Vale, personal communication). These populations are located southeast of the Blue Mountain foothills within Denny Flat, near the town of Unity, Oregon. *L. 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 (R. Meinke, ODA, personal communication). 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 (ODA 2010). 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. *L. 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. (ODA 2010). 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 (ODA 2010). 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 (ODA 2010), we are only now beginning to gain an understanding of the species' population dynamics and long-term trends. Population monitoring was initiated in 1993 by ODA and conducted annually until 1998. The Institute for Applied Ecology (IAE) began population monitoring in 2009 and 2012. Long-term monitoring plots were established 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; for more information on the methods/results of this work, see Trowbridge et al. (2012). 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 unsampled subpopulations to yield a more representative understanding of long-term trends across the entire population.

In addition to population monitoring, a variety of organizations have conducted surveys to gain understanding of the current status and extent of the species. Previous reports of Cusick's lupine from Grant and Harney counties were found to be misidentified (Rausch 2011). In 1990 and 1992, surveys were conducted on approximately 2500 acres near Unity Reservoir and Denny Flat and 1500 acres in the vicinity of Stinkingwater Creek. In 2010, IAE conducted work 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, only a partial census was completed, as the area in the vicinity of permanent monitoring transects was not surveyed. In 2014, IAE resurveyed extant subpopulations (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. In 2015 and 2016 we surveyed the same areas as in 2014, and also collected data on permanent monitoring transects focused on capturing information on population dynamics and the surrounding plant community. This information will provide the BLM with information to assess management plans for the conservation of this sensitive species.

METHODS

Population Surveys

Field surveys were conducted June 28 – July 1, 2016. Sites were identified using information gathered from 2010 and in previous surveys, where potential habitat was identified using aerial photos and topographic maps. Five 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). At 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 LUPINUS 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, and seedling (less than 5 cm diameter if not reproductive). Dead plants were not counted in 2015 or 2016. Reproductive plants were in fruit and flower simultaneously and many were extremely small but still producing flowers (Figure 2). Locations were documented using a 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.

Permanent Monitoring Transects

In 2016, we monitored transects that IAE had previously established (Massatti et al. 2009, Gray et al. 2015). Several transects monitored had been established in 2009, but several were newly established in 2015. In 2015, the original transects at ORV Hill 1 were modified to have consistent length, and new transects were established at ORV Hill 2 to better capture the current *L. lepidus* var. *cusickii* population distribution (Appendix C). There are twenty-four transects each measuring 10m in length (see Appendix C). Along each transect (in a 1m belt to either the left or the right of the baseline tape) we tallied the number of *L. lepidus* var. *cusickii* individuals into different size classes [vegetative: seedling (<5cm), small (5-10cm), medium (>10-25cm), and large (>25cm); reproductive: small (5-10cm), medium (>10-25cm), and large (>25cm)]. We noted if any grazing had occurred by mammal and/or insect. In addition, we monitored plant community in three 1m² quadrats placed randomly along each transect. This data was analyzed to determine population trends and plant community changes.

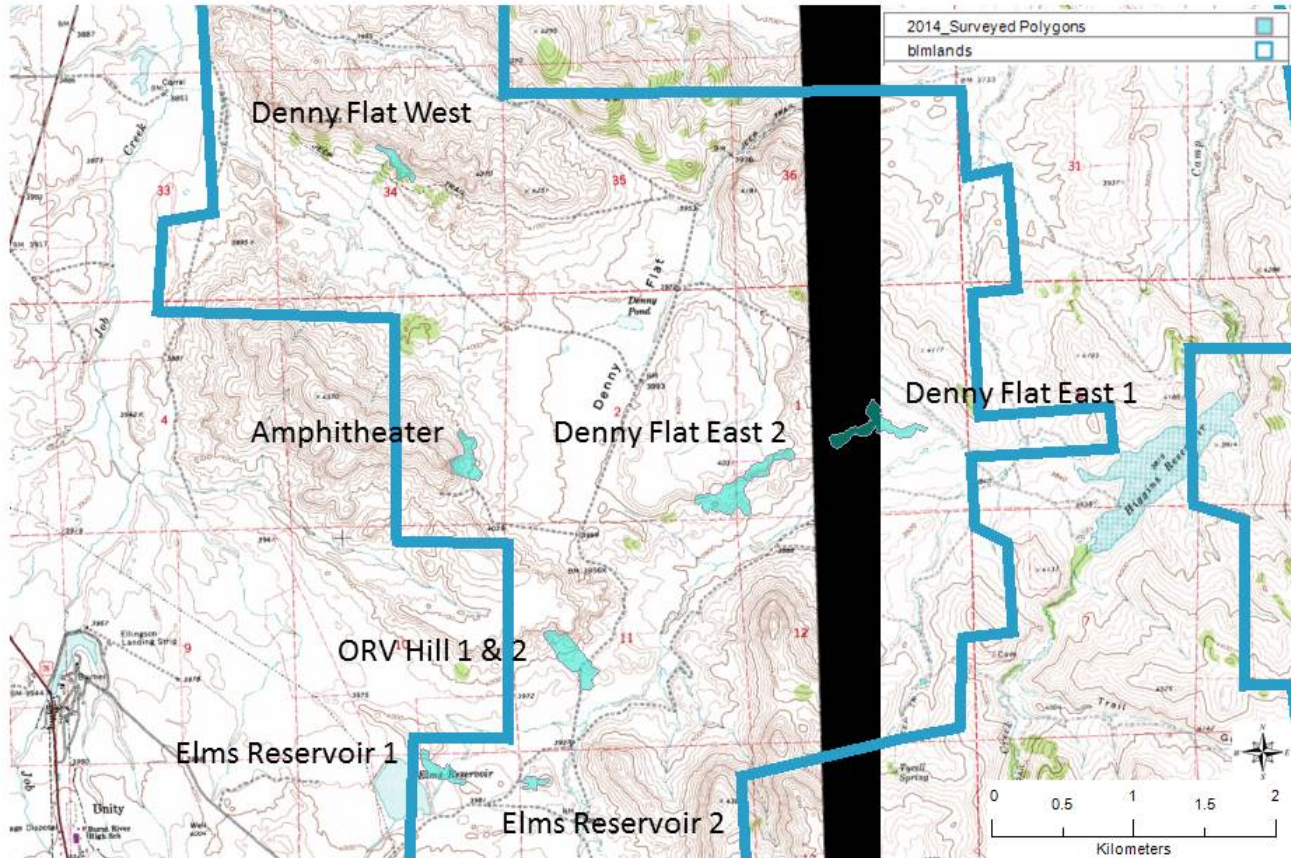


FIGURE 3. OVERVIEW OF *LUPINUS LEPIDUS* VAR. *CUSICKII* OCCURRENCES SURVEYED IN 2014, 2015, AND 2016 AT DENNY FLAT. AREAS SURVEYED ARE IN LIGHT BLUE, WITH THE BLM BOUNDARY IN DARKER BLUE.

RESULTS

Population Surveys

During the 2016 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 2014-2016, 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, 2015, and 2016 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 to the 2010 data (Table 1). Surveys were conducted in a similar fashion in all three surveys 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 *L. lepidus* var. *cusickii* fluctuate from 1634 plants in 2010,

497 plants in 2014, 1093 in 2015, up to 3442 plants in 2016. At Denny Flat East 1 and 2, 1330 individuals were recorded in 2010, 1370 in 2014, 6860 in 2015, and then a total of 12,224 plants in 2016, a dramatic increase. While we recorded 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), both sites had much higher numbers in 2015 and 2016 (4429 and 6883 at Amphitheater and 4908 and 10,737 at ORV Hill, respectively; Table 1). Elms Reservoir 1 and 2 showed an increase from each survey – from 4924 plants in 2010, up to 5477 in 2014, 6029 in 2015, and then 17,915 in 2016 (Table 1).

Although the numbers from 2010 can't be directly compared, the decreases in *L. lepidus* var. *cusickii* observed over a larger survey area in 2014 (at Denny Flat West, ORV Hill 1 & 2, and Amphitheater) followed by the increases seen in 2015 and 2016, highlight the highly variable year-to-year fluctuations for this species. The considerable increases observed in 2015 and 2016 for all sites may be due to climatic factors, such as precipitation. The winters preceding the 2015 and 2016 surveys had high precipitation rates (with a mean ppt of 1.51 inches in 2015 and 1.65 inches in 2016) as did the spring of 2015 (with May 2015 [2.69 inches ppt] having the highest mean precipitation of any spring month in 2010 and 2014-2016) (Figure 4, Table 2). The winter preceding the 2014 survey had the lowest precipitation rates (with a mean ppt of only 1.03 inches), which may have contributed to the low counts of *L. lepidus* var. *cusickii* that year (Figure 4, Table 2). The timing and amount of precipitation may be important factors driving populations of *L. lepidus* var. *cusickii*.

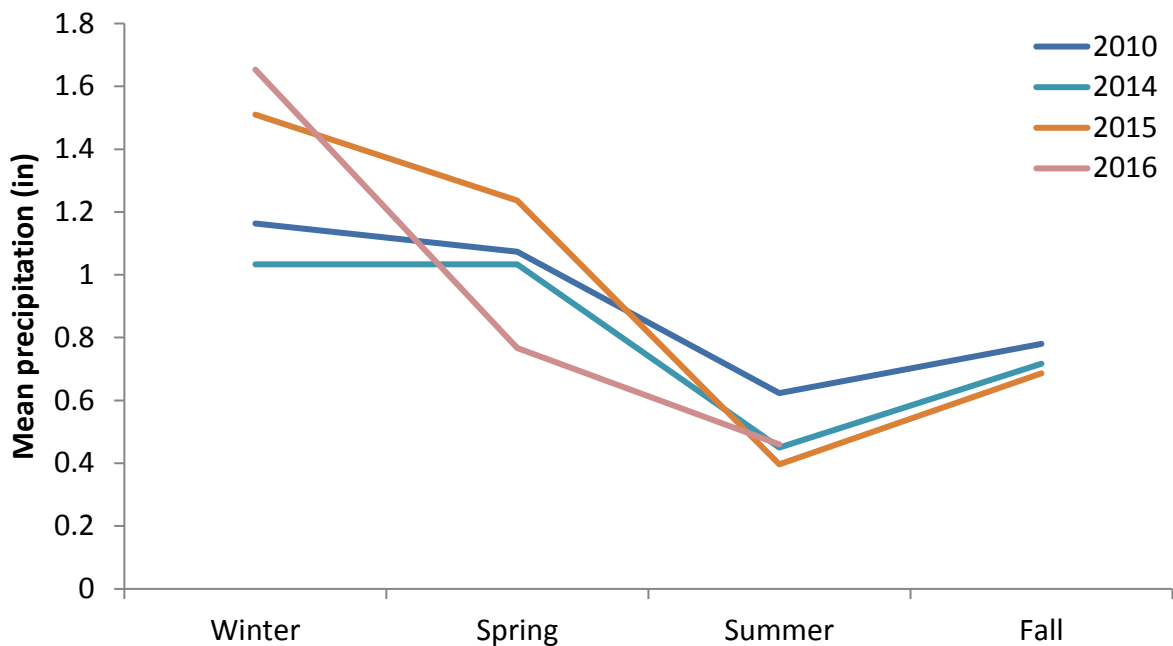


FIGURE 4. MEAN PRECIPITATION (INCHES) FOR 2010 AND 2014-2016 AT AMPHITHEATER (PRISM CLIMATE GROUP 2016).

TABLE 1. CHARACTERISTICS OF POPULATIONS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* SURVEYED IN 2014, 2015, AND 2016.

Site	Total live	Acres	Seedling			Vegetative			Reproductive			TOTAL		
	plants	Surveyed												
	2010	2014-16	2014	2015	2016	2014	2015	2016	2014	2015	2016	2014	2015	2016
*Elms Reservoir 1	4924	7.2	430	1289	6122	74	1860	519	1735	876	4130	2239	4025	10,771
*Elms Reservoir 2		2.9	1831	872	5798	69	827	92	1338	305	1254	3238	2004	7144
Denny Flat East 1	1330	14.6	414	1220	4037	82	2153	1372	345	1253	1703	841	4626	7112
Denny Flat East 2		21.8	278	519	3992	59	1141	253	192	574	867	529	2234	5112
Denny Flat West	1634	5.5	436	392	2082	4	336	234	57	365	1126	497	1093	3442
*ORV Hill 1 & 2	1592	16.3	580	1764	7748	25	2238	745	237	906	2244	842	4908	10,737
*Amphitheater East & West	2806	10.1	540	1035	4169	28	2381	529	473	1013	2185	1041	4429	6883

*2014-2016 surveys included areas not surveyed in 2010

TABLE 2. MONTHLY PRECIPITATION (INCHES) FOR 2010 AND 2014-2016 AT AMPHITHEATER (PRISM CLIMATE GROUP 2016).

Year	Dec	Winter			Spring				Summer			Fall				
		Jan	Feb	Mean	March	April	May	Mean	June	July	August	Mean	Sept	Oct	Nov	Mean
2010	1.09 (2009)	1.62	0.78	1.16	0.45	1.09	1.68	1.07	1.11	0.42	0.34	0.62	0.17	1.08	1.09	0.78
2014	0.87 (2013)	0.71	1.52	1.03	1.21	0.82	1.07	1.03	0.53	0.30	0.52	0.45	0.45	0.37	1.33	0.72
2015	2.94 (2014)	0.50	1.09	1.51	0.63	0.39	2.69	1.24	0.00	1.08	0.11	0.40	0.43	0.60	1.03	0.69
2016	2.95 (2015)	1.39	0.62	1.65	1.13	0.45	0.72	0.77	0.46	N/A	N/A	0.46	N/A	N/A	N/A	N/A

L. lepidus var. *cusickii* was somewhat uncommon throughout the entire area, but when encountered, formed dense patches. Surveys in 2014, 2015, and 2016 found concentrations of *L. lepidus* var. *cusickii* in the same areas, thus, the increases observed are concentrated in known occupied areas, rather than being indicative of an expanded range for *L. lepidus* var. *cusickii*. The population increases from 2015 to 2016 can be mainly attributed to a greater number of seedlings at each site (Table 1). The proportion of seedlings to the rest of the population was greater than 50% for every site, varying from 57% to 81%, with Elms Reservoir 2 having the greatest proportion of seedlings (Table 1). Populations ranged in size from 3442 (Denny Flat West) to 10,771 (Elms Reservoir 1) (Table 1). 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.

L. 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* ssp. *wyomingensis*, *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 macrocarpus* var. *macrocarpus*, *Cordylanthus ramosus*, *Machaeranthera canescens*, *Poa secunda*, *Silene* sp., and *Mimulus nanus*. Invasive community members included *Bromus tectorum*, *Sisymbrium altissimum*, *Lepidium perfoliatum*, and *Cardaria draba*. Also present at many of the sites was a larger perennial lupine and an annual lupine (*Lupinus uncialis*), but differentiation from *L. lepidus* var. *cusickii* was not an issue.

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. 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. The road bisecting the population at Elms Reservoir 1 was recently improved to provide better access to a mining operation, and this could possibly mean heavier traffic with detrimental impacts to the *L. lepidus* var. *cusickii* population. 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.

Permanent Monitoring Transects

In 2016 there were 1433 *L. lepidus* var. *cusickii* seedlings counted along the permanent monitoring transects, which was more than 2x the number counted in 2015 (663 seedlings) (Table 3). At every site there were more seedlings counted along transects in 2016 than in 2015. Of the sites monitored, Elms Reservoir 2 had the highest mean number of seedlings per m² in 2016 (Figure 5 and Figure 6). The large number of seedlings counted in both the permanent monitoring transects and across the entire site during surveying at Elms Reservoir 2 (had the greatest proportion of seedlings with 81% of the total population) indicate very high germination for this occurrence. Denny Flat West also had more than double the number of seedlings counted along its transects, with an average of 5.1 seedlings per m² in 2015 to 11.2 seedlings per m² in 2016 (Figure 6).

TABLE 3. COUNT OF LUPINUS LEPIDUS VAR. CUSICKII INDIVIDUALS (CATEGORIZED INTO SEEDLING, VEGETATIVE AND REPRODUCTIVE) FOUND ALONG PERMANENT MONITORING TRANSECTS IN 2015 AND 2016.

	Seedling	Vegetative	Reproductive	TOTAL
2015	663	343	183	1189
2016	1433	249	500	2182

The count of reproductive individuals went from 183 in 2015 to 500 in 2016 (Table 3). On the other hand, the count of vegetative individuals went from 343 in 2015 to 249 in 2016 (Table 3). The increase in mature plants, especially reproductive individuals, in 2016 indicates successful seedling recruitment from 2015 to 2016. With the large number of seedlings counted in 2016, there is potential for even greater numbers of mature plants next year, depending on the rate of seedling survival.

Along with the greater number of *L. lepidus* var. *cusickii* individuals counted in 2016, there was also greater percent cover of *L. lepidus* var. *cusickii* measured along the permanent monitoring transects in 2016 than in 2015 for all sites (Figure 7). In particular, Denny Flat West and Elms Reservoir 1 had considerably higher percent cover for *L. lepidus* var. *cusickii* in 2016 than in 2015 (9.9% versus 1.4% and 9.3% versus 2.4%, respectively).

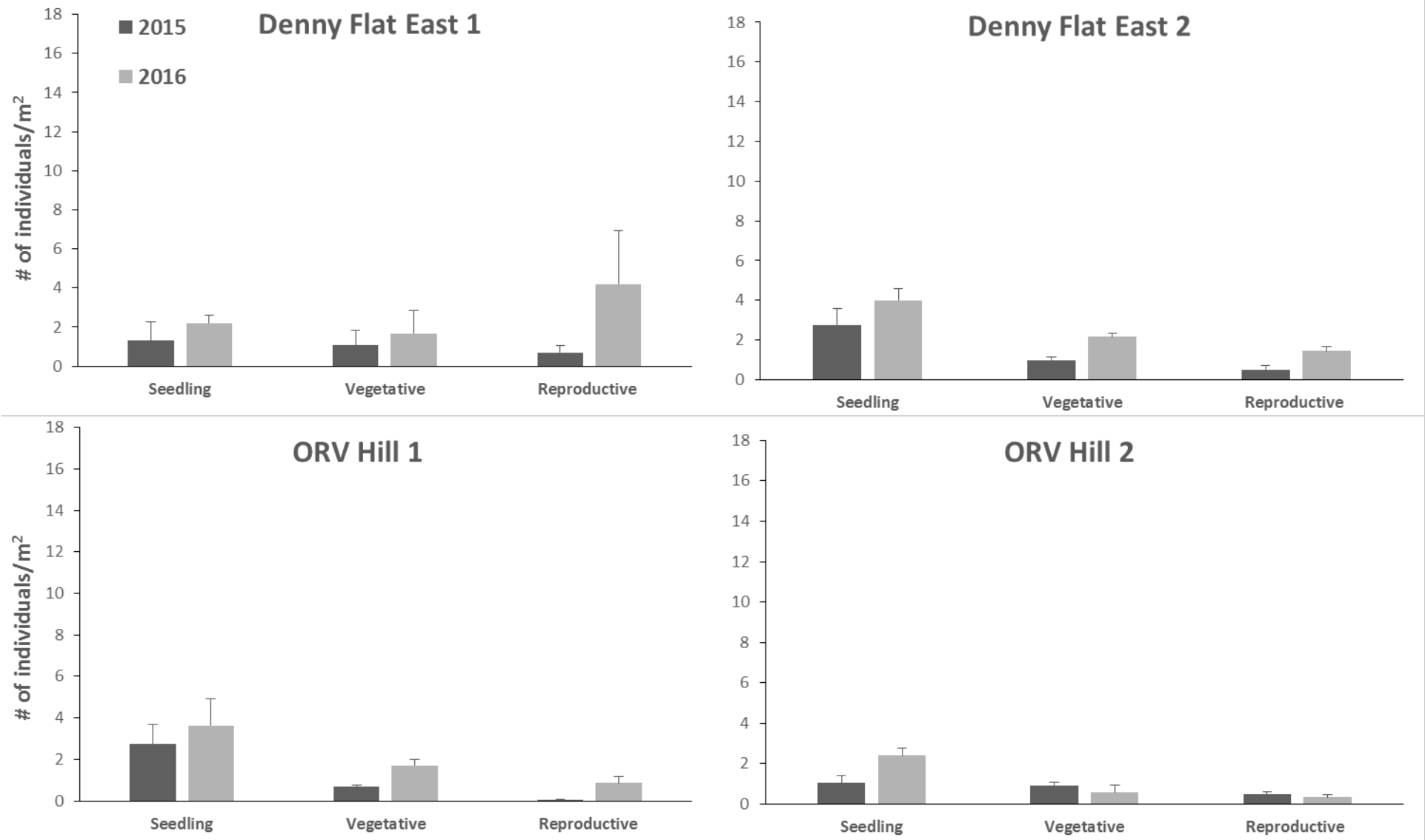


FIGURE 5. MEAN NUMBER OF *LUPINUS LEPIDUS* VAR. *CUSICKII* INDIVIDUALS PER M² [+SE] (CATEGORIZED INTO SEEDLING, VEGETATIVE, AND REPRODUCTIVE) FOUND ALONG PERMANENT MONITORING TRANSECTS AT DENNY FLAT EAST 1 & 2 AND ORV HILL 1 & 2 IN 2015 AND 2016.

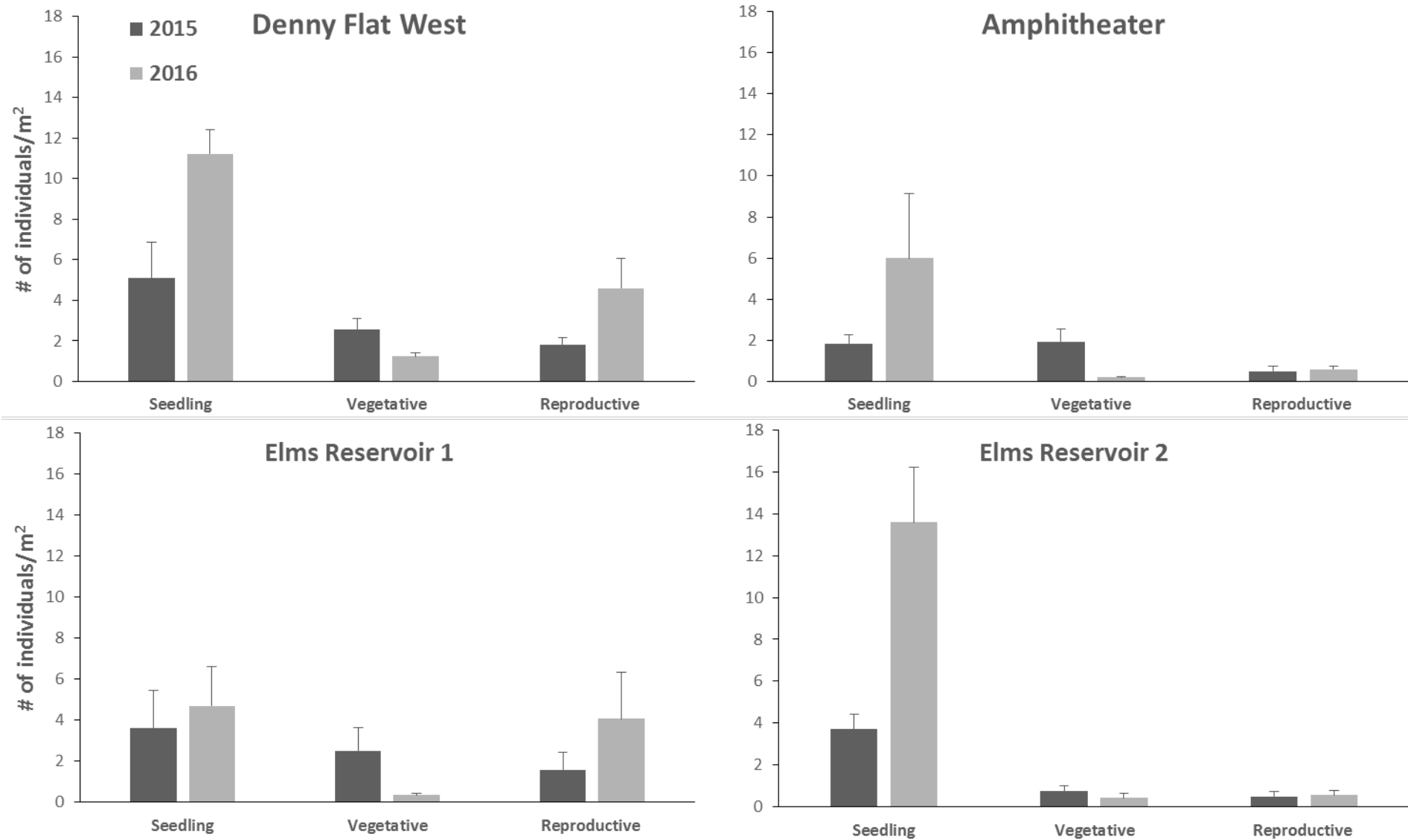


FIGURE 6. MEAN NUMBER OF *LUPINUS LEPIDUS* VAR. *CUSICKII* INDIVIDUALS PER M² [+SE] (CATEGORIZED INTO SEEDLING, VEGETATIVE, AND REPRODUCTIVE) FOUND ALONG PERMANENT MONITORING TRANSECTS AT DENNY FLAT WEST, AMPHITHEATER, AND ELMS RESERVOIR 1 & 2 IN 2015 AND 2016.

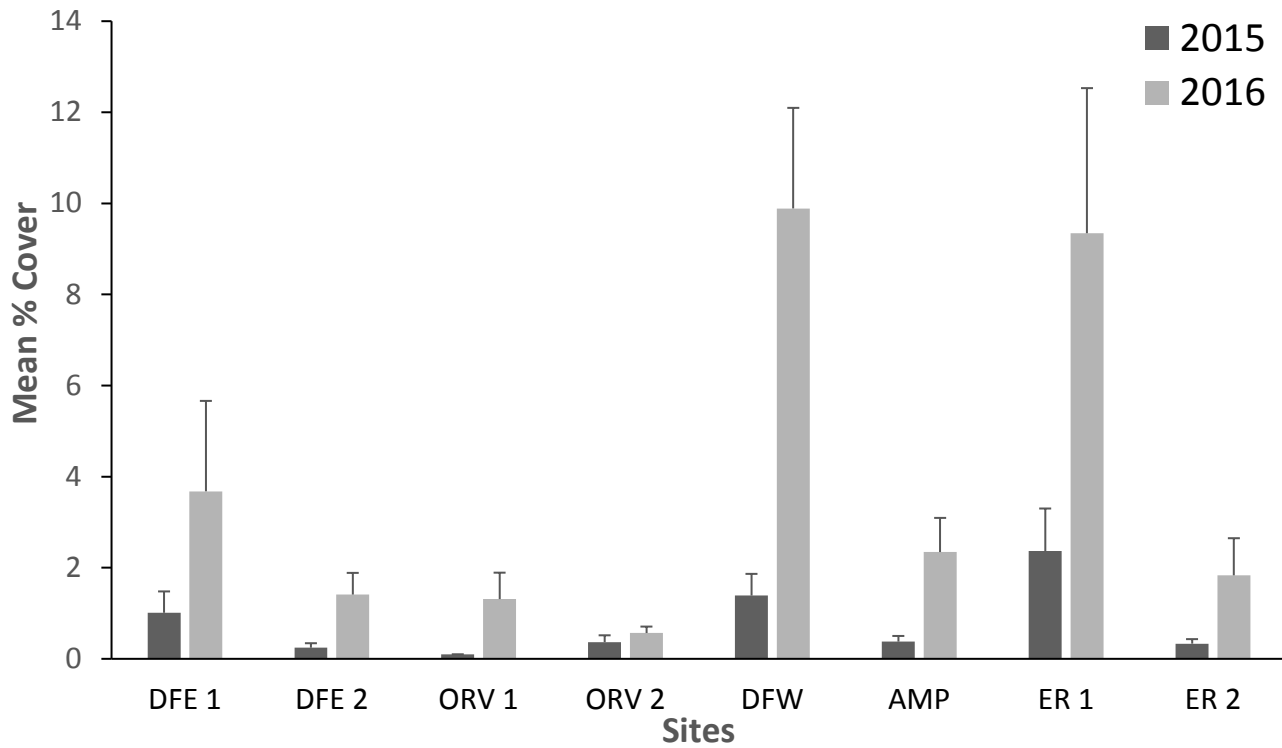


FIGURE 7. MEAN PERCENT COVER [+SE] OF *LUPINUS LEPIDUS* VAR. *CUSICKII* MEASURED IN PERMANENT MONITORING TRANSECTS IN 2015 AND 2016.

Plant community monitored in the permanent monitoring transects did not differ considerably from 2015 to 2016 (Appendix D). However, in 2016 there was greater species richness observed (43 species) than in 2015 (26 species). Although richness was greater in 2016, vegetation cover was still low along permanent monitoring transects in both years (Figure 8), as is typical of *L. lepidus* var. *cusickii* habitat. The sites with the highest cover (ORV Hill 2, ER 1&2, and DFE 1) had transects located in flatter areas with deeper soil deposition that could support a greater array of vegetation, including shrubs like *Ericameria nauseosa* and *Artemisia tridentata* ssp. *wyomingensis* (Appendix D). The percentage of the plant community that was identified as native versus exotic did not shift substantially from 2015 to 2016 (Figure 8). In both years ORV Hill 2 had the highest percent cover of exotic species, with *Bromus tectorum* and *Phleum pratense* having the highest cover (Figure 8, Appendix D). The mean percent cover of exotic species at ORV Hill 2 decreased from 2015 to 2016 (Figure 8), although the percent of the total cover for exotic species increased slightly from 20.8% to 23.4% of the total cover at ORV Hill 2 (Figure 8).

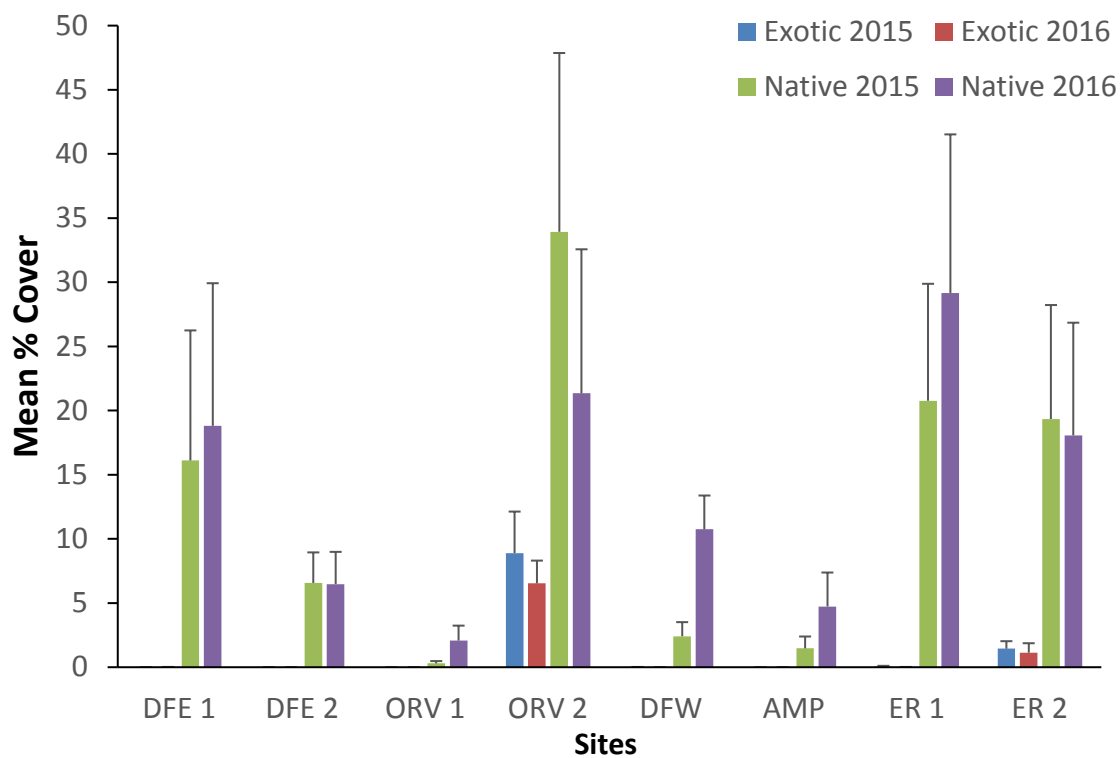


FIGURE 8. MEAN PERCENT COVER [+SE] FOR EXOTIC VERSUS NATIVE PLANT SPECIES SAMPLED ALONG PERMANENT MONITORING TRANSECTS AT EACH SITE IN BOTH 2015 AND 2016.

Surveys of Potential Habitat

In 2014 we surveyed Happy Camp, a site that had been identified as potential habitat to support *L. lepidus* var. *cusickii* (Gray et al. 2014). This site had been identified as potential habitat in collaboration with the BLM and looking over aerial photos for evidence of tuffaceous soils. 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 and we did not encounter any *L. lepidus* var. *cusickii*.

FUTURE ACTIVITIES

The surveys conducted from 2014 to 2016 enabled us to understand the current extent of *L. lepidus* var. *cusickii* and showed how much these populations can fluctuate year to year. Utilizing information gathered in surveys in 2014, we implemented long-term monitoring transects in these areas to incorporate un-sampled subpopulations to attempt to yield a more representative understanding of long-term trends across the entire population. As part of these long-term permanent monitoring transects, we will continue to collect detailed information on *L. lepidus* var. *cusickii* individuals to give us an idea of recruitment rates into the population. We will also continue to monitor the associated plant community to provide data on long-term changes and potential interactions with invasive species.

Transect data from 2016 is reported in Appendix D. This data will be used to compare changes in plant community and *L. lepidus* var. *cusickii* population trends with future monitoring. It is recommended to continue to census the population at regular intervals, in addition to monitoring of long-term permanent transects. Although the highly stochastic nature of this population is unlikely to be captured by the transects, they will yield valuable information regarding population trends and the adjacent plant community.

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

Amphitheater East and West

Survey Date: July 1, 2016

Observers: Meaghan Petix, Ari Freitag, Liza Holtz, Sarai Carter, and Paul Ruhe
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, OR 97333

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 0.6 miles. Plants were located approximately 500 feet from the road. UTM: 11T 407922E, 4923924N; Nad83

Occurrence information: The Amphitheater area has one of the largest occurrences of *L. lepidus* var. *cusickii* in the Denny Flat area (Figure 9). We found a total of 6883 live plants (4169 seedlings, 529 vegetative, and 2185 reproductive). This population demonstrates the stochastic nature of *L. lepidus* var. *cusickii*. In 2010, we did not monitor the area surrounding the long-term transects, yet the total number of plants (2806) was higher than that seen in 2014 (1041 live plants) when the area surveyed was expanded; however, by 2015, the population had increased to 4429 plants and by 2016, up to 6883 plants.

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 9). *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. Plant 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 transects, invasive plant species and cattle grazing are a threat. We noted several patches of invasive plant species (including *Bromus tectorum*) in the flats at the bottom of the hill, which are in close proximity to some large patches of *L. lepidus* var. *cusickii*. There was lots of evidence of cattle activity which could negatively impact the steep hillsides of this sensitive habitat.

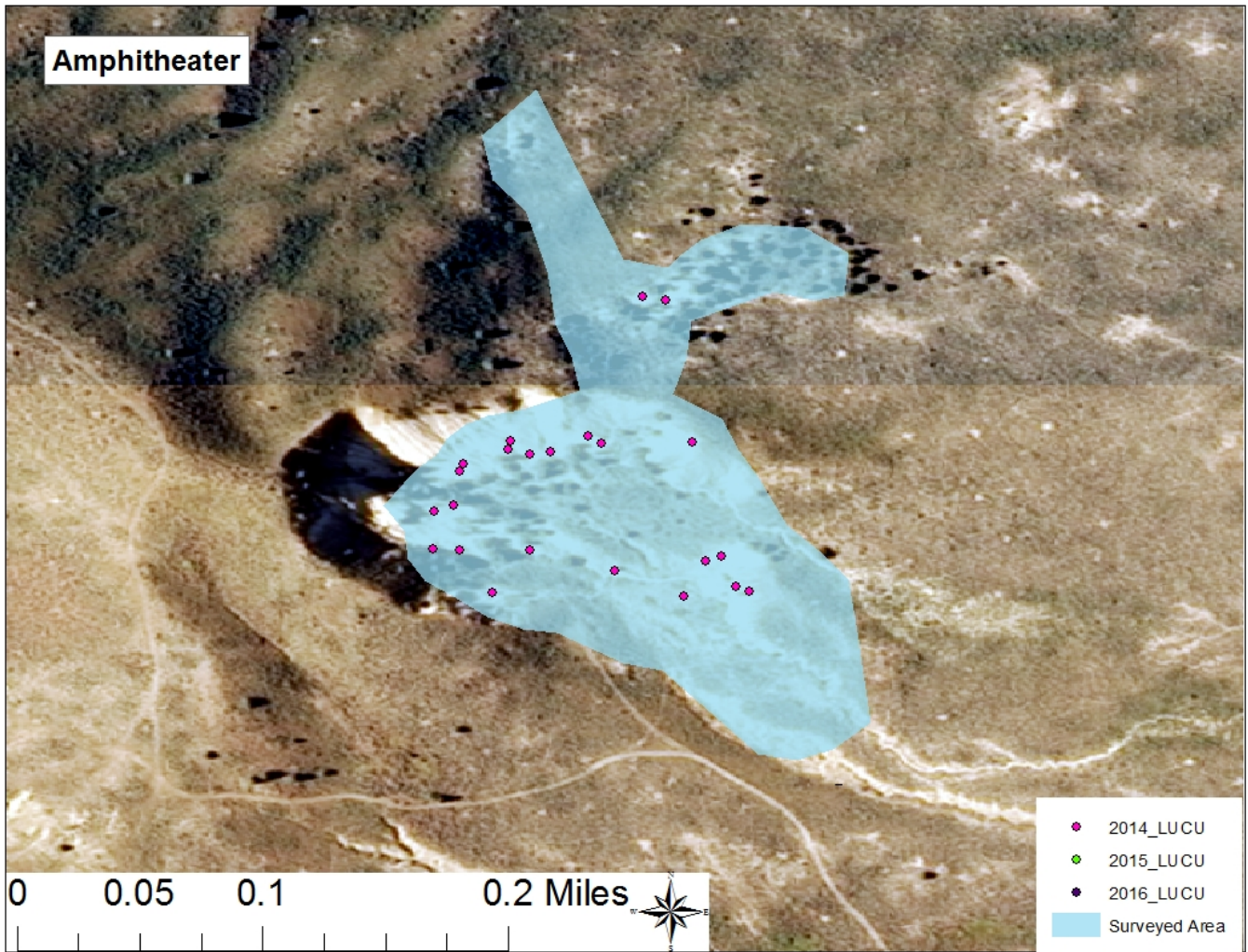


FIGURE 9. AREA SURVEYED IN 2014, 2015, AND 2016 AT AMPHITHEATER. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, WHILE THE LACK OF GREEN AND PURPLE DOTS INDICATE THAT PLANTS WERE FOUND IN SIMILAR LOCATIONS IN 2015 AND 2016.



FIGURE 10. *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: June 29, 2016

Observers: Meaghan Petix, Ari Freitag, Liza Holtz, Sarai Carter, and Paul Ruhe
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, OR 97333

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.
UTMs: 11T 410811E, 4923888N; Nad83

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 have discussed them separately since 2014. Site access is the same for both. The total area surveyed for Denny Flat East 1 was about 15 acres (Figure 11). In 2014, we found *L. lepidus* var. *cusickii* in areas where it was not noted before (Figure 11). In 2016, we found a substantial population of 7112 individuals (4037 seedlings, 1372 vegetative, and 1703 reproductive). Denny Flat East 1 & 2 were reported together in 2010, and the total number of plants found (1330) was much less than that found at each site in 2016 (7112 and 5112, 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 (i.e. presence of tuffaceous soil, low shrub cover), *L. 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* ssp. *wyomingensis*, 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 purshii*.

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 (cow trails/grasses grazed down in some areas), its effects seemed light and the plant community had all signs of being very healthy.

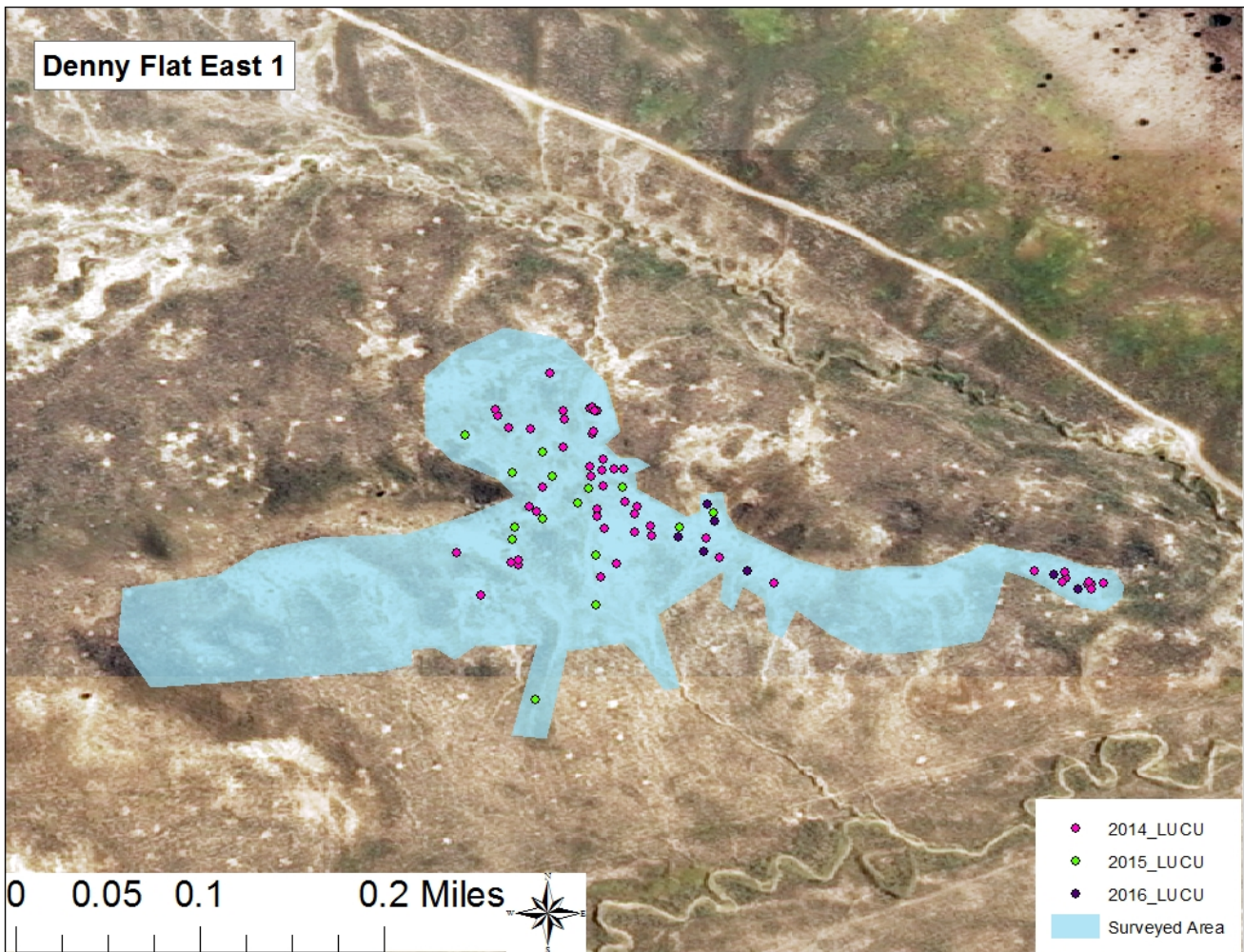


FIGURE 11. AREA SURVEYED IN 2014, 2015, AND 2016 AT DENNY FLAT EAST 1. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, GREEN DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2015, AND PURPLE DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2016.



FIGURE 12. IAE VOLUNTEER PAUL RUHE SETTING UP ONE OF THE PERMANENT MONITORING TRANSECTS AT DENNY FLAT EAST 1.

Denny Flat East 2

Survey Date: June 29, 2016

Observers: Meaghan Petix, Ari Freitag, Liza Holtz, Sarai Carter, and Paul Ruhe
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, OR 97333

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.
UTMs: 11T 409660E, 4923580N; Nad83

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 have discussed them separately since 2014. Site access is the same for both. The total area surveyed for Denny Flat East 2 was approximately 22 acres (Figure 13). In 2014 we noted individuals in areas far outside what was noted in 2010 (Figure 13). In 2016, we found a substantial occurrence of 5112 individuals (3992 seedlings, 253 vegetative, and 867 reproductive). Denny Flat East 1 & 2 were reported together in 2010, and the total number of plants (1330) found was much less than that found at each site in 2016 (7112 and 5112, 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* ssp. *wyomingensis*, *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.

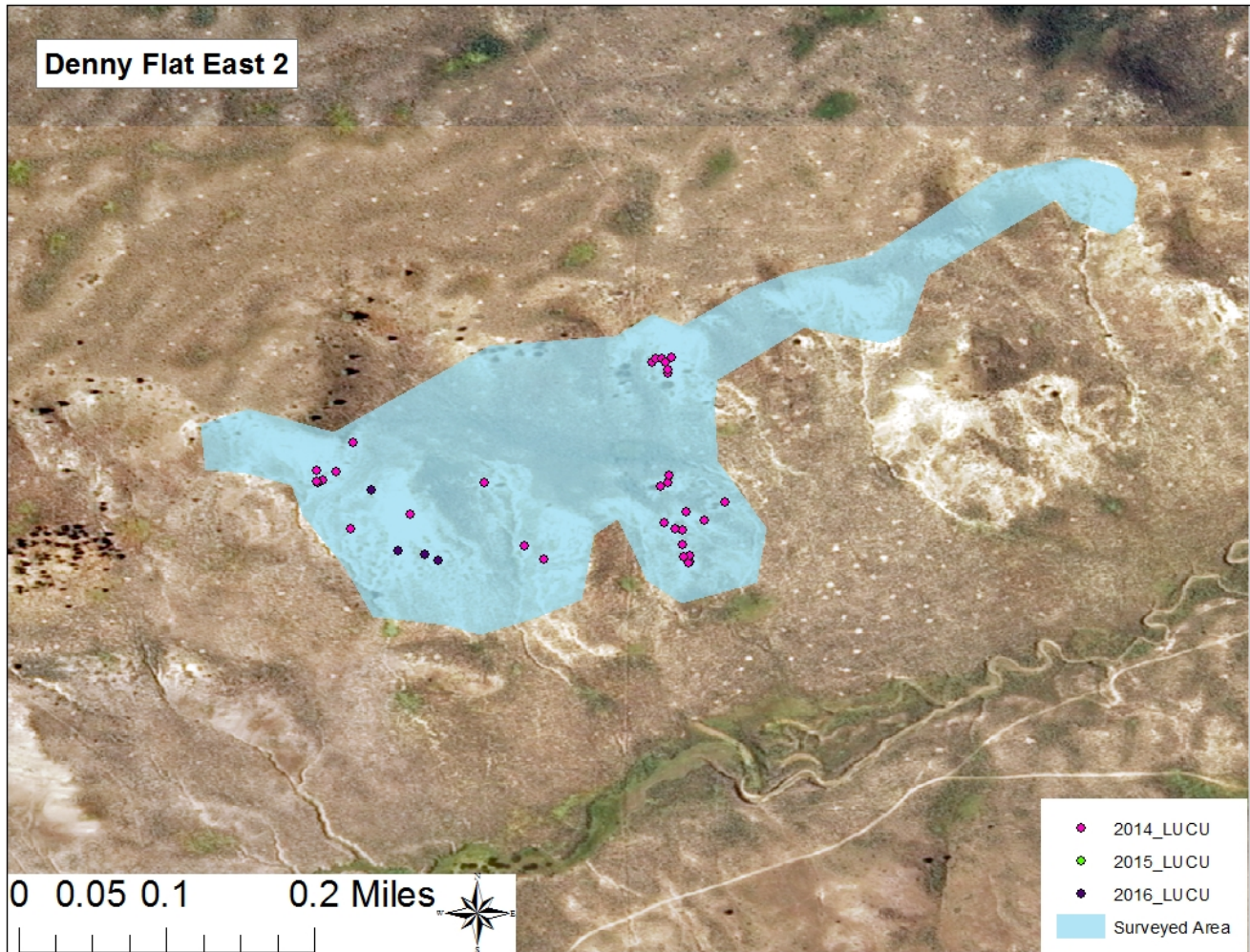


FIGURE 13. AREA SURVEYED IN 2014, 2015, AND 2016 AT DENNY FLAT EAST 2. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, WHILE THE LACK OF GREEN DOTS INDICATE THAT PLANTS WERE FOUND IN SIMILAR LOCATIONS IN 2015. PURPLE DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2016.



FIGURE 14. SURVEYING FOR *LUPINUS LEPIDUS* VAR. *CUSICKII* AT DENNY FLAT EAST 2.

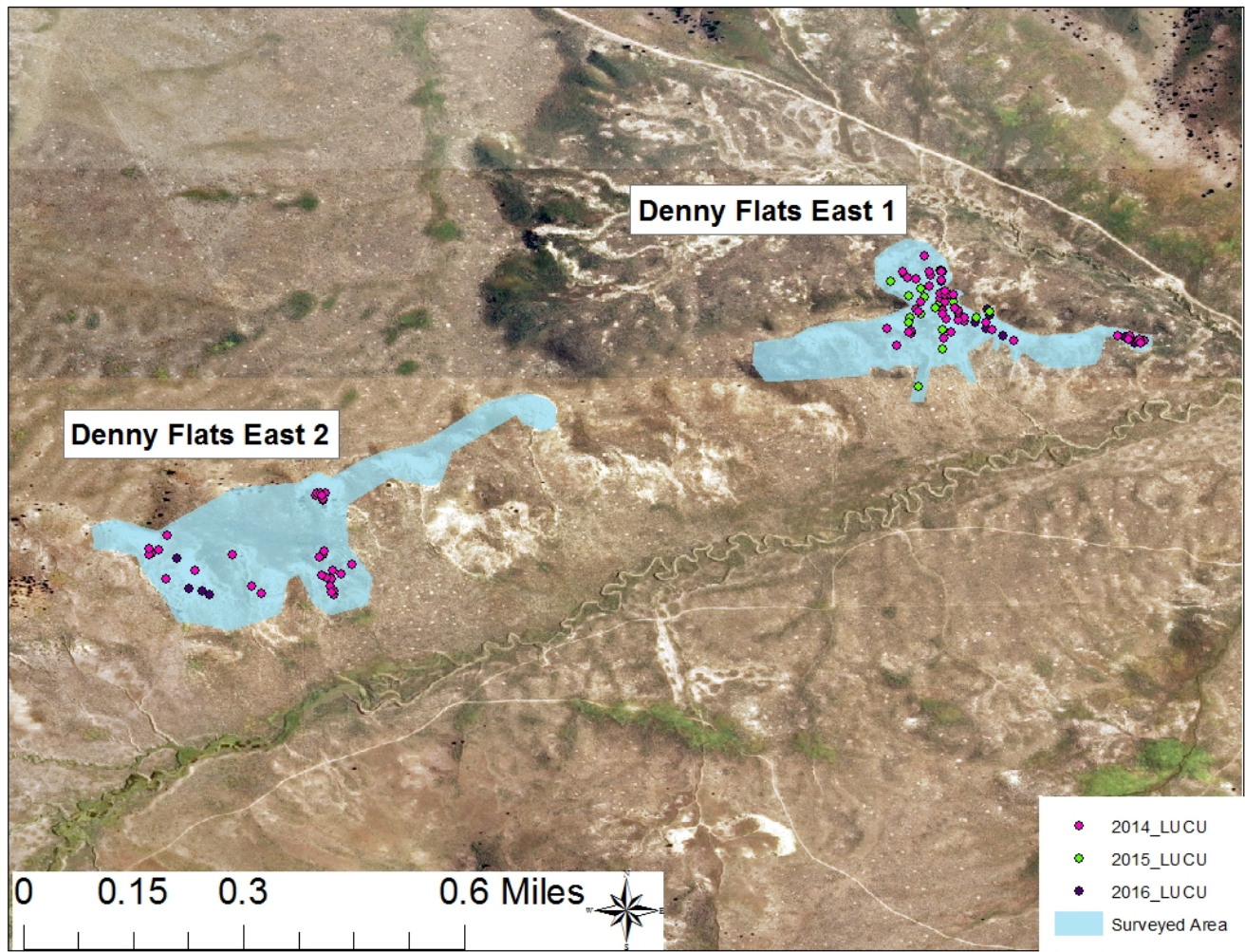


FIGURE 15. DENNY FLAT EAST 1 AND 2 OCCURRENCES SURVEYED IN 2014, 2015, AND 2016. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, GREEN DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2015, AND PURPLE DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2016.

Denny Flat West

Survey Date: June 30, 2016

Observers: Meaghan Petix, Ari Freitag, Liza Holtz, Sarai Carter, and Paul Ruhe
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, OR 97333

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)
UTMs: 11T 407634E, 4926024N; Nad83

Occurrence information: The occurrence we surveyed covered an area approximately 6 acres in size (Figure 16). In 2016 the population contained a total of 3442 plants (2082 seedlings, 234 vegetative, and 1126 reproductive). This was a considerable increase from the past two years (1093 individuals in 2015 and only 497 in 2014).

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 *L. 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*, and *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 17). *L. 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: Invasive species were present at this site, which may pose a threat to *L. lepidus* var. *cusickii*. In particular, *Cardaria draba* (whitetop) was observed in dense patches often in areas that may have been potential suitable habitat for *L. lepidus* var. *cusickii* (i.e. tuffaceous soils, low shrub cover). Additionally, there is evidence of a jeep trail nearby, but not directly 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 (Appendix B).

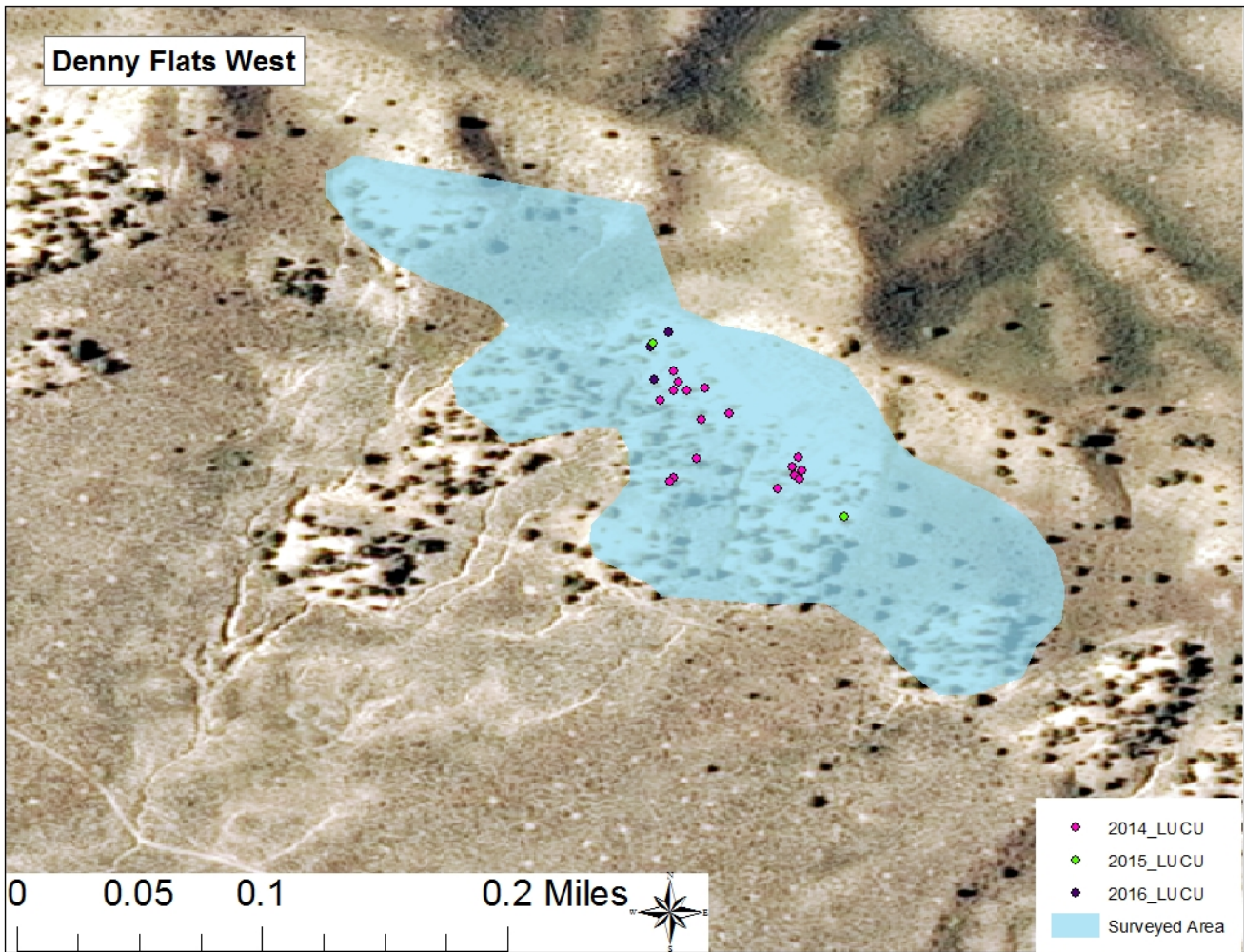


FIGURE 16. AREA SURVEYED IN 2014, 2015, AND 2016 AT DENNY FLAT WEST. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, GREEN DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2015, AND PURPLE DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2016.



FIGURE 17. *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: June 30, 2016

Observers: Meaghan Petix, Ari Freitag, Liza Holtz, Sarai Carter, and Paul Ruhe
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, OR 97333

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 0.15 mile to find the ORV Hill 1 population about 400 feet off the road to the west.
UTMs: 11T 408641E, 4922533N; Nad83

Occurrence information: In 2016 we found a total of 10,737 live plants (7748 seedlings, 745 vegetative, and 2244 reproductive). While we cannot compare numbers from surveys in 2010 directly, there were considerably more plants found in 2016, with monitoring being more extensive. In 2010, 1592 plants were found not including the areas surrounding long-term monitoring transects. In both 2015 and 2016 we noted plants in or near areas documented in 2014. The total area surveyed encompasses approximately 16 acres (Figure 18).

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 transects.

Habitat Information: This *L. lepidus* var. *cusickii* population occupies south-to southwest-facing slopes with highly erodible tuffaceous soil (Figure 19). 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 was illegal trash dumping observed along the road. There is also 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.

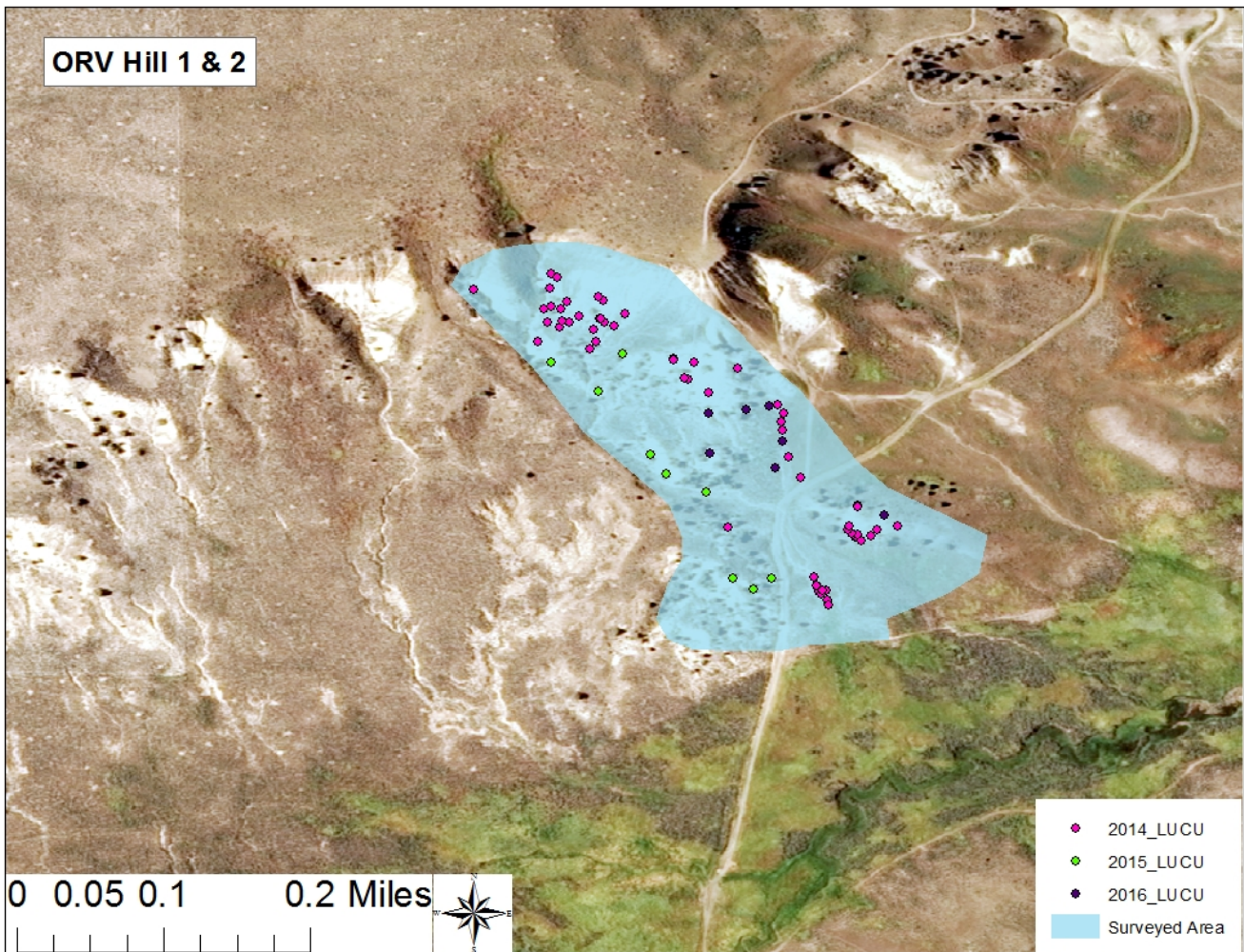


FIGURE 18. AREA SURVEYED IN 2014, 2015, AND 2016 AT ORV HILL 1 & 2. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, GREEN DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2015, AND PURPLE DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2016.



FIGURE 19. *LUPINUS LEPIDUS* VAR. *CUSICKII* HABITAT AT ORV HILL 1. NOTE THE LOW VEGETATION COVER ON THE EXPOSED TUFFACEOUS SLOPE. [PHOTO BY IAE INTERN SARAI CARTER]

Elms Reservoir 1

Survey Date: June 28, 2016

Observers: Meaghan Petix, Ari Freitag, Liza Holtz, Sarai Carter, Paul Ruhe, and Roger Ferriell
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, OR 97333

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.
UTMs: (Elms 1) 11T 407656E, 4921837N; Nad83

Occurrence information: We will discuss Elms Reservoir 1 and 2 separately, given that they were separated by a distance greater than 100 m. In 2016, a total of 10,771 live individuals were found (6122 seedlings, 519 vegetative, and 4130 reproductive). The total population area encompasses about 7.2 acres (Figure 20). In 2016, plants were found in or near areas noted in 2014 and 2015.

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, *L. 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* ssp. *wyomingensis*, *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. In 2016, it appeared that the road bisecting the site had been recently bladed to make for easier access to a developing mining operation further down the road. We observed a few *L. lepidus* var. *cusickii* individuals along the roadside that has been buried by debris/dirt from this process. Despite these threats, this remains one of the most robust populations in the Denny Flat area.

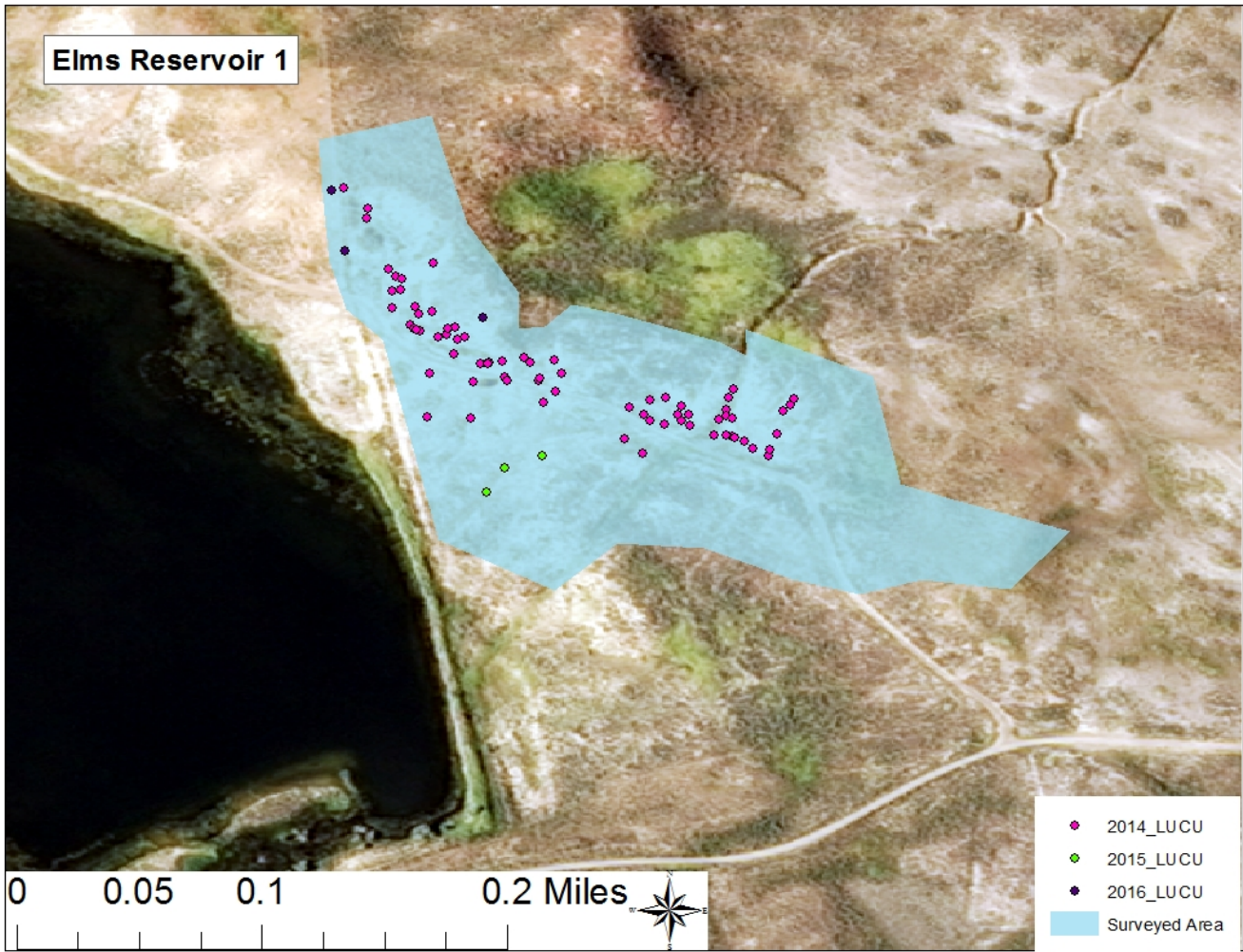


FIGURE 20. AREA SURVEYED IN 2014, 2015, AND 2016 AT ELMS RESERVOIR 1. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, GREEN DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2015, AND PURPLE DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2016.



FIGURE 21. *LUPINUS LEPIDUS* VAR. *CUSICKII* HABITAT AT ELMS RESERVOIR 1.

Elms Reservoir 2

Survey Date: June 28, 2016

Observers: Meaghan Petix, Ari Freitag, Liza Holtz, Sarai Carter, Paul Ruhe, and Roger Ferriell
Institute for Applied Ecology
563 SW Jefferson Avenue
Corvallis, OR 97333

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.

UTMs: (Elms 2) 11T 407720E, 4921683N; Nad83

Occurrence information: We will discuss Elms Reservoir 1 and 2 separately, given that they were separated by a distance greater than 100 m. A total of 7144 live individuals were found during the 2016 census (5798 seedlings, 92 vegetative, and 1254 reproductive). The total population area encompasses about 2.9 acres (Figure 22).

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, *L. lepidus* var. *cusickii* was found on a flat area along a highly disturbed jeep road leading to the top of a small butte (Figure 23). Other members of the plant community include *Artemisia tridentata* ssp. *wyomingensis*, *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 23).

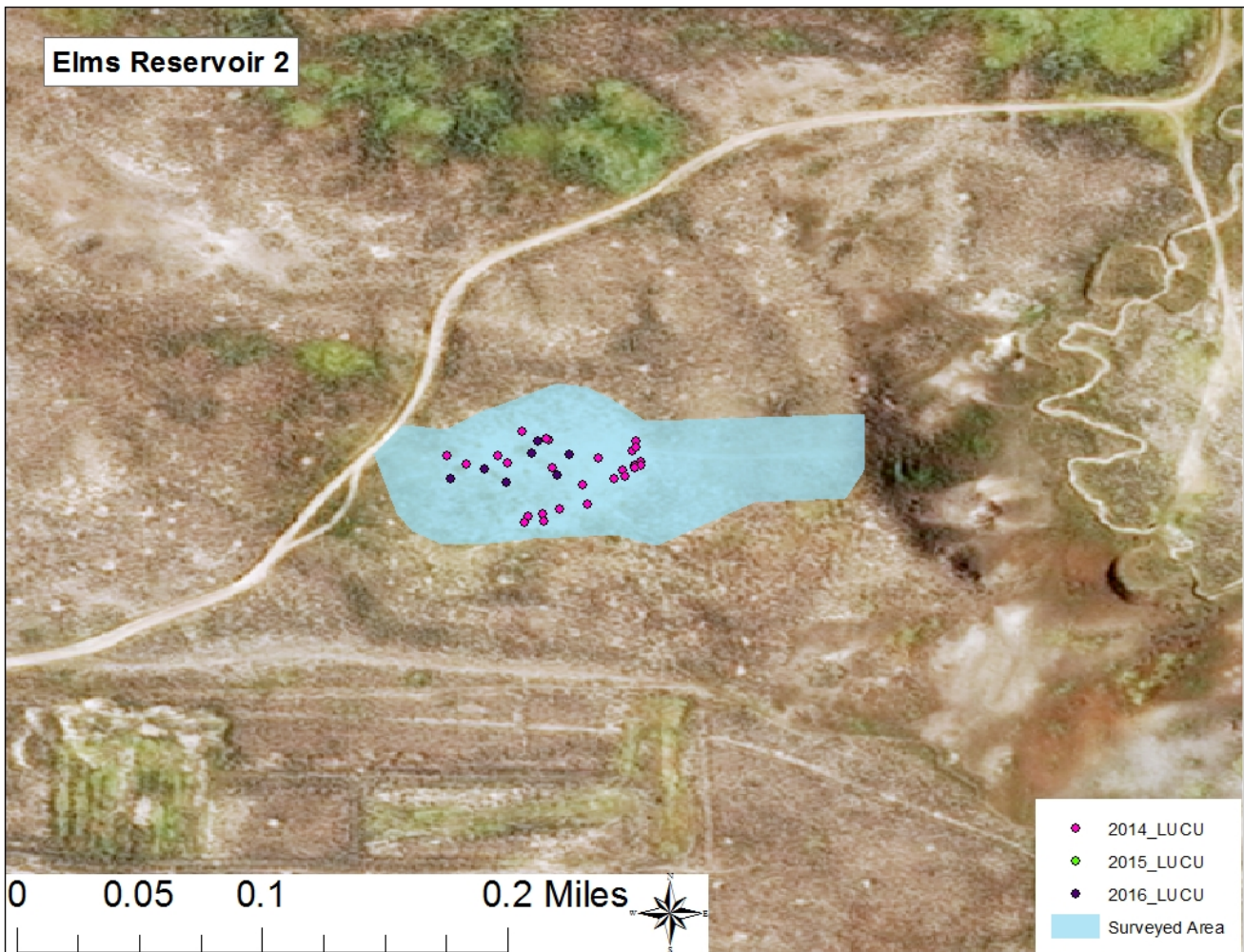


FIGURE 22. AREA SURVEYED IN 2014, 2015, AND 2016 AT ELMS RESERVOIR 2. COLORED DOTS REPRESENT AREAS OF *LUPINUS LEPIDUS* VAR. *CUSICKII* CONCENTRATION - PINK DOTS INDICATE CONCENTRATIONS FOUND IN 2014, WHILE THE LACK OF GREEN DOTS INDICATE THAT PLANTS WERE FOUND IN SIMILAR LOCATIONS IN 2015. PURPLE DOTS INDICATE ADDITIONAL CONCENTRATIONS FOUND IN 2016.



FIGURE 23. *LUPINUS LEPIDUS* VAR. *CUSICKII* POPULATION GROWING ALONG A JEEP TRACK AT ELMS RESERVOIR 2 (ABOVE), AND SMALL PLANT GROWING NEXT TO GARBAGE (BELOW).

APPENDIX B. OVERVIEW MAPS FOR DENNY FLAT.

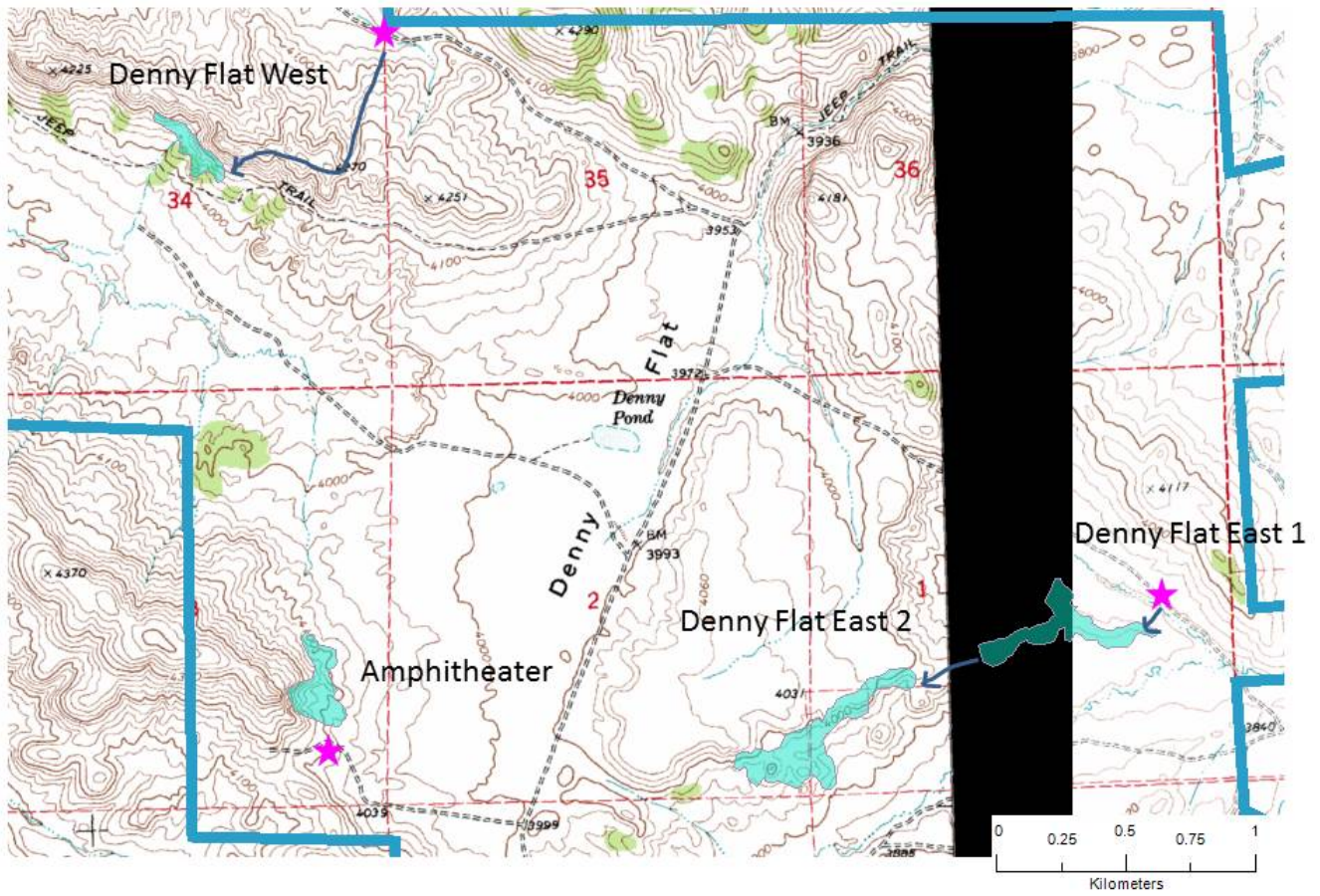


FIGURE 24. OVERVIEW OF NORTHERN SECTION OF DENNY FLAT. PINK STARS INDICATE AREAS TO PARK, AND GREY ARROWS INDICATE THE DIRECTION TO HIKE FOR SITE ACCESS.

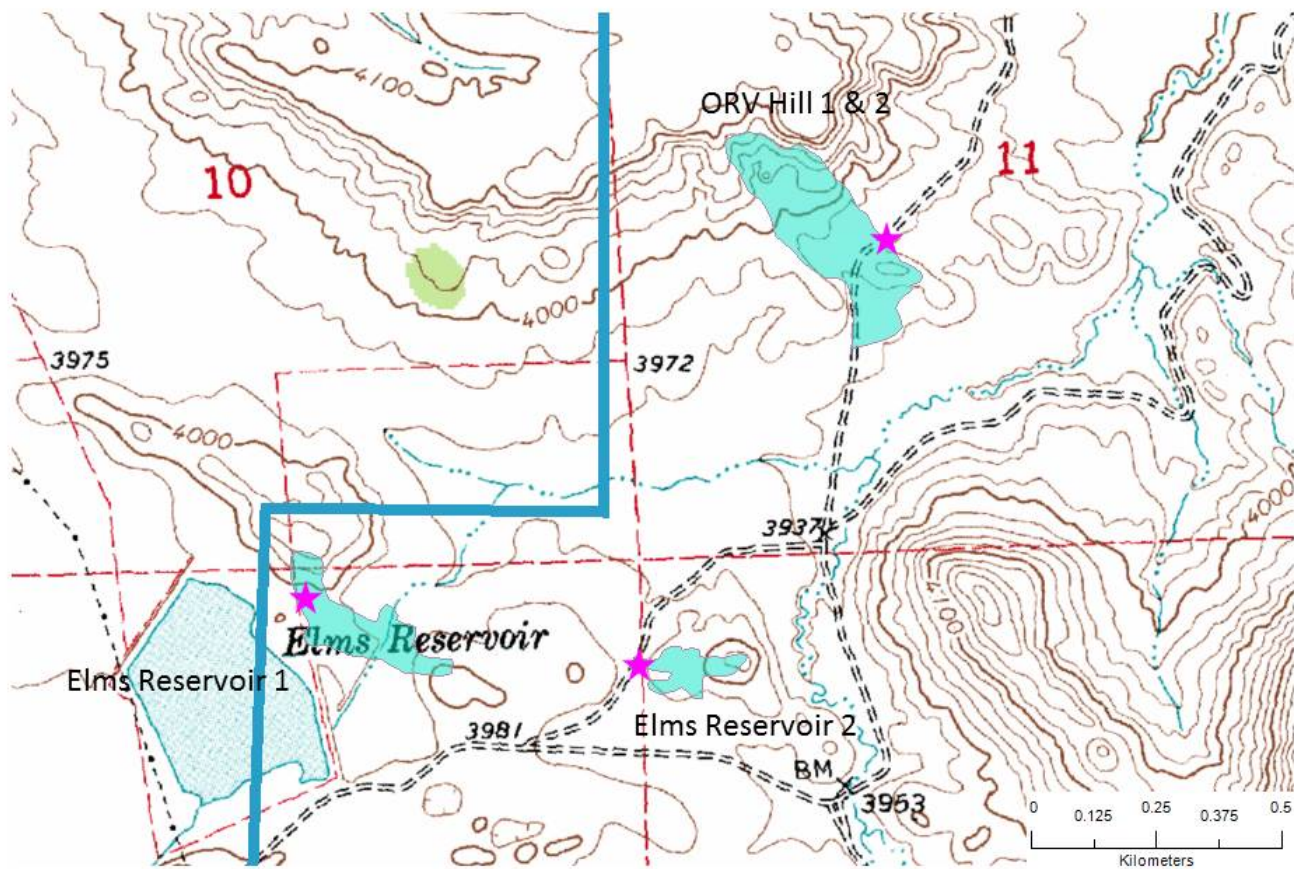


FIGURE 25. OVERVIEW OF SOUTHERN SECTION OF DENNY FLAT. PINK STARS INDICATE AREAS TO PARK FOR SITE ACCESS.

APPENDIX C. 2016 *LUPINUS LEPIDUS* VAR. *CUSICKII* TRANSECT LOCATIONS.

Sub-population	Transect	Tag #		GPS Coordinates (Origin)		Bearing (origin to end)	side of tape monitored	year established
		0m	10m					
Denny Flat East 1	1	562	563	44.46428	-118.12119	19°	NW (uphill)	2015
Denny Flat East 1	2	516	517	44.45989	-118.13560	295°	N (right from origin)	2015
Denny Flat East 1	3	564	565	44.46393	-118.12101	364°	E (right from origin)	2015
Denny Flat East 2	1	566	567	44.45989	-118.13560	210°	W (right from origin)	2015
Denny Flat East 2	2	538	539	44.45907	-118.13210	308°	N (right from origin)	2015
Denny Flat East 2	3	536	537	44.45931	-118.13233	338°	E (right from origin)	2015
ORV Hill 1	1	518	976	44.45091	-118.14810	167°	W (right from origin)	2009
ORV Hill 1	2	896	978	44.45082	-118.14805	167°	W (right from origin)	2009
ORV Hill 1	3	519	520	44.45081	-118.14810	187°	W (right from origin)	2009
ORV Hill 2	1	534	535	44.45074	-118.14808	95°	S (right from origin)	2015
ORV Hill 2	2	533	532	44.45106	-118.14774	130°	S (right from origin)	2015
ORV Hill 2	3	522	523	44.45097	-118.14777	150°	SW (right from origin)	2015
Denny Flat West	1	528	none	44.48121	-118.16118	70°	SE (right from origin)	2015
Denny Flat West	2	529	none	44.48170	-118.16171	314°	N (right from origin)	2015
Denny Flat West	3	531	none	44.48176	-118.16187	180°	E (right from origin)	2015
Amphitheater	1	530	993	44.46222	-118.15585	80°	N (upslope)	2009
Amphitheater	2	992	994	44.46204	-118.15583	126°	S (right from origin)	2009
Amphitheater	3	977	991	44.46202	-118.15583	126°	S (right from origin)	2009
Elm Reservoir 1	1	521	402	44.44321	-118.15937	310°	N (left from origin)	2009
Elm Reservoir 1	2	524	none	44.44295	-118.15903	86°	N (left from origin)	2009
Elm Reservoir 1	3	403	none	44.44301	-118.15912	100°	W (left from origin)	2009
Elm Reservoir 2	1	525	none	44.44255	-118.15160	30°	W (left from origin)	2015
Elm Reservoir 2	2	526	none	44.44253	-118.15185	140°	NE (left from origin)	2015
Elm Reservoir 2	3	527	none	44.44222	-118.15197	74°	N (left from origin)	2015

APPENDIX D. 2016 PERMANENT MONITORING TRANSECT DATA FOR *LUPINUS LEPIDUS* VAR. *CUSICKII*.

Number and size class of vegetative and reproductive *Lupinus lepidus* var. *cusickii* found in permanent monitoring transects in 2016.

Site	Vegetative					Reproductive		
	Transect	Seedling (<5cm)	Small (5-10cm)	Medium (>10-25cm)	Large (>25cm)	Small (5-10cm)	Medium (>10-25cm)	Large (>25cm)
Denny Flat East 1	1	27	45	1	0	12	3	2
Denny Flat East 1	2	27	0	0	0	89	14	5
Denny Flat East 1	3	12	4	0	0	0	1	0
Denny Flat East 2	1	34	18	0	0	15	2	0
Denny Flat East 2	2	32	23	0	0	6	2	0
Denny Flat East 2	3	54	24	0	0	10	8	0
ORV Hill 1	1	24	10	1	0	0	2	0
ORV Hill 1	2	17	17	0	0	2	6	1
ORV Hill 1	3	68	23	0	0	4	8	3
ORV Hill 2	1	30	0	0	0	0	0	0
ORV Hill 2	2	27	14	0	0	5	0	0
ORV Hill 2	3	15	3	0	0	5	0	0
Denny Flat West	1	137	15	1	0	23	48	6
Denny Flat West	2	87	9	0	0	10	27	9
Denny Flat West	3	113	11	1	0	2	11	2
Amphitheater	1	136	1	0	0	1	5	2
Amphitheater	2	12	2	1	0	0	1	1
Amphitheater	3	32	2	0	0	0	7	1
Elms Reservoir 1	1	19	2	0	0	0	1	0
Elms Reservoir 1	2	28	3	0	0	6	19	2
Elms Reservoir 1	3	94	5	0	0	19	66	9
Elms Reservoir 2	1	138	5	0	0	1	5	1
Elms Reservoir 2	2	191	8	0	0	4	5	0
Elms Reservoir 2	3	79	0	0	0	1	0	0

Plant community data for *Lupinus lepidus* var. *cusickii* permanent monitoring transects in Denny Flat East 1&2 and ORV Hill 1&2 in 2015 and 2016.

Species/Ground Cover	Growth Form	Nativity	Denny Flat East 1		Denny Flat East 2		ORV Hill 1		ORV Hill 2	
			2015	2016	2015	2016	2015	2016	2015	2016
moss/lichen			-	1.7	-	0.1	-	-	-	-
bareground			90.3	90.2	89.2	90.2	95.6	98.7	87.8	85.4
litter			1.4	3.2	2.2	3.1	0.7	1.0	2.3	21.3
rock			6.2	7.8	9.8	7.8	4.3	1.7	4.7	2.0
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>	Shrub	N	0.0	0.2	-	-	-	-	2.2	2.1
<i>Chrysothamnus viscidiflorus</i>	Shrub	N	5.8	5.6	-	-	-	-	8.4	1.8
<i>Ericameria nauseosa</i>	Shrub	N	0.4	-	-	-	-	-	0.2	7.3
<i>Eriogonum sphaerocephalum</i>	Shrub	N	2.8	3.1	-	-	-	-	-	0.3
<i>Grayia spinosa</i>	Shrub	N	-	1.2	-	-	-	-	3.9	3.3
<i>Achnatherum hymenoides</i>	Gram	N	-	-	-	-	-	-	-	0.1
<i>Achnatherum thurberianum</i>	Gram	N	-	0.6	-	0.2	-	0.1	-	-
<i>Agropyron cristatum</i>	Gram	I	-	-	-	-	-	-	1.1	0.1
<i>Bromus tectorum</i>	Gram	I	-	0.0	-	-	-	-	2.3	1.9
<i>Bromus</i> sp.	Gram	-	-	-	-	-	-	-	-	-
<i>Carex douglasii</i>	Gram	N	-	-	-	-	-	-	-	-
<i>Elymus elymoides</i>	Gram	N	-	-	-	0.0	0.0	-	9.6	2.9
<i>Festuca idahoensis</i>	Gram	N	0.2	0.0	0.0	-	-	-	1.8	0.1
<i>Hesperostipa comata</i>	Gram	N	0.7	-	0.0	-	0.1	-	-	-
<i>Phleum pratense</i>	Gram	I	-	-	-	-	-	-	5.1	4.2
<i>Poa secunda</i>	Gram	N	0.1	0.6	-	-	-	-	-	-
<i>Pseudoregnaria spicata</i>	Gram	N	-	-	-	-	-	-	0.3	0.1
<i>Achillea millefolium</i>	Forb	N	-	-	-	-	-	-	6.3	2.5
<i>Amsinckia</i> sp.	Forb	-	-	-	-	0.0	-	-	-	-
<i>Astragalus purshii</i>	Forb	N	-	-	-	-	-	-	-	-
<i>Cardaria draba</i>	Forb	I	-	-	-	-	-	-	-	0.3
<i>Chaenactis douglasii</i>	Forb	N	0.1	-	-	-	-	-	0.1	-
<i>Corallorhiza</i> sp.	Forb	-	-	-	-	0.0	-	-	-	-
<i>Cordylanthus ramosus</i>	Forb	N	-	-	-	-	-	-	-	-
<i>Cryptantha</i> sp.	Forb		-	-	-	-	-	-	-	-
<i>Erigeron linearis</i>	Forb	N	-	-	-	-	-	-	-	-
<i>Erigeron pumilus</i>	Forb	N	-	-	0.1	-	-	-	-	0.1
<i>Eriogonum microthecium</i>	Forb	N	5.0	3.9	6.2	4.9	0.1	0.7	-	-
<i>Eriogonum</i> sp. #1	Forb	-	-	1.3	-	-	-	-	-	-
<i>Eriogonum</i> sp. #2	Forb	-	-	-	-	-	-	-	-	0.0
<i>Eriogonum</i> sp. #3	Forb	-	-	-	-	-	-	-	-	-
<i>Eriogonum vimineum</i>	Forb	N	-	-	-	-	-	-	-	0.0
<i>Lactuca serriola</i>	Forb	I	-	-	-	-	-	-	-	-
<i>Lepidium perfoliatum</i>	Forb	I	-	-	-	-	-	-	0.3	-
<i>Linanthus pungens</i>	Forb	N	-	-	-	-	-	-	0.7	-

<i>Lupinus lepidus</i> var. <i>cusickii</i>	Forb	N	1.0	3.7	0.2	1.4	0.1	1.3	0.4	0.6
<i>Mimulus nanus</i>	Forb	N	-	-	-	-	0.0	-	-	-
<i>Machraerantha canescens</i>	Forb	N	-	-	-	-	-	-	-	-
<i>Mentzelia albicaulis</i>	Forb	N	-	-	-	-	-	-	-	-
<i>Penstemon</i> sp.	Forb	-	-	0.0	-	-	-	-	-	-
<i>Phacelia heterophylla</i>	Forb	N	-	-	-	-	-	0.0	-	0.0
<i>Phlox hoodii</i>	Forb	N	-	-	-	-	-	-	-	0.2
<i>Silene</i> sp.	Forb	-	0.3	0.6	0.3	0.5	0.7	0.1	-	-
<i>Tragopogon</i> sp.	Forb	I	-	-	-	-	-	-	-	-
UNK Brassicaceae	Forb	-	-	-	-	-	-	-	-	0.1
UNK thistle	Forb	-	-	-	-	-	-	-	-	0.0
UNK <i>Castilleja</i> or <i>Orthocarpus</i>	Forb	-	-	-	-	-	-	-	-	-

NOTE: “0.0” values indicate the species was present but had low cover (average % cover < 0.1); “-” indicates the species was not present.

Plant community data for *Lupinus lepidus* var. *cusickii* permanent monitoring transects in Denny Flat West, Amphitheater, and Elms Reservoir 1&2 in 2015 and 2016.

Species/Ground Cover	Growth Form	Nativity	Denny Flat West		Amphitheater		Elms Reservoir 1		Elms Reservoir 2	
			2015	2016	2015	2016	2015	2016	2015	2016
moss/lichen			-	0.3	-	-	0.9	1.1	-	0.2
bareground			38.4	32.3	80.1	91.6	90.6	95.9	95.0	97.8
litter			8.3	17.6	0.0	0.9	5.2	6.3	2.8	7.9
rock			53.2	62.2	19.8	37.2	0.5	0.1	2.3	1.4
<i>Artemisia tridentata</i> ssp. <i>wyomingensis</i>	Shrub	N	-	-	-	-	3.5	5.6	2.8	1.7
<i>Chrysothamnus viscidiflorus</i>	Shrub	N	-	-	0.0	0.6	1.7	-	2.7	2.1
<i>Ericameria nauseosa</i>	Shrub	N	-	-	-	-	-	4.3	0.6	1.2
<i>Eriogonum sphaerocephalum</i>	Shrub	N	0.1	0.1	0.7	0.8	-	-	-	-
<i>Grayia spinosa</i>	Shrub	N	-	-	-	-	0.7	0.7	2.0	-
<i>Achnatherum hymenoides</i>	Gram	N	-	-	-	-	-	-	-	-
<i>Achnatherum thurberianum</i>	Gram	N	-	-	-	0.0	-	0.1	-	1.8
<i>Agropyron cristatum</i>	Gram	I	-	-	-	-	-	-	1.4	1.1
<i>Bromus tectorum</i>	Gram	I	0.0	-	-	-	-	-	-	0.0
<i>Bromus</i> sp.	Gram	-	-	-	-	-	0.1	-	-	-
<i>Carex douglasii</i>	Gram	N	-	-	-	0.0	-	-	-	3.9
<i>Elymus elymoides</i>	Gram	N	-	-	-	-	1.1	2.7	1.6	0.6
<i>Festuca idahoensis</i>	Gram	N	0.7	0.2	0.0	0.6	3.6	0.7	0.2	-
<i>Hesperostipa comata</i>	Gram	N	-	-	-	-	1.1	0.1	7.8	-
<i>Phleum pratense</i>	Gram	I	-	-	-	-	0.1	-	-	-
<i>Poa secunda</i>	Gram	N	-	-	-	0.0	1.2	0.9	-	0.4
<i>Pseudoregnaria spicata</i>	Gram	N	-	-	-	-	-	-	-	0.1
<i>Achillea millefolium</i>	Forb	N	-	-	-	-	1.1	0.8	-	-
<i>Amsinckia</i> sp.	Forb	-	-	-	-	-	-	-	-	-
<i>Astragalus purshii</i>	Forb	N	-	-	-	-	0.1	0.2	-	-
<i>Cardaria draba</i>	Forb	I	-	-	-	-	-	-	-	-
<i>Chaenactis douglasii</i>	Forb	N	-	-	-	-	0.0	0.0	0.1	-
<i>Corallorhiza</i> sp.	Forb	-	-	-	-	-	-	-	-	-
<i>Cordylanthus ramosus</i>	Forb	N	-	-	-	-	-	-	-	1.1
<i>Cryptantha</i> sp.	Forb	-	-	-	0.0	-	-	-	0.1	0.0
<i>Erigeron linearis</i>	Forb	N	-	0.0	-	-	-	-	-	-
<i>Erigeron pumilus</i>	Forb	N	0.0	-	-	0.0	-	-	-	-
<i>Eriogonum microthecium</i>	Forb	N	0.2	0.5	0.3	0.4	0.0	-	-	-
<i>Eriogonum</i> sp. #1	Forb	-	-	0.2	-	-	-	-	-	-
<i>Eriogonum</i> sp. #2	Forb	-	-	-	-	-	-	-	-	-
<i>Eriogonum</i> sp. #3	Forb	-	-	-	-	-	-	0.0	-	-
<i>Eriogonum vimineum</i>	Forb	N	-	-	-	0.0	-	-	-	-
<i>Lactuca serriola</i>	Forb	I	-	-	-	-	-	0.0	-	-
<i>Lepidium perfoliatum</i>	Forb	I	-	-	-	-	-	-	-	-

<i>Linanthus pungens</i>	Forb	N	-	-	0.1	-	4.4	1.9	1.5	3.2
<i>Lupinus lepidus</i> var. <i>cusickii</i>	Forb	N	1.4	9.9	0.4	2.3	2.4	9.3	0.3	1.8
<i>Mimulus nanus</i>	Forb	N	-	-	-	-	-	-	-	-
<i>Machraerantha canescens</i>	Forb	N	-	-	-	-	-	0.0	-	-
<i>Mentzelia albicaulis</i>	Forb	N	-	-	-	-	-	-	-	0.0
<i>Penstemon</i> sp.	Forb	-	-	0.1	-	-	-	0.0	-	-
<i>Phacelia heterophylla</i>	Forb	N	-	-	-	-	-	-	-	-
<i>Phlox hoodii</i>	Forb	N	-	-	-	-	-	1.8	-	0.1
<i>Silene</i> sp.	Forb	-	-	-	0.1	0.3	0.1	0.6	0.3	0.0
<i>Tragopogon</i> sp.	Forb	I	-	-	-	-	-	-	0.1	-
UNK Brassicaceae	Forb	-	-	-	-	-	-	-	-	-
UNK thistle	Forb	-	-	-	-	-	-	-	-	-
UNK <i>Castilleja</i> or <i>Orthocarpus</i>	Forb	-	-	-	-	-	-	0.1	-	-

NOTE: "0.0" values indicate the species was present but had low cover (average % cover < 0.1); "-" indicates the species was not present.