ATTACHMENT D

USE OF CONTROLLED ECOLOGICAL BURNS IN WILLAMETTE VALLEY NATIVE PRAIRIES

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May 2011

Controlled ecological burning involves the controlled use of fire as a management tool in natural areas. Scientists have been using controlled burns throughout the Willamette Valley to meet natural area conservation objectives and habitat restoration goals. The purpose of this paper is to provide historical background and ecological information to better understand why controlled ecological burns are considered to be so essential to natural area management in the Willamette Valley.

1. Natural History and Role of Fire in the Willamette Valley

The first explorers and settlers who arrived in the Willamette Valley in the early 1800's described the Willamette Valley as supporting extensive areas of prairie and oak savanna. Land surveys conducted by the General Land Office of the US Government in the 1850's documented that about 1 million acres of the Willamette Valley were prairie lands at that time (Christy and Alverson, in press). These native prairie and oak habitats have been greatly reduced in extent due to agriculture, grazing of domestic livestock, residential and urban development, and expansion of forest vegetation into former prairies. Only small remnants of high quality native prairie and savanna are known to currently exist in the Willamette Valley at present. The exact number of remaining acres has not been documented, but the reduction from the original extent has been estimated to be close to 98%.

The exact details of how the prairies and savannas originally became established are uncertain. The prairies may have become established during a time when the climate was warmer and drier than today (Hansen 1942, Walsh et al. 2010). At present, the climate of the Willamette Valley is sufficiently cool and moist to support forest vegetation on most sites in the absence of disturbance, but prairie or savanna may have been the "climax" vegetation at an earlier time when the climate was warmer and drier than today.

However, there is some evidence that the extensive prairies and savannas were maintained, if not actually created, by fires set by Native Americans. Studies documenting pollen deposits in the Willamette Valley since the end of the ice age has shown a positive correlation between increases in grass pollen and increases in charcoal contained in the sediments at certain times in the past (Walsh et al. 2010). This suggests the possibility that prairies and savannas may have been created or maintained by human-set fires, since the incidence of lightning-caused fires in the Willamette Valley is generally low. More studies are needed to provide greater understanding of how prairies

and savannas came to dominate the Willamette Valley in prehistoric times, but many researchers today believe that fire played a significant role.

The Kalapuya Indians had abundant motivation to use fire in the landscape (Boyd, 1999). Because of the falls on the Willamette River at Oregon City, the Willamette was not a major salmon stream, and the Kalapuya did not utilize salmon to the extent that tribes along the Columbia River did. Instead, the Kalapuya hunted game such as deer and elk, and gathered food plants from the native flora. The prairies provided the majority of their food plants, including camas (*Camassia* spp.) bulbs, yampah (*Perideridia* spp.) roots, and tarweed (*Madia* spp.) seeds. Though they were not farmers in the conventional sense, they used fire to maintain habitats for valued food plants just as a farmer tills and plants a field to produce a crop. In addition, they may have found fire useful in hunting game, by attracting animals to browse on the fresh green growth that emerges soon after a fire. During the millennia that the Kalapuya people (presumably) subjected the Willamette Valley to fires, a diverse flora and fauna evolved that had appropriate adaptations to avoid, withstand, or even become dependent on fire to maintain suitable habitats. In some cases, these were animal and plant species occurring nowhere else in the world except the Willamette Valley.

Thus it was a "natural" landscape shaped (most likely) by human-set fires that the first explorers and settlers encountered in the early 1800's (Habeck 1961, Johannessen et al. 1970, Towle 1974). Morris (1934), Johannessen (1971) and Boyd (1986) document this practice through reviews of the early explorers and missionaries journals (David Douglas-1826, John Work-1834, C. Wilkes1845, B. Hines-1881, etc.). These records report that fires were set annually in late summer and early fall, and covered extensive portions of the Willamette Valley. The main difficulty with the historic record is that it does not clearly describe how often presettlement fires returned to any given location, and that is a pertinent question that cannot necessarily be determined from the historical record (Whitlock and Knox, 2002).

Drastic population declines resulting from introduced diseases, and ultimately, the removal of the Kalapuya Indians to the Grand Ronde Reservation halted wide scale burning in the Willamette Valley in the 1830's and 1840's. Without fire, wet prairies that have been left undisturbed have in many cases gradually changed into ash forests, while the drier prairies and savannas have succeed to oak woodlands and maple and Douglas-fir forests.

2. Fire Effects

Having established that fires likely were a significant feature of the presettlement landscape, scientists began developing hypotheses regarding the specific roles that fire plays in maintaining prairie habitats. Historical analyses of vegetation change at individual sites led to the development of a number of hypotheses, including:

1) Fires occurring at frequent intervals maintained open prairie habitats and prevented colonization of trees and shrubs on sites where they would be able to occur if fire was excluded;

2) Many herbaceous prairie species possess tolerance or even adaptation to fire as a frequent influence; and

3) Some non-native plant species, particularly those coming from regions where fires do not occur, are negatively affected by fire.

Thus, implementing controlled ecological burns could potentially reduce cover of invading woody plants, enhance the populations of native plant species, and help reduce the abundance of some undesirable non-native plants.

Experience with controlled burning in native prairies began in the 1970's at Finley National Wildlife Refuge, and continued in the 1980's on land at Fern Ridge Reservoir owned by the US Army Corps of Engineers, and at The Nature Conservancy's Willow Creek Natural Area. Ten controlled burns, typically covering 10 to 50 acres, have been conducted in the wet prairie habitats at Willow Creek, in 1986, 1987, 1991, 1994, 1996, 1998, 2001, 2005, 2007, and 2009. Over the past 15 years, additional controlled burns have occurred on BLM lands in 1996, 1998, 2000, 2005, and 2009, and on City of Eugene land in 2002, 2007, and 2008. In general, the results of the burns have supported the hypotheses listed above. Typically, new green growth begins to sprout within two weeks after the burn; species such as tufted hairgrass, the dominant native grass in wet prairies, grow more vigorously through the fall and winter than in unburned areas. The following year, and often the following two years, see increases in the flowering and seed production of many native prairie plants.

With increased flowering and seed production, the fire adapted species may gradually increase in population size. For example, a study of the State and Federal listed endangered Bradshaw's lomatium (*Lomatium bradshawii*) found that within two years of a fire the populations showed an increase in density of vegetative and reproductive plants (Pendergrass et al., 1999). At Willow Creek, monitoring data consistently show native species that were used as food plants by Kalapuya people such as camas (*Camassia quamash*), wild onion (*Allium amplectens*), and yampah (*Perideridia* spp.) increase in abundance in the year following woody vegetation removal or controlled burns (Jancaitis 2001). This is consistent with research at Fern Ridge Reservoir where camas (*Camassia quamash*), and tarweed (*Madia glomerata*), two species used by Kalapuya people, increased in abundance after repeated burning (Taylor 1999, Pendergrass 1995).

From 2001 to 2007, The Nature Conservancy collected data for an experiment designed to compare the response of wet prairie species to burning and mowing. Burn and mow treatments were implemented twice through the duration of the study, in 2001 and 2005. For both, burn and mow treatments, more "desirable" species responses (increases in a native species or decreases in non-native species) were recorded. However, 15 species showed a desirable treatment response from burning, while only 8 species showed a desirable treatment response from mowing. The higher

level of desirable responses from the burn treatments suggests that fire is a critical management tool in wet prairie, at least in higher quality native remnants (Nuckols et al., in press).

While late summer mowing is a useful management treatment for holding back vegetative succession, we have observed stronger effects of fire on woody vegetation than from mowing. While most woody plants (except for conifers) readily sprout after mowing or burning, we have observed that controlled ecological burns are successful in killing a small percentage of trees and shrubs outright. After repeated controlled burns, tree stumps become sufficiently damaged that a percentage are completely consumed by fire, resulting in an end to additional sprout production. In the last few years at Willow Creek, manual removal of woody plants has been implemented in conjunction with controlled burns, to help speed progress toward achieving site management goals.

Burning also appears to reduce the use of prairie habitats by meadow voles, which are small rodents that eat vegetation. During peak years of vole abundance (such as in 2001 and 2005), they can have substantial negative impacts on native prairie communities because of their herbivory (grazing) of native prairie plants.

We still have much to learn about fire effects in Willamette Valley prairies. The response of prairie species to management treatments such as fire or mowing are complex and may vary from year to year depending upon a variety of environmental factors, from fire behavior to precipitation patterns. As we continue to implement controlled burns, long term monitoring and data collection efforts will be a key to helping us improve our prairie management strategies as well as refine our restoration priorities.

3. Benefits and Potential Drawbacks to Controlled Ecological Burns

Reviewing the landscape history of the Willamette Valley provides the perspective that fire has been an important component of the "natural" ecosystem for thousands of years, and monitoring data for recent controlled burns supports the idea that many native prairie plants benefit from such fires. One of the reasons herbaceous prairie plants benefit from fire is because the fires that burn in these prairies are of low intensity and are of short duration. During a low intensity controlled burn, the dried leaf litter is consumed, but the meristems (growing points) of the plants are left unharmed, protected in the crown of the plant or buried underground. The precise reasons for the benefits of fire are not fully understood, but a variety of mechanisms have been proposed. For some species, seeds may lie dormant in the soil until the heat from a fire breaks the seed coat and stimulates germination. The burning of leaf litter that occurs during a fire releases nutrients and makes them available to plants when they otherwise would not be, providing a sort of fertilizer effect. When the leaf litter is burned, the bare soil that is left behind may be a better microenvironment for germination of seeds of native prairie plants, due to increased light and better contact with the soil. Other biological functions, such as soil microbial activity, may also be stimulated by fire.

Of course, fires can have negative effects as well. Most animals are able to move out of the way of typical prairie fires, and we have observed only a minor amount of vertebrate wildlife mortality (small numbers of dead garter snakes) in previous controlled burns in West Eugene. Invertebrates, especially those that are present in the leaf litter, may be more subject to mortality by controlled burns, but their populations can usually persist if some areas of habitat are always left unburned. Because of this possibility, The Nature Conservancy burns more no more than 1/3 of the habitat of the endangered Fender's blue butterfly at Willow Creek in any one year.

Controlled ecological burns will always need to be treated with caution because of the potential for fire to spread beyond the burn unit. Safety is always the paramount consideration, and it is incumbent upon the burn boss to ensure that a controlled burn is conducted under appropriate conditions. Fire managers use computer models to predict fire behavior given certain site conditions, and under specific weather conditions. These models are used to determine the appropriate range of temperatures, humidity, and wind speed under which a burn can be safely conducted. For each controlled burn, a burn plan is prepared that states the conditions under which the controlled burn can be safely carried out, and if those conditions are not met, the burn is postponed until a later date. The burn plan also specifies the crew and equipment needed, and the pattern by which ignition will occur. Safety is also bolstered by providing appropriate fire breaks that are mowed or plowed around the burn unit to help contain the fire within the desired area

The main drawback of controlled ecological burns from the point of the general public is the smoke that is generated. While a controlled burn may resemble a grass field burn, the amount of smoke produced by a controlled burn in a native prairie is much less than a burn of an equal area of grass seed field. This is because the amount of fuel present in a grass seed field is 2 to 4 times greater per unit area than in a native prairie. Controlled burns in Eugene are only conducted when the prevailing wind blows the smoke away from the populated urban areas, and under atmospheric conditions that provide for the most efficient dispersal of smoke. Weather conditions are monitored continuously during a burn to ensure prevailing winds remain appropriate during the entire ignition period. Similarly, burn units are typically smaller than grass seed fields which mean that the actual length of time during which the burns occur is quite short and the amount of fuel burned during an event is generally less than typical grass seed field burns.

4. Alternatives to Controlled Ecological Burns

A number of alternatives to controlled ecological burning have been proposed, but none appear to provide all of the ecological benefits of fire. Mowing can inhibit the growth of woody plants and maintain the open prairie aspect. Mowing also may improve habitat for some of the rare prairie species, if it is done at the proper time of year. For example, the Bradshaw's lomatium population in Amazon Park has greatly increased in size over the past 15 years since the first mowing has been delayed until the plants have finished growth and the seeds have matured. At the plant community level, as noted above, mowing was found to provide ecological benefits in wet prairie, but not as extensive as the benefits of controlled burns.

However, mowing large acreages can be expensive, and wet prairies typically have a very irregular surface with numerous divots, hummocks, and ant mounds that make equipment operation difficult. Mowing may promote the growth of invasive non-native grasses such as tall fescue (*Festuca arundinacea*). Mowing also does not provide the nutrient cycling benefits or microhabitats suitable for seedling germination that fire provides.

Manual labor can be used to remove woody plants that have invaded prairie habitats. In fact, at Willow Creek we have determined that manual removal is necessary to achieve our management goals because the ash and pear trees are too well established to be removed by fires occurring on a 2 to 5 year interval. Removal of woody plants also reduces the amount of fuel that the fire could consume, and reduces the smoke that is produced by controlled burns. However, once the woody plants are removed, fire plays a useful role by killing back any seedlings or stump sprouts that may emerge.

Using heavy equipment to remove woody plants is an undesirable option in native prairie remnants, because the soil disturbance would damage existing vegetation and likely allow invasive non-native species to increase. Using manual labor to remove woody vegetation causes less damage to the existing herbaceous cover, but is generally more expensive.

It may be possible to use tractor-mounted propane torches to achieve some of the ecological benefits of controlled burns in sites that are especially smoke-sensitive. However, the same problems with negotiating the divots, hummocks, and ant mounds mentioned above under mowing are pertinent here.

5. Summary and Conclusions

The Willamette Valley has an interesting history of interactions between human populations and the natural landscape, of which fire was a significant component. Controlled ecological burning is viewed by scientists and land managers as an important tool for ensuring that this natural legacy is passed on to future generations. Some type of active management of these native prairie sites is necessary to maintain open habitat conditions and keep out woody plants, and fire is the most natural means to achieve these ends. Without controlled burning, we will find it to be both more difficult and more expensive to maintain remaining high quality native prairie sites. Although controlled burns may result in some localized, short term inconveniences to the public, our experience as land managers indicates that the overall benefits, both to the general public and to the natural habitats, outweigh the inconveniences involved.

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