Initial Observations on the Effects of Fire on Willamette Valley Wetland Prairie Vegetation

Trevor Taylor
541.687.7902
trevtay@darkwing.uoregon.edu
450 W. Broadway, #8
Eugene, OR 97401

Abstract

Significant and precipitous declines in the quantity and quality of wetland prairie habitat in the Willamette Valley have led land managers to reintroduce prescribed fire as a tool of habitat restoration. It is believed that anthropogenic fires influenced the structure and function of prairies and that modern fire repression has contributed to their degradation. This paper provides initial observations of a study intended to evaluate the impacts of prescribed fires on vegetation at the Fern Ridge Research Natural Area (RNA) in Eugene, Oregon. The objective of this study is to compare species frequency data collected in 1998, with data collected in 1988, 1989, and 1990 as part of another study. Final results are pending, but initial observations suggest that species responses to burns vary widely. Explicit restoration goals and inclusion of other biotic and abiotic factors will be necessary for effective use of prescribed burns in wet prairie restoration.

Keywords

restoration, prescribed burning, botany, resource management

Introduction

There have been significant and precipitous declines in the amount of intact wetland prairie habitat in the Willamette Valley. Currently, only about 1,000 acres of high quality native prairie remain, a reduction of 99.9% (Alverson 1995). Much of this decline has been attributed to direct conversion of land by development. In addition to concerns over loss of wetland prairies, there is concern for the quality of remaining protected and unprotected areas. Land managers and researchers have noted at least two significant and alarming trends occurring in Willamette Valley wetland prairies. The first has been a succession of these prairie grassland habitats to shrubland and woodland habitats

dominated by woody species (Frenkel and Heinitz 1987). The second trend has been an increasing dominance of these habitats by exotic species (Christy and Alverson 1994). These trends have resulted in transformations of the native plant communities as well as the hydrologic functions of these habitats. In many cases, there is concern that particular native plant species will be lost entirely.

Although the historical process of prairie creation and maintenance is not certain, there is growing evidence that disturbances such as fire play an important role in shaping and maintaining oak savanna and prairie type ecosystems (e.g. Streatfield and Frenkel 1997). Similarly, it is believed that intentional anthropogenic fires served as an important and regular source of disturbance throughout much of the Willamette Valley prior to EuroAmerican influence in the 1840's (Sprague and Hansen 1946, Habeck 1961, Johannessen et al. 1971, Boyd 1986). Fire repression and prevention in the Willamette Valley has now been practiced for over 140 years (Boyd 1986), and may be contributing to many of the important vegetative changes occurring within these ecosystems.

This belief has led several public and nonprofit agencies to attempt to reestablish historical burning regimes in an effort to conserve and restore this habitat type. However, there is little available information as to the effectiveness or impacts of these attempts. Several initial studies have been undertaken (e.g. Acker 1986, Pendergrass 1995, Streatfield and Frenkel 1997, Pendergrass et al. 1998), but many questions remain unanswered including long term effects of prescribed burning and optimal fire intervals.

The objective of this study was to evaluate the immediate and longer term impacts of prescribed fires on wetland prairie vegetation at the Fern Ridge Research Natural Area (RNA) in Eugene, Oregon. Four wetland prairie plant communities were identified at the Fern Ridge RNA and sampled. Frequency data from all species was collected in 1998 and compared with data collected in an earlier study (Pendergrass 1995) to evaluate the impacts to selected indicator species of prescribed fires initiated in 1988, 1989, and 1991. It is anticipated that by looking at the effects of these fires on vegetation over time, a better understanding of the short term impacts and the longer term recovery of these plant communities will emerge.

Methods

Study Area

Two study sites, Rose Prairie (~6 ha) and Fisher Butte (~20 ha), were selected for study. Both sites are located within the Fern Ridge Research Natural Area (RNA), approximately 13 km west of Eugene, Oregon. The Fern Ridge RNA was established in 1988 to conserve exemplary communities of Willamette Valley wet prairie habitat. Soils at these sites are alluvial, poorly drained, and subject to frequent lengthy periods of flooding from November to May (Pendergrass 1995). Climate in this region is characterized by mild winters with an average annual precipitation of 114 cm and an average temperature of 12° C (Pendergrass 1995). The combination of climate, hydrology, and soil type contribute to a complex microtopography characterized by numerous small hummocks with eroded depressions between. Thus, the tops of the hummocks remain drier than the lower depressions which stay inundated longer. This complex microtopography is an important contributing factor to the biological diversity of wetland prairies. Further detailed background about the study area is described in Pendergrass (1995).

The Fern Ridge RNA is administered by the U. S. Army Corps of Engineers. There have been no recorded prescribed fires at Fisher Butte or Rose Prairie, prior to 1988, since their transfer to the Army Corps of Engineers in the 1940s (R. Hayes. Park Ranger. U.S. Army Corps of Engineers, Fern Ridge Reservoir, Junction City, OR. Personal communication.)

Data Collection

Experimental design replicated the methods established by Pendergrass (1995). Frequency data was collected for all vascular plant species occurring in areas sampled from four Willamette Valley wet prairie communities. Each community surveyed received three experimental treatments; twice burned (1988 and 1989), three-times burned (1988, 1989, and 1991), or unburned (control). Initial transects and plots established and sampled in 1988 were relocated and resampled by Pendergrass

in 1989, and 1990, and then again during this study in 1998. Initial data collected by Pendergrass was compared with data collected in this study in an effort to assess the longer term effects of the three treatments.

Two plant communities were identified at the Fisher Butte location and two plant communities were identified at the Rose Prairie location. At Fisher Butte, one community is dominated by *Rosa nutkana* (Nootka rose) and *Juncus nevadensis* (Sierra rush), while the second is dominated by *Deschampsia cespatosa* (Tufted hairgrass) and *Danthonia californica* (California oat grass). At Rose Prairie, one community is dominated by *Deschampsia cespatosa* and *Danthonia californica*, while the second is dominated by *Vaccinium caespitosum* (Dwarf huckleberry). In each of the four communities, three sets of three transects were established; one in each treatment. In each treatment, data was collected from permanent plots located along three 30 meter transects radiating from a center point in random compass directions. Every meter along transects, presence/absence data for all vascular plant species was recorded from nested plots of 50x50 cm, 25x25 cm, and 12.5x12.5 cm. Thus, 270 plots of data were recorded from each community (90 from each treatment).

Data Analysis

Data presented in Figure 1 depicts mean frequencies for six species averaged over all four communities with error bars representing ±1 standard error. Thus, the most abundant species would have a mean frequency close to 30 along a transect and less abundant species would have a mean frequency close to 0. The bar graphs show comparative data from 1988 and 1998 for six species selected to provide a range of responses. Several other species were compared but their data are not included in this proceedings. By comparing data from 1988 (pre-burning) to data from 1998, a general sense of a species' response may be interpreted. A fire effect can be conservatively recognized for a species for which the 1988 and 1998 means for the control remain similar, and the 1988 and 1998 means for 2 or 3 burn treatments are different. This graphical illustration is useful for identifying species which may respond to prescribed burns. However, more statistically rigorous analysis will be necessary to illuminate more subtle effects or effects confounded by variation. A final version of this study is forthcoming and will include such analyses.

Initial Observations

The graphical comparison of species means and standard errors in Figure 1 suggests several interesting effects of fire on vegetation. Firstly, the three native species presented showed a response to prescribed burns. *Camassia quamash* (Common camas) and *Eryngium integrifolia* (Coyote thistle) increased in frequency from 1988 to 1998 in response to fire. Alternatively, *Grindelia integrifolia* (Willamette Valley gumweed) declined in frequency from 1988 to 1998 in response to fire. *Camassia quamash* was an important food for native peoples and its positive response to fire is believed to be one of the reasons that native peoples burned prairies (Boyd 1986).

Alternatively, many species did not seem to be affected significantly by fires. For example, comparing means and standard errors for data from 1988 and 1998 for *Anthoxanthum odoratum* (Sweet vernal grass), a non-native species, indicates that the population has remained stable despite treatment. Other species have increased their populations [e.g. *Juncus marginatus* (Grass-leaf rush)] while some showed decreases in population sizes [e.g. *Holcus lanatus* (Common velvet grass)] despite the use of prescribed fires. It is interesting to note that *Juncus marginatus* was not present in transects during the 1988 study, but has spread throughout the study area at Rose Prairie. Although these three species are all non-native, this lack of discernible fire effect was common for both native and non-native species.

Several other species showed increases or decreases which may relate to burning, however, annual variations not associated to fire (e.g. climate) confound simple comparisons. It is anticipated that conducting more rigorous statistical analyses will be useful in dissociating fire effects from other effects.

These observations corroborate the findings of Pendergrass (1995) who found that although several species showed clearly discernible responses to fire treatments, most did not. This observation suggests several things.

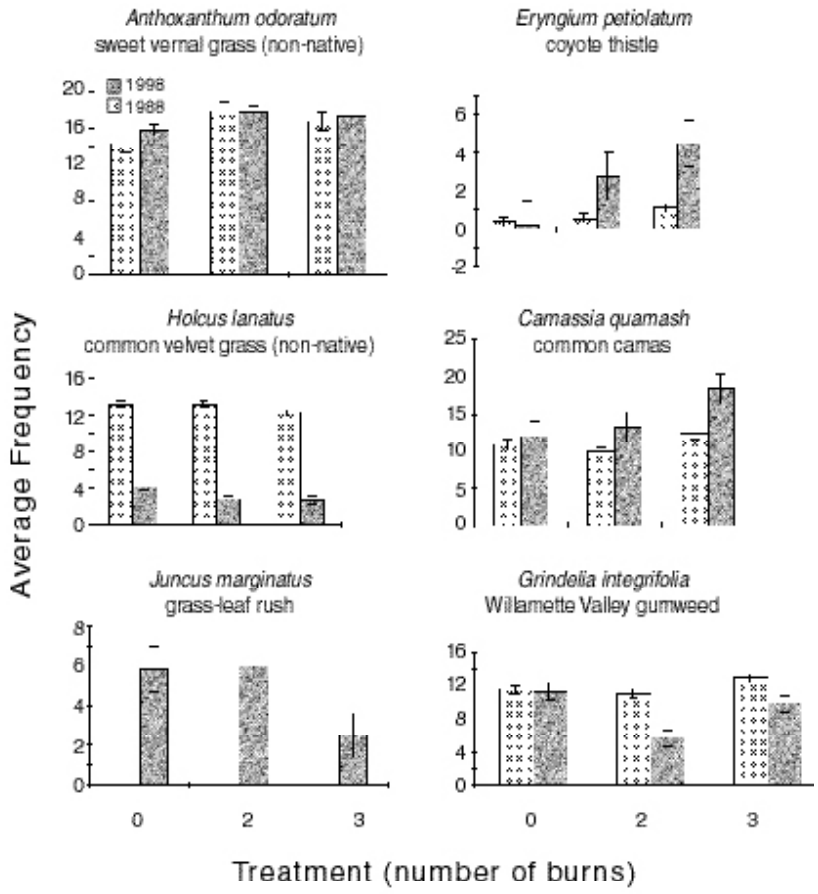

Figure 1. Average frequency and standard error bars for six species comparing 1988 data with 1998 data. Bars on right (mottled) represent data from 1998, and bars on the left (speckled) represent data from 1988. Treatments identified include 0 burns (control), 2 burns (1988 & 1991), and 3 burns (1988, 1989, & 1991). Note all 1988 data was collected prior to treatment. A fire effect is likely for species for which the means and standard errors for the control overlap and means and standard errors for 2 or 3 burn treatments do not overlap. Juncus marginatus *data is from Rose Prairie only.*

First, although fire is an important disturbance in this system, other biotic and abiotic factors play significant roles in population dynamics. Fire alone, may not be a "magic bullet" for the restoration of the native prairie plant community. Other biotic and abiotic considerations will need to be integrated into a restoration plan.

Second, the fire regime studied, which involved three fires initiated in 1988, 1989, and 1990, may not have been sufficient to discernibly alter species composition at these sites. A community shift related to prescribed fire may require a long term commitment to the reintroduction of fire as a land management tool. Furthermore, it is important to note that this study emphasized the longer term impacts of prescribed fires in order to evaluate the recovery of the prairie after fires initiated in 1988, 1989, and 1990.) Other studies have suggested that wetland prairie ecosystems show resilience to disturbance (Frenkel and Streatfield 1997, Pendergrass 1995). Thus, short term fire induced population responses may be dampened over time and may not be illuminated through this study.

Finally, it is likely that a different fire regime would induce different responses. This hypothesis is corroborated by research at the Willow Creek Nature Conservancy and Finley Wildlife Reserve, in which annual prescribed fires contributed to increased dominance of annual species (both native and non-native) and decreased dominance of perennial species (E. R. Alverson, field ecologist, The Nature Conservancy, Eugene Public Works Division, Eugene, OR. Personal communication.). Alternatively, longer intervals between fires (i.e. 3-5 years) may provide a disturbance regime, which allows perennial species to become established. Pendergrass et al. (1998) predict that repeated prescribed burns could be useful at controlling and reducing the spread of woody vegetation, but that long intervals between burns would allow woody vegetation establishment. Thus, effects on vegetation may vary depending on method and frequency of prescribed burns.

Conclusions/ Recommendations

These observations suggest that restoration goals associated with using prescribed fires will need to be explicit. For example, burning areas annually may enhance conditions for annual species as noted at the Willow Creek Nature Conservancy and Finley Wildlife Reserve, but may exclude

perennial species. Accordingly, different effects may be induced through different burning regimes and it will be important to identify the specific objective of burning prescriptions. It is unlikely that the three fires conducted as part of this study will be sufficient to reestablish the desired balance between native and non-native species, and it is likely that future burns will be required.

Additionally, it is important to consider that abiotic factors, other than fire, will have influential impacts on species frequencies. Changes to hydrology, climatic fluctuations, ecosystem connectivity, disturbance patterns, and other changes over the past 140 years have affected the biotic community in important ways. Thus, it is unlikely that reapplying historical fire regimes exclusively will restore native plant communities to desired conditions. However, prescribed burns will be a useful tool for land managers interested in restoration of native wetland prairie vegetation, especially when used in conjunction with other management efforts.

Finally, proceeding this conference additional analyses will be conducted on data generated from this study to determine more conclusively if above noted observations remain statistically reliable. Results will be published in 1999 as part of my thesis for the University of Oregon.

Acknowledgments

Thanks to M. Griffin, C. Hoffman, J. Rahn, and V. Winston for field assistance and J. Koenig and D. Predeek for assistance with plant identification. Thanks also to K. Pendergrass and R. Hayes for laying the groundwork and to my wife Kristen for all her support and encouragement. Financial assistance for this project was provided in part by the Emerald Chapter of the Native Plant Society of Oregon.

References

Acker, S. A. 1986. Analysis of experimental tree burning at the Willow Creek Preserve, Lane County, Oregon. The Nature Conservancy, Portland, Oregon. Unpublished report.

Alverson, E. R. 1995. Justification for Fire Management of Willamette Valley Prairies. The Nature Conservancy, Portland, Oregon. Unpublished report.

Boyd R. 1986. strategies of Indian burning in the Willamette Valley. Canadian Journal of Anthropology. 5:65-85.

Christy, J. A. and E. R. Alverson. 1994. Saving the valley's wet prairie. The Nature Conservancy - Oregon Chapter Newsletter, Portland, Oregon.

Frenkel, R. E. and E. R. Heinitz. 1987. Composition and structure of Oregon ash (*Fraxinus latifolia*) forest in William L. Finley National Wildlife Refuge, Oregon. Northwest Science 61:203-212.

Habeck, R. J. 1961. The original vegetation of the mid-Willamette Valley, Oregon. Northwest Science 35(2): 65-77.

Johannessen, C. L., W. A. Davenport, A. Millet, and S. McWilliams. 1971. The vegetation of the Willamette Valley. Association of American Geography Annals 61:286-302.

Pendergrass K. L. 1995. Vegetation composition and response to fire of native Willamette Valley wetland prairies. Thesis. Oregon State University, Corvallis, Oregon.

Pendergrass K. L., P. M. Miller, and J. B. Kauffman. 1998. Prescribed fire and the response of woody species in Willamette Valley wetland prairies. Restoration Ecology 6(3):303-311.

Sprague, F. L. and H. P. Hansen. 1946. Forest succession in the McDonald Forest, Willamette Valley, Oregon. Northwest Science 20:89-98.

Streatfield R. A. and R. E. Frenkel. 1997. Ecological survey and interpretation of the Willamette Floodplain Research Natural Area, Finley National Area, W. L. Finley National Wildlife Refuge, Oregon, USA. Natural Areas Journal 17(4): 346-354.