# FINAL REPORT

# Restoration of Fender's blue butterfly and its prairie ecosystem: Management applications of fire to Baskett Slough NWR


Submitted by

**Mark V. Wilson**
and
**Deborah L. Clark**


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## Summary

We tested the recolonization ability of the Fender's blue butterfly and monitored the vegetation response to a management-scale prescribed fire at the Baskett Slough National Wildlife Refuge, western Oregon. The prescribed fire successfully cut shrub cover in half, but also reduced the size of *Festuca roemeri*, a dominant native grass. Although the fire killed all Fender's blue butterfly larvae, as expected, adult females were able to recolonize the burned area from a nearby, unburned patch. These results support predictions that the Fender's blue butterfly can recolonize burned areas for a distance of at least 100 m.

## Introduction

Baskett Slough National Wildlife Refuge contains some of the best examples of upland prairies in western Oregon. Prairies once covered most of the Willamette Valley, maintained by periodic fires set by the Kalapuya. After settlement starting in the 1830s, regular burning of native prairies ceased and most of the Valley was gradually developed for agricultural or urban uses. Woody species and non-native weeds invaded remaining natural areas. As a result, upland prairies are now highly fragmented and are in critical need of restoration and management. Even so, remnants of these highly diverse, complex, and poorly understood ecosystems provide necessary habitats for many rare plant and animal species. At the Baskett Slough refuge, upland prairies provide habitat for the Fender's blue butterfly and the Willamette daisy (Federally listed endangered species), Kincaid's lupine (Federally listed threatened species), and spur lupine (with Kincaid's lupine, a host plant for the Fender's blue butterfly).

Because of the dynamic nature of these habitats, the protection and restoration of upland prairies and the rare species they harbor requires active management. Moreover, management should be integrated with careful scientific studies to help design improved restoration strategies.

Recent research at the Refuge (Wilson and Clark, 1997) has provided key information on the role of prescribed burning and mowing on the abundance of invading shrubs, non-native weeds, and native plants. Burning and mowing were found to be effective in woody plant control, stimulating flowering of lupines, and attracting Fender's blue butterflies. The present report describes activities building on these results, testing the experimental-plot results at a landscape scale. A separate report (Clark and Wilson 2000) describes results of establishing native plants from seed into treated areas.

Fire kills Fender's blue butterfly larvae (C. B. Schultz, pers. comm.; Wilson et al., in prep.), eliminating the on-site source of population regeneration. As a result, conservationists are concerned that prescribed burning to control woody-plant invasion in native prairies might irreparably harm this endangered butterfly species. Recent research of the flight behavior of Fender's blue butterfly suggest that adult females can travel 100 m or more is search of ovipositioning sites (C. B. Schultz, pers. comm.). If this is true, females could recolonize burned areas when adjacent populations within 100 m are left unburned. The present report tests these predictions by observing Fender's blue butterfly recolonization after prescribed burning.

The activities described in this report occurred in Area 6 of Baskett Slough National Wildlife Refuge (using the naming convention in Hammond 1996). This approximately 2 ha area contains good upland prairie, with Fender's blue butterflies and their host lupines concentrated within a 1 ha portion of the site. Encroachment by woody plants and non-native weeds threaten the prairie.

## Methods

### Mapping Area 6

In 1997 and 1998, we searched Area 6 extensively for Kincaid's lupine and spur lupine. Only spur lupine were located. West of the trail, lupines were only in a relative compact clump. East of the trail, lupines were widely dispersed (Figure 1). This spatial arrangement of lupines was ideal for examining the post-fire recolonizating ability of Fender's blue butterflies. On March 16, 1999, we verified the map of lupines by recording distances from the unburned "source" patch west of the trail to each marked plot of lupines in the burned plots east of the trail.

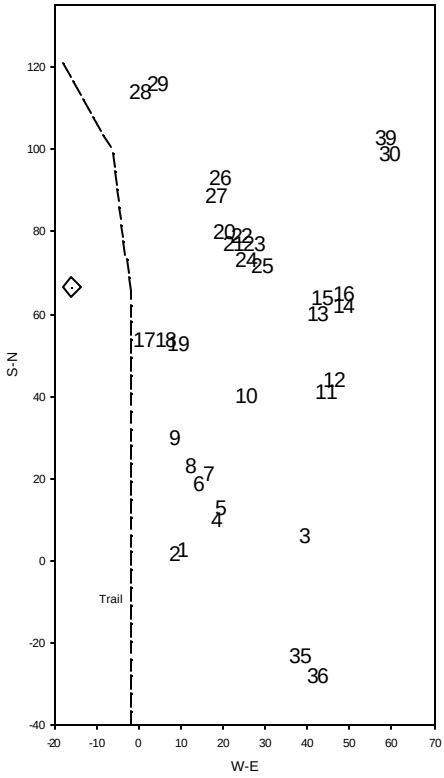


**Figure 1**. Location of measurement plots, Area 6. Numerals refer to plot numbers, each centered on a lupine patch. ◇ shows the location of the source lupines in the unburned, west portion of the study area. Coordinates are in meters.

### Pre-manipulation measurements

We established a series of permanent plots at 33 lupines patches. Within 10-m$^2$ plots centered in each patch, we recorded the overall cover of lupines, the number of lupine inflorescences, and the number of inflorescences of selected Fender's blue butterfly nectar plants (*Brodiaea congesta, Eriophyllum lanatum*, *Linum angustifolium*, and *Vicia hirsuta*). Also within the 10-m$^2$ plots we marked individuals of the key native prairie grasses *Festuca roemeri* and *Elymus glaucus* and the important non-native weed *Festuca arundinacea*. (Some *F. rubra* might have been included in the *F. roemeri* samples.) We recorded plant size and flowering intensity for each marked plant.

Within a 0.5-m$^2$ quadrat centered in each patch, we counted each lupine stem and lupine leaf, recorded the maximum height and number of lupine inflorescences, and counted Fender's blue butterfly eggs.

Within a 30-cm × 30-cm subplot near the patch center, we recorded the density of each non-native annual grass species and of *Hypericum perforatum*. We also recorded vegetative cover and depth of litter.

We recorded shrub and tree cover along 15 line transects extending from the trail to the east border of the study area. Cover was recorded as interception along each line. We also recorded shrub height by species at 5-m intervals along the transects.

### Prescribed burning

On August 28, 1998, we guided Tim Cochran of the US Fish and Wildlife Service as he mowed a safety strip around the burn area of Area 6.

On September 17, 1998, US Fish and Wildlife crew burned the buffer around the edge of Area 6. On September 20, 1998, the crew completed the prescribed burning of Area 6. First ignition was at 1:04 pm. In the first hour of burning wind speed was 2-5 mph from the northwest, temperature was 24°C, and relative humidity was 48%.

### Post-manipulation measurements

In 1999, during the growing season following the prescribed burning, we repeated the pre-manipulation measurements of lupine height, number of stems, number of leaves, and number of inflorescences; nectar plant flowering; perennial grass size and flowering; Fender's blue butterfly eggs; density of non-native annual grass species and of *Hypericum perforatum*; and shrub and tree cover and height.

## Results

### Shrubs and trees

Shrub and tree cover decreased with burning from 10.8% to 5.8% (Table 1). This strong and statistically significant decrease was almost entirely of the shrubs. There were few trees in the samples, and they changed little in cover or height. The shrubs that remained after burning had about the same average height (23 cm).

### Non-native annual grasses and *Hypericum perforatum*

Non-native annual grasses and *Hypericum perforatum* seedlings changed little in density from before to after the prescribed burn (Table 1).

Table 1. Abundance of shrubs and trees, exotic annual grasses, and nectar plants. Averages in 1998 and 1999. P is for signed rank test.

| | 1998 | 1999 | *P* |
|---|---|---|---|
| Shrub & tree (cover) | 10.8% | 5.8% | <**0.01** |
| Exotic annual grass (number per 900 $cm^2$) | 39.5 | 35.3 | 0.87 |
| *Hypericum perforatum* seedlings (# / 900 $cm^2$) | 0.2 | 0.3 | 1.00 |
| FBB nectar plants (flowering units per 10$m^2$) | 7.3 | 21.5 | <**0.01** |
| *Vicia hirsuta* (a FBB nectar plant) (frequency) | 0.59 | 0.78 | 0.20 |

**Perennial grasses**

Although we observed no mortality of marked perennial grasses with prescribed burning, burning did have some dramatic effects on these plants. The average circumferences and lengths of the longest leaf of *Elymus glaucus* (native), *Festuca arundinacea* (non-native), and *Festuca roemeri* (native) all decreasing from before to after burning (Table 2). These decreasing were strongest and statistically significant for the two fescues.

Table 2. Size and flowering of monitored perennial grasses. Averages in 1998 and 1999. *P* is for the signed rank test.

| | *Elymus glaucus* | | | *Festuca arundinacea* | | | *Festuca roemeri* | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1998 | 1999 | *P* | 1998 | 1999 | *P* | 1998 | 1999 | *P* |
| Number of samples | 14 | 14 | | 13 | 13 | | 14 | 14 | |
| Circumference (cm) | 22.0 | 15.8 | 0.21 | **36.0** | **15.2** | **0.01** | **38.0** | **19.3** | **<0.01** |
| Longest leaf (cm) | 16.8 | 12.6 | 1.00 | **52.7** | **24.7** | **<0.01** | **30.5** | **10.6** | **<0.01** |
| Number of inflorescences | 5.4 | 5.6 | 0.80 | **6.5** | **1.9** | **<0.01** | 7.6 | 5.6 | 0.11 |

**Nectar sources**

Plants that serve as nectar sources for Fender's blue butterfly adults were in much higher abundance after burning than before (Table 1).

### Spur lupine

Lupines tended to be larger in all measured traits after burning than before (Table 3). The 1.4× increase in number of leaves and the 2× increase in number of inflorescences were statistically significant.

Table 3 Characteristics of spur lupines and number of FBB eggs in 0.5m$^2$ plots. Averages for 1998 and 1999. *P* is for the signed rank test.

| | 1998 | 1999 | *P* |
|---|---|---|---|
| Lupine height (cm) | 47.7 | 52.2 | 0.46 |
| Lupine stems (no.) | 14.6 | 16.9 | 0.07 |
| Lupine leaves (no.) | **105** | **147** | <**0.01** |
| Lupine inflorescenes (no.) | **5.2** | **10.7** | <**0.01** |
| Fender's blue butterfly eggs (no.) | **10.9** | **5.5** | **0.01** |

### Fender's blue butterfly

In May 1999, after the prescribed burning the previous fall, there were no Fender's blue butterfly larvae or sign of larval damage to lupine stems within the 33 lupine plots. In contrast, six of eight lupine plots in the unburned portion of Area 6 had signs of Fender's blue butterfly larvae.

The number of Fender's blue butterfly eggs significantly declined with burning, from 10.9 eggs per 0.5-m$^2$ plot to 5.5 eggs per plot (Table 3). There was no change in numbers of eggs with distance from the unburned source, using either a simple regression ($b$ = 0.04, $P$ = 0.41) or the best multiple regression, $Eggs_{99}^{1/2} = 0.94 + 0.28 \cdot Eggs_{98}^{1/2} + 0.004 \cdot Distance$, with $P$ = 0.33 for the *Distance* term. Neither the measured traits of lupine nor the abundance of nectar plants had a statistically significant effect on the number of Fender's blue butterfly eggs oviposited in the spring after the prescribed burning.

## Discussion

### Caveat

This study was designed to test predictions about the recolonization abilities of Fender's blue butterfly and to monitor the effects of management-scale prescribed burning. Because the study was not set up as a classical experiment and lacked replication and controls, caution should be exercised in

interpreting some of the results. Some variables, like flowering and abundance of annuals, change dramatically from year to year. Changes between 1998 and 1999 for these variables should not be strictly interpreted as being caused by the prescribed burning. Rather, these monitoring results serve as an "early warning" of potentially dangerous responses to fire. Continued monitoring is essential to resolve these patterns.

On the other hand, some variables do not change much from year to year. Changes in these variables, like sizes of the perennial grasses, shrubs, and trees, can more safely be ascribed to the prescribed burning.

There are insufficient data to know the year-to-year variability in the density of Fender's blue butterfly eggs. Instead, our results serve as a single test of the Schultz models that predict that Fender's blue butterflies should be able to recolonize areas the size of this prescribed burn.

**Prescribed fire effects on vegetation**

A primary objective of using prescribed fire for prairie management is the control of invasive woody plants. In the management-scale burning of Area 6, this objective was well met, reducing shrub cover by half. Because the cover of unmanaged shrubs typically increases little (but inexorably) in a single year, the observed changes can safely be ascribed to the burning treatment. Repeated burning in this site, perhaps every one to three years, should be very effective at stemming current shrub invasion and preventing future invasion.

Some studies have found the prescribed burning can have adverse effects through the promotion of weedy non-native annual grasses (Maret and Wilson, 2000). This increase in annual grasses did not occur after fire in Area 6, but it is possible that weather in 1999 was poor for annual grass establishment, erasing any promotion by prescribed burning.

Perennial grasses with exposed aboveground meristems can be more susceptible to damage by burning than are cryptophytic and hemi-cryptophytic perennial herbs. This damage was certainly evident in the two fescues. It is unknown why prescribed burning had little effect on the third perennial grass, *Elymus glaucus*.

**Prescribed fire effects on the Fender's blue butterfly, spur lupine, and nectar plants**

For many, the primary interest in these prairie communities is the presence of the endangered Fender's blue butterfly. Prescribed burning has the potential to adversely affect Fender's blue butterfly populations by killing their larvae, damaging their larval food plant (spur lupine in Area 6), or reducing the availability of nectar sources for adults. Prescribed burning also has the potential to *benefit* Fender's blue butterfly populations by reducing woody plant cover and by increasing the abundance

and vigor of larval food plants (spur lupine) and nectar plants. Increased vigor of lupines after burning could, in fact, accelerate Fender's blue butterfly recolonization rates (Wilson, et al., *in preparation*).

The results from this study in Area 6 suggest that prescribed burning has both negative and positive effects on Fender's blue butterflies. We confirmed that all larvae are killed when exposed to fire, a direct negative effect. Yet adult females found the invigorated lupines throughout the burned area. Egg numbers were less after burning, but recolonization occurred throughout the burned area (Figure 2). Nectar plant flowering was also increased, although this positive change might be year-to-year variation unrelated to the prescribed burning. Finally, the significant reduction in shrub cover with burning is important for maintaining the open prairie habitat required by Fender's blue butterfly.

## References


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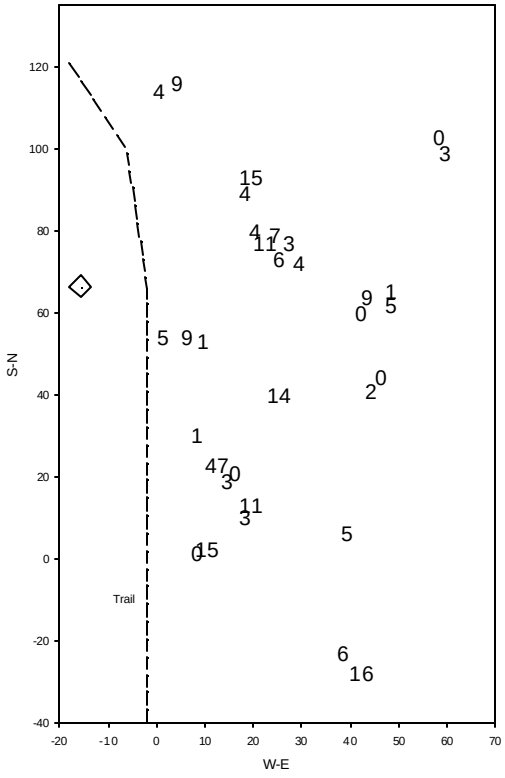


**Figure 2**. Number of Fender's blue butterfly eggs per lupine plot, in the spring after prescribed burning. ◊ shows the location of the source lupines in the unburned, west portion of the study area. Coordinates are in meters.