Kincaid's Lupine (*Lupinus oreganus*) and Habitat Monitoring at Fir Butte

2017

Report to the Bureau of Land Management, Eugene District

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Institute for Applied Ecology

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PREFACE

This report is the result of an agreement between the Institute for Applied Ecology (IAE) and a federal agency. IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, 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.

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Kincaid's lupine at Fir Butte, 2017

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Cover photograph: Kincaid's lupine (*Lupinus oreganus*).

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This report documents work conducted on Kincaid's lupine (*Lupinus oreganus*), a threatened species listed by the Oregon Department of Agriculture and the U.S. Fish and Wildlife Service, and the surrounding plant community at Fir Butte. Kincaid's lupine serves as the primary larval host plant for the endangered Fender's blue butterfly (*Icaricia icarioides fenderi*); both species are endemic to western Oregon prairies. Fir Butte is an 18 acre prairie remnant owned by the Eugene District BLM and currently managed primarily for Kincaid's lupine and Fender's blue butterfly.

In 2017 we monitored Kincaid's lupine and the plant community at Fir Butte.

- Blackberry cover was reduced in the initial research experiment, but cover remains relatively high.
    - Mowing can be used to maintain current blackberry cover values, but herbicides and/or grubbing will likely be required to further reduce blackberry.
- Lupine cover rebounded over the past two sampling years, with cover measuring 2,469 m^2 in 2017, which was the second highest cover value measured throughout the course of this study.
- Introduced perennial grasses were the dominant components of the plant community.
    - Continued efforts to decrease these populations and increase native plant diversity are necessary.
- High litter cover observed in recent years could limit native species. There is little bare ground available for seed germination.

Kincaid's lupine (*Lupinus oreganus*) and Habitat Monitoring at Fir Butte

2017 REPORT

INTRODUCTION

This report documents work conducted on Kincaid's lupine (*Lupinus oreganus*; Figure 1), a rare member of the legume family (Fabaceae) listed by the Oregon Department of Agriculture and the U.S. Fish and Wildlife Service as a threatened species. Kincaid's lupine is found in native prairie remnants in the Willamette Valley, southwestern Washington, and forest openings in Douglas County, Oregon. In the Willamette Valley, Kincaid's lupine serves as a larval host plant for the rare Fender's blue butterfly (*Icaricia icarioides fenderi*), making conservation of the lupine a common strategy for the success of both species.

FIGURE 1. KINCAID'S LUPINE (*LUPINUS OREGANUS*)

Kincaid's lupine is an herbaceous perennial that reproduces by seed. Plants form clumps of basal leaves and eventually produce one or more flowering stems. This species also appears to spread vegetatively, though it is unknown to what extent vegetative growth might result in the formation of physiologically distinct clones. Kincaid's lupine requires insects for successful fertilization and seed formation (Kaye 1999).

Fender's blue butterfly oviposits small white eggs on the undersides of Kincaid's lupine leaves. After eggs hatch, the larvae emerge and feed on lupine leaves (Figure 2) before overwintering in the soil near the base of plants.

One of the largest known extant populations of Kincaid's lupine occurs at Fir Butte, located northwest of Eugene, Oregon (T17S R5W Sec. 24 NE¼). Fir Butte is an 18 acre prairie remnant owned by the Eugene District BLM and currently managed primarily for the lupine and Fender's blue butterfly. Prior to purchase by the BLM, Fir Butte was used as a horse pasture and hay field. The site includes both upland and wetland prairie habitats. The overall habitat quality at the site is poor, with heavy infestations of alien plants such as *Rubus armeniacus* (Himalayan blackberry) and *Arrhenatherum elatius* (tall oatgrass). These non-native plants are the primary threats to the lupine and butterfly, and their control is the main objective for management at this site. Since 1999, BLM crews have made substantial headway in reducing meadow knapweed (*Centaurea pratensis*), Scotch broom (*Cytisus scoparius*), and maintaining Himalayan blackberry cover.

GOALS AND OBJECTIVES

This report summarizes the results of monitoring Kincaid's lupine and the plant community at Fir Butte in 2017. This project had 2 primary objectives:

1) summarize the abundance of Kincaid's lupine in 2017 and long term population trends

2) summarize the plant community composition

In 2017, there was an additional objective of obtaining pre-treatment data for an upcoming herbicide/management trial to be conducted at the site.

FIGURE 2. HERBIVORY OF KINCAID'S LUPINE BY LARVAE OF FENDER'S BLUE BUTTERFLY RESULTS IN CLUSTERS OF DAMAGED STEMS, LEAVES, AND GROWING POINTS (LEFT) BECAUSE THE LARVAE TYPICALLY FEED ON YOUNG LEAVES AND APICAL MERISTEMS.

METHODS

Monitoring of Kincaid's lupine was initiated at Fir Butte in 1998 to provide data on population trends and test the effects of experimental habitat management treatments, namely mowing and prescribed burning, on Kincaid's lupine cover and Fender's blue butterfly reproductive success. In 2011, lupine sampling was modified to increase efficiency. Monitoring of Fender's blue butterfly eggs was discontinued in 2011 due to concerns about damage to the eggs. In 2011, 2014, 2015, and 2017, we monitored plant community composition using $1m^2$ quadrats randomly placed within each subplot at the site.

Plot design

Plots (Figure 3) were established in July 1998. A total of 18 plots were established at the site within a 216 x 288 m macroplot covering the entire area occupied by Kincaid's lupine. Each plot is 20 x 100 m, surrounded by a 2 m wide buffer on each of the long sides and a 4 m wide buffer on each of the narrow sides (Figure 3). Plots are marked with fence posts in their corners, *outside the buffer*. Thus, the plot size within the posts, inclusive of the buffer, is 24 x 108 m. Each fence post is labeled with a pre-numbered aluminum tag. The long axis of the plots runs due east and west. Within each of these plots, two subplots were selected at random for sampling. Subplots are 100 m transects marked at each end with metal conduit posts.

Mowing and burning treatments

In 2001, three mowing treatments were randomly assigned to plots at Fir Butte, every year, every other year, and every third year (Figure 3). Mowing was performed during the late summer/early fall (generally September), when Fender's blue butterfly larvae are dormant in the soil litter layer and the lupine have likewise retreated to a dormant stage until the following spring. In fall 2005, all plots were mowed and treatments were reassigned. In 2006, all plots assigned to be mowed every year or every other year were mowed and the plots assigned to be mowed every other year were assigned to be mowed twice a year, in September and February (while the lupine and butterfly were still dormant). This treatment did not occur as scheduled (Sally Villegas, *personal communication*), however, these plots were analyzed separately due to their history of different management relative to other plots. Eugene

District BLM attempted to burn plots in October 2004, but due to a green-up of vegetation caused by early fall rains, the grassy fuels at the site would not combust. Only plot #9 was burned, and this was a patchy, incomplete burn that left a large amount of standing fuel and generated very little heat. In October 2006, all burn treatment plots were successfully burned.

2007 was the last year that treatments were applied as assigned to plots, thus data collected in 2008 was the last we could include in our analyses. Currently, Fir Butte is being managed with annual mowing, ecological burns, and solarization.

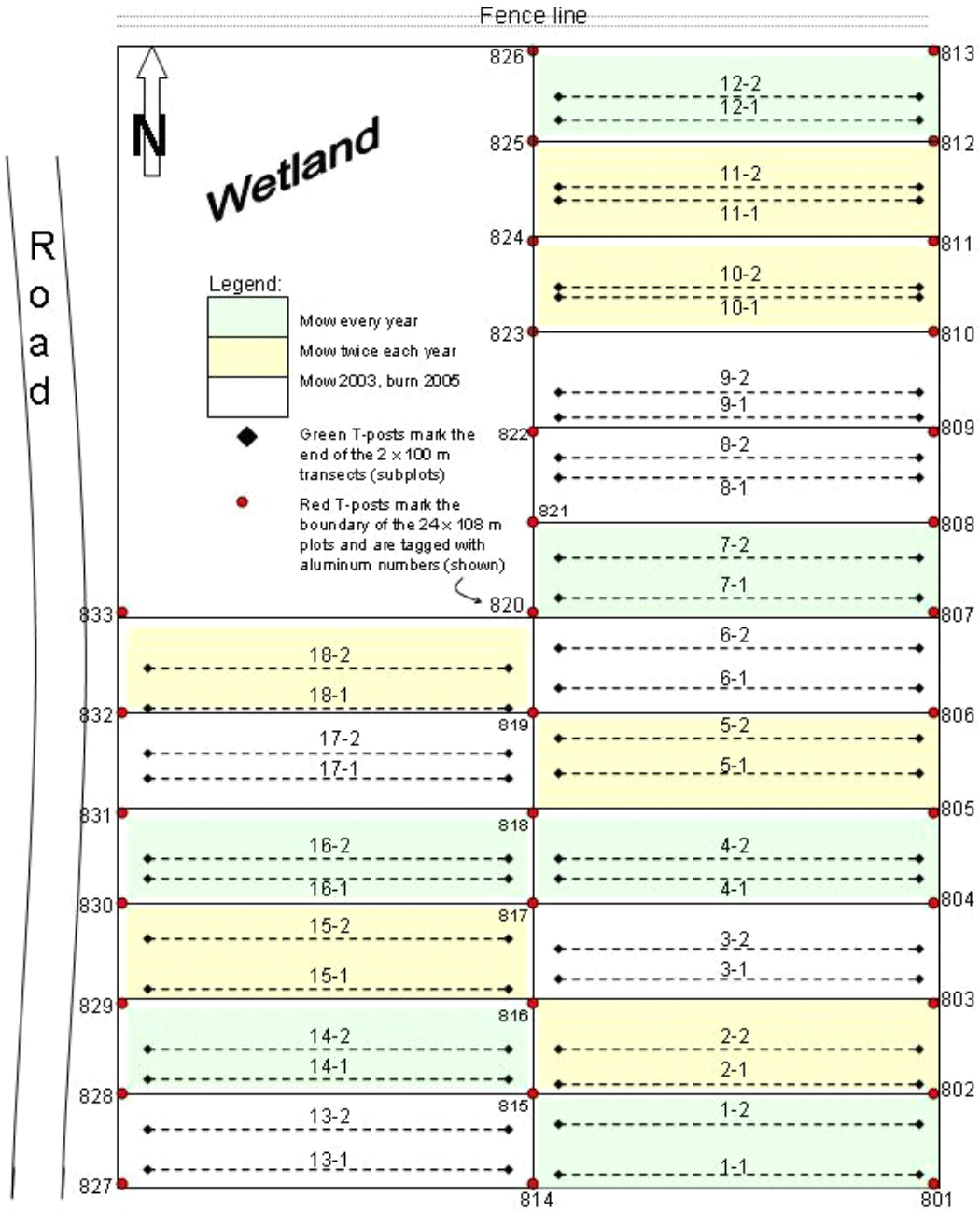

FIGURE 3. DIAGRAM OF PLOT LAYOUT AT THE FIR BUTTE KINCAID'S LUPINE SITE. ASSIGNED TREATMENTS WERE PERFORMED FROM 2001-2007.

Lupine monitoring

From 1998-2010, subplots were monitored by measuring the lupine within 1m of the north and south sides of a 100m transect (for a total of a 100m x 2m sampling area); the subplots thus represented a 15.7% sample of the total macroplot. In 2011, 2014, 2015, and 2017, one side of the tape was randomly selected, thus reducing the area monitored for each subplot to 100m x 1m.

In each subplot, we recorded the cover of Kincaid's lupine, number of mature and aborted Kincaid's lupine inflorescences, the number of Fender's blue butterfly eggs on the leaves (only from 1998-2010), percent cover of Himalayan blackberry (*Rubus armeniacus*) and bracken fern (*Pteridium aquilinum*), and the presence/absence of meadow knapweed (*Centaurea pratensis*). Cover of lupine was determined by measuring the approximate rectangular area occupied by a clump. Cover of blackberry and bracken fern were estimated as the percent of the ground surface covered by the species.

Values for each response variable in each subplot were summed (inflorescences, eggs) or averaged (lupine cover, blackberry cover) to derive a single measure. Values from each of the two subplots were then averaged to derive whole-plot estimates. Subplot data (n = 36) were used for whole-population estimates. Treatment unit averages (n = 6 for each treatment) were used in testing for treatment effects.

As lupine cover, the number of lupine inflorescences, and blackberry cover in 2008 were not independent of the 2005 data (prior to the initiation of the treatments), we tested for treatment differences using an Analysis of Covariance with 2005 values for each variable as a covariate. Percent cover of blackberry was log transformed to meet assumptions of normality. The number of Fender's blue butterfly eggs in 2008 was dependent on the cover of lupine in 2008, which in turn was dependent on the cover of lupine in 2005. Thus, to test for treatment effects on Fender's blue butterfly, the response variable was the number of butterfly eggs/m^2 lupine cover in 2008 with lupine cover in 2005 as a covariate.

Community monitoring

From 2006 to 2010, plant community composition at Fir Butte was monitored using a modified point-intercept method (Massatti and Thorpe 2009, Newton and Thorpe 2010). While this method has the advantage of being easily replicated between years, it has the potential to miss particularly rare species (Dethier *et al*. 1993). Thus, in 2011, 2014, 2015, and 2017, we sampled 36 1m^2 quadrats, which have a higher potential to capture rare species.

For each subplot, one side of the 100m transect (N or S) and meter (between 0 and 99) were randomly selected for placement of the quadrat. We assessed the percent cover of all vascular plant species and four ground cover types (bare soil, litter, rock, and moss). Percentage cover was visually estimated to the nearest 1%; for species occurring at <1% cover we estimated cover to 0.1% or 0.5%. Species names and supplementary information follows the USDA Plants Database (http://plants.usda.gov/java/) and local floras.

RESULTS AND DISCUSSION

Treatment effects

As reported in Kaye and Benfield (2005), mowing at Fir Butte in late summer or early fall had neutral or negative effects on blackberry and positive effects on Kincaid's lupine. The effects of mowing annually were much stronger than the effects of mowing on a two or three year cycle. In 2005, treatments were altered at Fir Butte so that annual mowing became the baseline treatment. Mowing every 2 or 3 years was dropped, and mowing twice per year was scheduled, though not implemented. Plots designated as

mow every 3 years/burn were burned in October 2006.

In 2008, we found positive effects of mowing and burning on lupine and negative effects on the cover of blackberry (Thorpe *et al*. 2008). All management treatments resulted in an increase in the cover of lupine and the number of inflorescences compared to their 2005 levels. The ecological burn had the greatest treatment effects.

These results are consistent with or even more promising than those of studies and observations at other lupine sites. Mowing annually for three years at Baskett Butte (Baskett Slough National Wildlife Refuge) substantially reduced the cover of woody plants while lupine cover stayed the same or increased slightly and inflorescence production doubled (Wilson *et al*. 2003). In addition, lupine in mowed plots attracted ovipositing female Fender's blue butterflies, resulting in much higher egg numbers in mowed plots compared to unmanipulated plots (Schultz *et al*. 2003).

Blackberry levels in 2017 (14.3 ± 1.3%) were similar to observed values in 2015 (14.9 ± 1.6%), and were slightly lower than observed values reported in 2014 (17.7 ± 1.3%). The remaining blackberry is lower stature than the original infestation(s) which could reduce competition with native species, but will likely require a more aggressive management regime to reduce it below current levels. Mowing has been successful at maintaining the current level of cover, but manual removal or herbicide(s) would be recommended to reduce cover of blackberry.

Kincaid's lupine abundance

Kincaid's lupine abundance generally increased from 1998-2010 (Figure 4). After reaching a high of 2,605 m^2 in 2010, lupine cover decreased to 2,426 m^2 in 2011 and 1,569 m^2 in 2014. Lupine cover rebounded over the past two sampling years, with cover measuring 2,469 m^2 in 2017, which was the second highest cover value measured throughout the course of this study (Figure 4).

Community composition

Point-intercept monitoring at Fir Butte had previously estimated that the most abundant species were introduced graminoids (Massatti and Thorpe 2009, Newton and Thorpe 2010, Gray 2013). Using quadrats, we found that introduced perennial grasses were dominant in 2017, with 55.8 ± 12.5% cover (Figure 5). The most common introduced perennial grasses at the site were *Agrostis capillaris* and *Arrhenatherum elatius* (Appendix A). Data from both methods showed that total cover of native species was less than one third that of introduced species.

After introduced perennial grasses, introduced annual and biennial forbs were the most abundant in 2017 (Figure 5). Introduced annual and biennial forb cover increased from 2015 to 2017, with each group averaging less than 10% in 2015 and averaging greater than 25% in 2017 (Figure 5). Native perennial forbs, which includes *L. oreganus*, were the greatest component of native species at the site with 18.5 ± 7.5% cover in 2017 (Figure 5). As has been found during point-intercept monitoring, litter is the most abundant ground cover type. Litter nearly doubled from 2011 (45.9 ± 2.7%) to 2015 (80.1 ± 2.5%), and remained at high levels in 2017 (83.6 ± 3.9%). On average, there was <5% cover of bareground, and <2% moss cover.

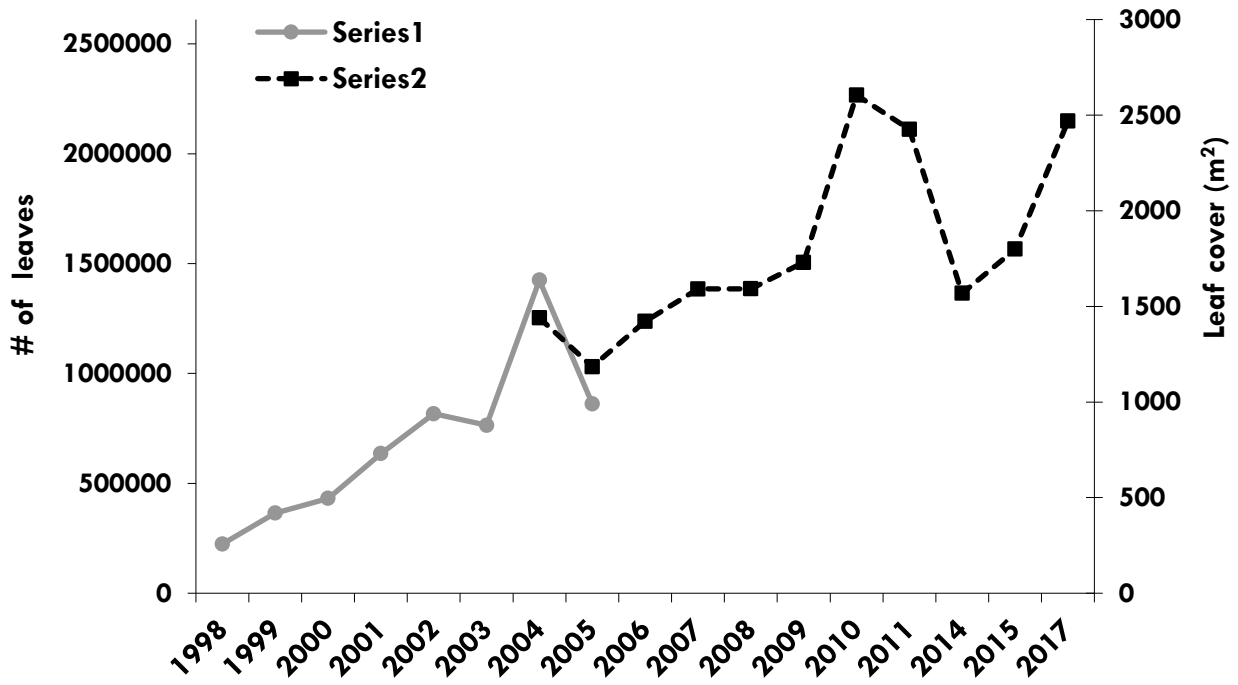

FIGURE 4. ABUNDANCE OF KINCAID'S LUPINE , MEASURED BY NUMBER OF LEAVES (SERIES 1; 1998-2005) AND LEAF COVER (SERIES 2; 2004-2017) AT FIR BUTTE FROM 1998-2017.

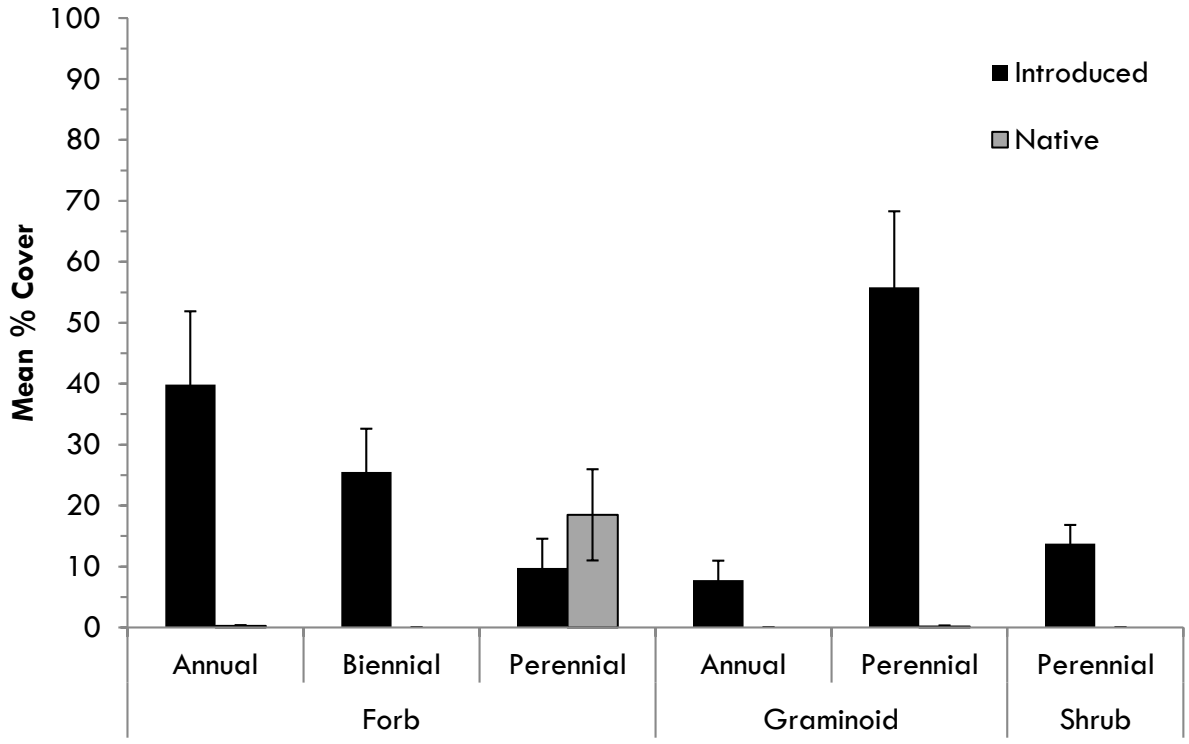

FIGURE 5. MEAN PERCENT (%) COVER OF PLANTS BY GROWTH FORM (FORB, GRAMINOID, OR SHRUB), NATIVITY (INTRODUCED OR NATIVE), AND LIFE HISTORY (ANNUAL, BIENNIAL, OR PERENNIAL) IN 36 1M² QUADRATS AT FIR BUTTE IN 2017. ERROR BARS REPRESENT ± 1 S.E.

CONCLUSIONS

- Blackberry cover was reduced in the initial research experiment, but cover remains relatively high.
    - Mowing can be used to maintain current blackberry cover values, but herbicides and/or grubbing will likely be required to further reduce blackberry.
- Kincaid's lupine increased in cover in 2017 to the second highest levels measured throughout the course of this study.
- Introduced perennial grasses were the dominant components of the plant community.
    - Continued efforts to decrease these populations and increase native plant diversity are necessary.
- High litter cover observed in recent years could limit native species. There is little bare ground available for seed germination.

Kincaid's lupine at Fir Butte, 2017

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APPENDIX A. SPECIES IDENTIFIED IN 36 1M^2 QUADRATS SAMPLED AT FIR BUTTE IN 2017.

Species	US Nativity	Growth Habit	Duration	Average	SE
Clarkia sp.	Native	Forb	Annual	0.04	0.03
Collomia grandiflora	Native	Forb	Annual	0.01	0.01
Galium aparine	Native	Forb	Annual	0.00	0.00
Lotus micranthus	Native	Forb	Annual	0.18	0.09
Achillea millefolium	Native	Forb	Perennial	0.03	0.03
Camassia sp.	Native	Forb	Perennial	0.00	0.00
Dichelostemma congestum	Native	Forb	Perennial	0.14	0.07
Eriophyllum lanatum	Native	Forb	Perennial	0.31	0.23
Lomatium nudicaule	Native	Forb	Perennial	0.01	0.00
Lupinus oreganus	Native	Forb	Perennial	9.58	3.25
Prunella vulgaris	Native	Forb	Perennial	0.08	0.04
Pteridium aquilinum	Native	Forb	Perennial	8.08	3.68
Sidalcea sp.	Native	Forb	Perennial	0.25	0.17
Galium parisiense	Introduced	Forb	Annual	19.95	5.42
Geranium dissectum	Introduced	Forb	Annual	1.24	0.40
Lathyrus sphaericus	Introduced	Forb	Annual	0.06	0.06
Linum bienne	Introduced	Forb	Annual	0.23	0.22
Parentucellia viscosa	Introduced	Forb	Annual	11.14	2.89
Plantago lanceolata	Introduced	Forb	Annual	0.96	0.84
Vicia hirsuta	Introduced	Forb	Annual	5.30	1.89
Vicia sativa	Introduced	Forb	Annual	1.01	0.30
Cirsium vulgaris	Introduced	Forb	Biennial	0.06	0.06
Crepis capillaris	Introduced	Forb	Biennial	5.54	1.92
Daucus carota	Introduced	Forb	Biennial	19.92	5.11
Calystegia sp.	Introduced	Forb	Perennial	5.97	3.53
Hypericum perforatum	Introduced	Forb	Perennial	0.08	0.03
Hypochaeris radicata	Introduced	Forb	Perennial	1.36	0.44
Myosotis discolor	Introduced	Forb	Perennial	0.01	0.01
Rumex acetosella	Introduced	Forb	Perennial	2.37	0.76
Festuca roemeri	Native	Graminoid	Perennial	0.17	0.17
Aira caryophyllea	Introduced	Graminoid	Annual	0.94	0.51
Bromus hordeaceus	Introduced	Graminoid	Annual	3.88	1.08
Bromus rigidus	Introduced	Graminoid	Annual	1.53	0.76
Cynosurus echinatus	Introduced	Graminoid	Annual	0.18	0.11
Vulpia bromoides	Introduced	Graminoid	Annual	1.23	0.74
Agrostis capillaris	Introduced	Graminoid	Perennial	35.11	4.37
Anthoxanthum odoratum	Introduced	Graminoid	Perennial	5.60	2.00
Arrhenatherum elatius	Introduced	Graminoid	Perennial	12.90	4.41
Dactylis glomerata	Introduced	Graminoid	Perennial	0.75	0.56
Festuca arundinacea	Introduced	Graminoid	Perennial	0.83	0.83
Holcus lanatus	Introduced	Graminoid	Perennial	0.62	0.27
Poa compressa	Introduced	Graminoid	Perennial	0.01	0.01
Alopecurus sp.	N/A	Graminoid	N/A	1.11	0.87
Luzula sp.	N/A	Graminoid	N/A	0.06	0.06

Vulpia sp.	N/A	Graminoid	N/A	0.86	0.83
Cytisus scoparius	Introduced	Shrub	Perennial	0.01	0.01
Rubus armeniacus	Introduced	Shrub	Perennial	13.72	3.07
Quercus garryana	Native	Tree	Perennial	0.14	0.14

Kincaid's lupine at Fir Butte, 2017