
Kincaid's lupine (*Lupinus oreganus*) and habitat monitoring at Fir Butte

2011 Report

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PREFACE

This report is the result of a cooperative Challenge Cost Share project between the Institute for Applied Ecology (IAE) and a federal agency. 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.

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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.

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 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* (blackberry), *Cytisus scoparius* (Scotch broom), *Centaurea pratensis* (meadow knapweed), 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 the meadow knapweed, Scotch broom, and blackberry cover.



Figure 1. Kincaid's lupine (*Lupinus oreganus*).

Objectives

This report summarizes the results of monitoring Kincaid's lupine and the plant community at Fir Butte in 2011. Specifically, we (1) summarize the abundance of Kincaid's lupine in 2011 and long term population trends, (2) briefly review the effectiveness of mowing and burning as management treatments, and (3) summarize the plant community composition and the utility of using quadrat vs. point-intercept sampling

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 due to concerns about damage to the eggs. In 2011, we monitored plant community composition using 1m² 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 and cover 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 100m 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



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.

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 and ecological burns.

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, one side of the tape was randomly selected, reducing the area monitored for each subplot to 100m x 1m.

From 1998-2010, 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, percent cover of Himalayan blackberry (*Rubus armeniacus*) and bracken fern (*Pteridium aquilinum*; 2006-2010), 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 was 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/m² lupine cover in 2008 with lupine cover in 2005 as a covariate.

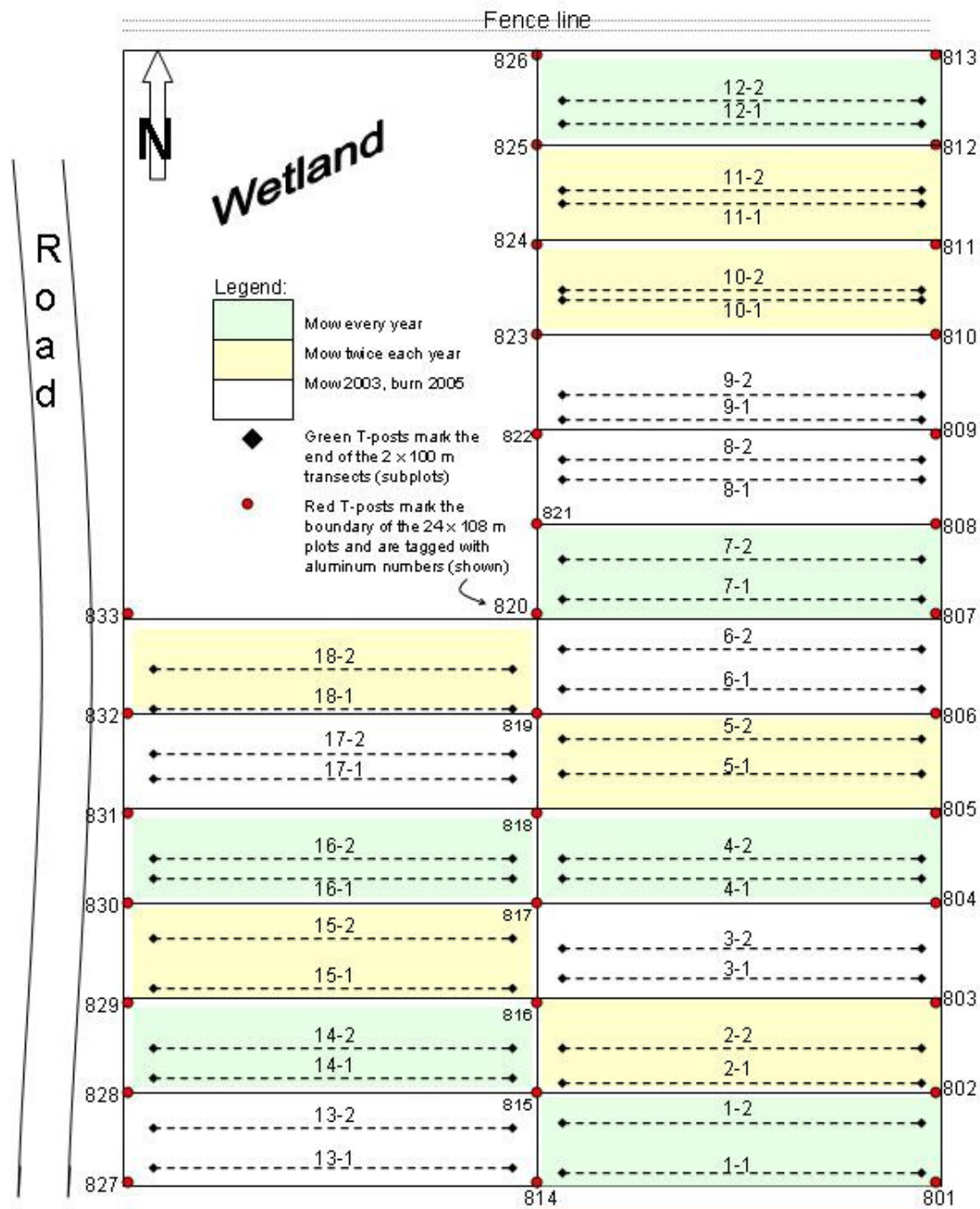


Figure 3. Diagram of plot layout at the Fir Butte Kincaid's lupine site. Assigned treatments were performed from 2001-2007.

Community monitoring

Since 2006, plant community composition at Fir Butte has been 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. Thus, in 2011, we sampled 36 1m² quadrats, which have a higher potential to capture rare species.

For each subplot, a 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 three 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 (www.plants.usda.gov) 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).

Kincaid's lupine abundance

Kincaid's lupine abundance has generally increased since 1998 (Table 1, Figure 4). There was a slight decrease in lupine cover in 2011; however, particularly considering the dramatic increase from 2009 to 2010, this decline is not currently of concern.

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). Using quadrats, we found that introduced perennial shrubs (blackberry) and introduced perennial

grasses was both dominant (Figure 5; Appendix A). Data from both methods showed that total cover of native species was less than one third that of introduced species. As has been found during point-intercept monitoring, litter is the most abundant ground cover type ($45.9 \pm 2.7\%$). On average, there was 3% cover of bareground, and a trace of moss cover. Quadrat sampling did not identify any species that previously had not already been identified through point-intercept monitoring, thus it is our recommendation that point-intercept monitoring be the default community sampling method due to its better reliability between years. This could be combined with an annotated species list to most thoroughly sample the plant community at the site.

Table 1. Estimated totals of Kincaid's lupine inflorescences, leaves, and butterfly eggs at the Fir Butte site, 1998 – 2011. A hyphen (-) indicates that no measurements were taken for a variable in that year.

		Lupine cover (m²)	# Leaves	# Inflorescences	# Butterfly eggs
1998	total at Fir Butte	—	220,634	13,468	11,698
	90% CI		±78,048	±5,683	±4,846
1999	total at Fir Butte	—	359,381	22,776	8,740
	90% CI		±123,540	±8,408	±2,780
2000	total at Fir Butte	—	425,219	26,821	12,056
	90% CI		±149,757	±10,494	±4,195
2001	total at Fir Butte	—	626,782	34,800	14,068
	90% CI		±188,744	±11,009	±4,372
2002	total at Fir Butte	—	805,089	37,963	19,805
	90% CI		±230,423	±10,275	±5,546
2003	total at Fir Butte	—	753,608	47,335	28,731
	90% CI		±209,530	±12,196	±7,811
2004	total at Fir Butte	1,440	1,404,495	55,456	51,897
	90% CI	±373	±377,513	±14,219	±14,056
2005	total at Fir Butte	1,185	849,518	43,623	2,817
	90% CI	±303	±256,989	±12,227	±761
2006	total at Fir Butte	1,421	—	64,377	1,009
	90% CI	±378		±17,503	±404
2007	total at Fir Butte	1,591	—	97,437	4,485
	90% CI	±404		±22,965	±1,357
2008	total at Fir Butte	1,592	—	116,438	3,367
	90% CI	±390		±26,312	±1,197
2009	total at Fir Butte	1,730	—	86,920	6,887
	90% CI	±387		±19,792	±1,958
2010	total at Fir Butte	2,605	—	133,112	17,950
	90% CI	±599		±29,986	±7,346
2011	total at Fir Butte	2,426	—	—	—
	90% CI	±614			

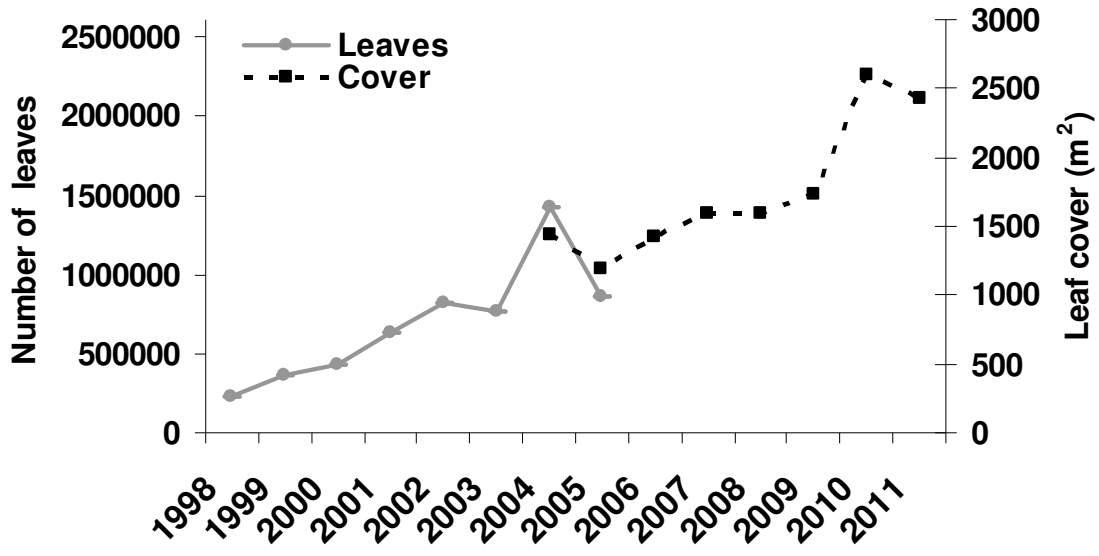


Figure 4. Abundance of Kincaid's lupine at Fir Butte from 1998 - 2011.

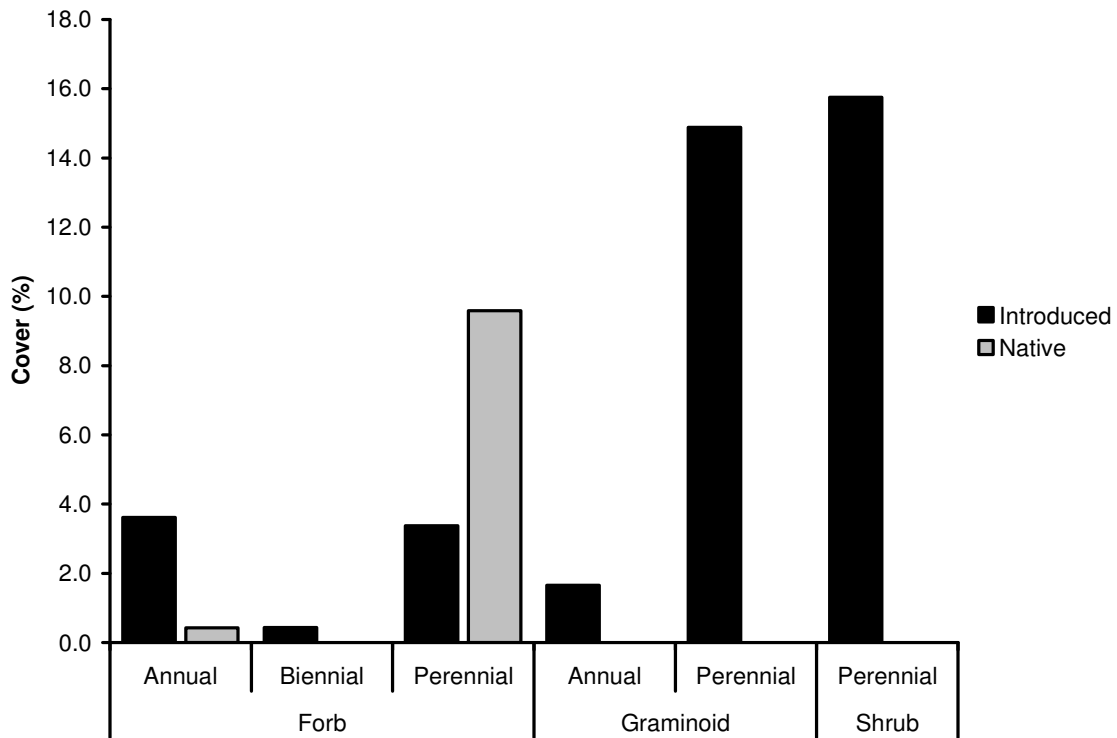


Figure 5. Average cover of plants by growth form, nativity, and life history at Fir Butte in 2011.

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Appendix A. Species identified in 36 1m² quadrats sampled at Fir Butte in 2011.

Species	US Nativity	Growth Habit	Duration	Cover	
				Average	SE
<i>Plantago lanceolata</i>	Introduced	Forb	Annual	0.1	0.1
<i>Geranium dissectum</i>	Introduced	Forb	Annual	0.3	0.2
<i>Cerastium glomeratum</i>	Introduced	Forb	Annual	0.3	0.5
<i>Vicia sativa</i>	Introduced	Forb	Annual	0.4	0.2
<i>Parentucellia viscosa</i>	Introduced	Forb	Annual	0.6	0.3
<i>Galium parisiense</i>	Introduced	Forb	Annual	0.6	0.3
<i>Vicia hirsuta</i>	Introduced	Forb	Annual	1.4	0.7
<i>Cirsium vulgare</i>	Introduced	Forb	Biennial	0.1	0.1
<i>Daucus carota</i>	Introduced	Forb	Biennial	0.4	0.2
<i>Senecio jacobaea</i>	Introduced	Forb	Perennial	0.1	0.1
<i>Hypericum perforatum</i>	Introduced	Forb	Perennial	0.1	0.2
<i>Rumex acetosella</i>	Introduced	Forb	Perennial	1.0	0.6
<i>Centaurea pratensis</i>	Introduced	Forb	Perennial	1.0	1.0
<i>Hypochaeris radicata</i>	Introduced	Forb	Perennial	1.2	1.0
<i>Aira caryophylla</i>	Introduced	Graminoid	Annual	0.1	0.1
<i>Bromus hordeaceus</i>	Introduced	Graminoid	Annual	0.7	0.5
<i>Vulpia bromoides</i>	Introduced	Graminoid	Annual	0.9	0.7
<i>Dactylis glomerata</i>	Introduced	Graminoid	Perennial	0.6	0.5
<i>Arrhenatherum elatius</i>	Introduced	Graminoid	Perennial	1.2	0.8
<i>Holcus lanatus</i>	Introduced	Graminoid	Perennial	1.5	0.7
<i>Schedonorus phoenix</i>	Introduced	Graminoid	Perennial	2.3	2.1
<i>Anthoxanthum odoratum</i>	Introduced	Graminoid	Perennial	2.7	1.1
<i>Agrostis capillaris</i>	Introduced	Graminoid	Perennial	6.6	1.8
<i>Rubus armeniacus</i>	Introduced	Shrub	Perennial	15.8	3.8
<i>Galium aparine</i>	Native	Forb	Annual	0.4	0.3
<i>Pteridium aquilinum</i>	Native	Forb	Perennial	1.1	1.2
<i>Lupinus oreganus</i>	Native	Forb	Perennial	8.5	4.6