Management of Tall Oatgrass
Arrhenatherum elatius
in Willamette Valley Prairies:
Preliminary Report

A component of the project
Restoration and Vegetation Management of
Fender's Blue Butterfly Habitats

Prepared by

Deborah L. Clark

and

Mark. V. Wilson

Department of Botany and Plant Pathology

Oregon State University

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SUMMARY

Native prairies, which once dominated the landscape of the Willamette Valley, are considered among the rarest of Oregon's ecosystems. Even though only remnants remain today, they harbor rare and endangered species such as the Fender's blue butterfly (*Icaricia icariodes fenderi*) and its preferred host plant, Kincaid's lupine (*Lupinus sulphureus* ssp. *Kincaidii*).

Invasion of weedy non-native species in the remnant prairies is of great concern to agencies and managers responsible for conserving these native ecosystems. This report focuses on control of *Arrhenatherum elatius* (tall oatgrass), one of the more important noxious weeds threatening Fender's blue butterfly habitat. The first section covers the basic biology of tall oatgrass and then reviews potential control methods. The final section summarizes preliminary recommendations for controlling tall oatgrass in Willamette Valley prairies. Evidence to date suggests that mowing is the optimal choice for both controlling existing stands of tall oatgrass and preventing spread by seed dispersal.

INTRODUCTION

Willamette Valley native prairies

Native prairies, remarkable for their biodiversity, once dominated the landscape of the Willamette Valley. Before the mid-1800's the Kalapuya, indigenous people of the Willamette Valley, maintained the open grassy nature of the valley by setting annual fires to facilitate hunting and gathering of food plants (Boyd 1986, Boag 1992). These fires reduced the abundance of shrubs and trees, favored the abundance of grasses, and promoted a rich variety of native forbs.

The original valley grasslands can be separated into two broad types: wetland prairie and upland prairie. Wetland prairies, often characterized by an abundance of *Deschampsia cespitosa* (tufted hairgrass), occur on bottomlands with poorly drained soils, and generally experience winter flooding or ponding (Finley 1994). The upland prairies, in contrast, have well-drained soils and are characterized by a mix of native bunchgrasses, including *Festuca idahoensis* var. *roemeri* (Franklin and Dyrness 1973).

Presently, however, these prairies are considered among the rarest of Oregon's ecosystems (ONHP 1983). They are highly fragmented and in critical need of conservation. For example, only 47 native upland prairies remain in the Willamette Valley with only five of these sites containing relatively large areas of high or very high quality prairies (Wilson 1996).

Historically, urbanization and agricultural activities destroyed these native prairies; these threats are also prominent today (Hammond and Wilson 1993). Most of the few unplowed, ungrazed, and undeveloped remnants are now threatened by succession to shrublands and forest. Most Willamette Valley prairies are seral communities that have been maintained by fire or other human activities (Franklin and Dyrness 1973). Since the arrival of settlers in the mid-1800's, large-scale fires have been prevented, allowing the encroachment of trees and shrubs onto the prairies (Habeck 1961, Johannessen et al. 1971, Towle 1982).

Additionally, invasion of non-native pest species threaten these remnant prairies. Euro-american settlers introduced many new plants to the Willamette Valley, many of which spread rapidly and becoming dominant in native prairies to the detriment of the native species. As early as 1919, about half of the grass species near Salem were introduced (Nelson 1919).

Fender's blue butterfly, *Icaricia icariodes fenderi*

Even though only remnant prairies remain today, they harbor rare and endangered species, several of which are endemic to the Willamette Valley, such as the Fender's blue butterfly, *Icaricia icariodes fenderi*, a Federal Category 2 Candidate species (Hammond and Wilson 1993) and the Willamette daisy, *Erigeron decumbens* var. *decumbens* (Clark et al. 1993).

Native upland grasslands support the largest populations of Fender's blue butterfly (*Icaricia icariodes fenderi*) and its preferred host plant, Kincaid's lupine (*Lupinus sulphureus* ssp. *Kincaidii*). These remnant grasslands supply the butterfly with food plants, egg-laying sites, and proper flight conditions. The grasslands supply the lupine with essential light and nutrient resources and proper growing conditions. To a large extent, the recovery of the Fender's blue butterfly relies on the protection and restoration of these native grasslands (Wilson et al. 1992).

Pest plants dominance by such species such as *Arrhenatherum elatius* (tall oatgrass) is a threat because exotic plants suppress the native vegetation, including Kincaid's lupine and plants that supply nectar for Fender's blue butterfly adults. The tall foliage of the pest plants shades many native species, and their extensive root systems can out compete native species for nutrients and water. The tall foliage of both pest herbaceous plants and woody plants also shades the flight paths of the Fender's blue butterfly, slowing its activities, which probably lowers its feeding and reproductive rates. For example, Fender's blue female will lay fewer eggs on Kincaid's lupine plants in the shade (P.C. Hammond, pers comm.).

This invasion of weedy non-native species is of great concern to agencies and managers responsible for conserving these remnant prairies and the rare endangered species contained within. Hammond and Wilson (1993) report that aggressive herbaceous weeds are a threat to 7 of 13 Fender's blue butterfly sites. Five plant species were identified by Wilson (1994) as major pest plants threatening the Fender's blue butterfly and its grassland habitat. This list arose from observations of their abundance and role at Fender's blue butterfly sites, experience with plants at other grassland sites, the advice of Paul Hammond, and the information provided by Hammond and Wilson (1993). The five major pest plants listed are *Arrhenatherum elatius* (tall oatgrass), *Cytisus scoparius* (Scots broom), *Pseudotsuga menziesii* (Douglas-fir), *Pteridium aquilinum* (bracken fern), and *Rosa* spp. (rose).

This report focuses on control of *Arrhenatherum elatius*. The first section summarizes the biology of tall oatgrass and then reviews potential control methods. The final section makes recommendations for controlling tall oatgrass in Willamette Valley prairies.

CONTROL METHODS FOR TALL OATGRASS

Biology of *Arrhenatherum elatius* (tall oatgrass)

Arrhenatherum elatius is a perennial grass native to Eurasia but widely introduced throughout western North America, New Zealand and Australia (Pfitzenmeyer 1962). It is a tall (up to 180 cm), usually erect, tussock-forming perennial grass with very short rhizomes (Pfitzenmeyer 1962). Two types exist in the Willamette Valley, a non-bulbous form and a bulbous form (var. *bulbosum*), which is characterized by corms, forming a group of four to five stacked up on top of another (Tanphiphat and Appleby 1990a).

In its native habitat in the British Isles, tall oatgrass is most commonly found on well-aerated, moderately deep neutral or near neutral soils of high to moderate fertility. Features such as erect tall stature, high growth rates, fast tissue turnover, and rapid allocation of photosynthate after clipping promote the dominance of tall oatgrass on high fertility sites, but these features are believed to adversely affect the competitive ability on nutrient poor grasslands (Berendse et al. 1992, Schlaepfer and Ryser 1996, Vazquez De Aldana et al. 1996, Ryser and Notz 1996).

Caryopses are produced annually from the first year of germination (Pfitzenmeyer 1962). Each mature plant produces 25-30 panicles each with 50-100 spikelets and one caryopsis per spiklet, which readily shed at maturity (Pfitzenmeyer 1962). The seeds have no innate dormancy (Pfitzenmeyer 1962, Tanphiphat and Appleby 1990a, Maret 1996), apparently not forming a persistent seedbank (Wilson and Maret, unpublished data 1996). Germination rates vary with temperature, with germination better at 8C and 15C than at 25C; higher temperatures promote fungal attack (Pfitzenmeyer 1962).

Germination occurs entirely after the fall rains (Maret 1996); sprouts also appear on mature plants at this time (Tanphiphat and Appleby 1990a). Little growth of seedlings or sprouts occurs during the winter, but rapid growth occurs in the spring with senescence occurring during the summer drought (Tanphiphat and Appleby 1990a).

Vegetative regeneration is reported to be very important for the bulbous variety, but regeneration for other varieties is believed to be by seed alone (Pfitzenmeyer 1962). Tanphiphat and Appleby (1990a), who worked with the bulbosum variety found no seedling establishment by *A. elatius*. Field studies conducted at Carson Prairie, a remnant upland prairie in McDonald-Dunn Forest located near Corvallis, indicate that tall oatgrass proliferated little from seeds (Wilson and Maret, unpublished data 1996). The dominant type at this site is the non-bulbous variety. In contrast, tall oatgrass readily established from seed at Baskett Slough Wildlife Refuge (Wilson and Clark 1997a).

Criteria for control methods

A pest plant control method should have several important attributes in order to be suitable for application at Fender's blue butterfly sites. First, the methods should be effective at controlling abundance of existing populations of the pest plant and/or preventing the spread of the population at the site. Second, control methods should not promote other non-native pest plants and should optimally control their growth and spread. Third, control methods should not cause unacceptable harm to native plants or to other native species such as the Fender's blue butterfly. Finally, the method should be suitable for application at these sites, that is, the method should be inexpensive and safe.

Four general methods are considered in this section: burning, herbicide application, mowing, and biological control. Each is evaluated against the criteria for selecting preferred control methods.

Burning

Burning is a favored management tool in many of the native grasslands in the Willamette Valley. A prime reason for the use of prescribed fire is its ability to slow or prevent the invasion of woody plants during natural succession (Pendergrass 1996, Wilson and Clark 1996, 1997b, Clark and Wilson 1996, 1997). A second motivation for the use of fire in management is the historical role of fire in the Willamette Valley (Johannessen et al. 1971, Towle 1982, Boyd 1986). Returning the natural disturbance process of fire is thought to aid in habitat restoration.

One hundred years ago, reinstitution of periodic fire may have been sufficient to maintain these grasslands as native-dominated systems. Today, however, widespread invasion of exotic species, which can suppress abundance of native species, has significantly altered the remaining prairies. Moreover, strict smoke management regulations generally require managers to burn in early fall, which may not coincide with historical time of burning.

Although fire reduces woody plant cover, its effect on native herbaceous plants can sometimes be unclear or even detrimental (Magee 1986, Wilson and Ingersoll 1993, Macdonald 1993, Wilson et al. 1993, Wilson and Maret, unpublished data 1996, Clark and Wilson 1997). In other circumstances, prescribed fires can stimulate the growth of some native species (Connelly and Kauffman 1991, Wilson et al. 1993, Clark and Wilson 1997).

Another possible drawback to the use of fire is direct damage to native animals like the Fender's blue butterfly. At Baskett Slough National Wildlife Refuge almost no larvae of Fender's blue butterfly remained in the year following a fall prescribed burn (Wilson and Clark 1997b). Leaving a portion of the site unburned should overcome this disadvantage.

Limited data are available on the effect of fire specifically on *Arrhenatherum elatius*. At Carson Prairie, an upland prairie near Corvallis, seedling establishment of *A. elatius* was slightly less in burned seedbeds compared to unburned seedbeds (Maret 1996). However, seedlings in the burned seedbeds survived in greater numbers through the winter compared to seedlings in the unburned seedbeds (Maret 1996). A relatively thick litter layer strongly promoted *A. elatius* seedling emergence, while litter removal (without burning) was strongly associated low seedling emergence (Maret 1996). Because prescribed burning promoted the seedling establishment of other species, especially natives, without increasing *Arrhenatherum* seedlings, burning was recommended as an effective site treatment for improving the establishment of sowed seed into a prairie dominated by the *A. elatius* (Maret 1996). Burning created significantly more favorable microsites for another exotic species, *Hypochaeris radicata*, but establishment response for native species tested was generally much more dramatic than for the exotic species (Maret 1996).

Herbicide application

Herbicide use has the twin advantages of relatively low expense and relatively high effectiveness. Herbicides are often applied once; control methods like fire and mowing often require repeated application to effect pest plant control. The disadvantage is that herbicides may have side effects detrimental to non-target plants and animals. A decline in the number of Fender's blue larvae after application herbicide to control woody plants was possibly due to direct herbicide toxicity (Wilson and Clark 1997b).

Glyphosate is a nonselective herbicide used to control perennial weeds because of its rapid translocation and generally high phytotoxicity. The use of glyphosate for control of *A. elatius* var. *bulbosum* has produce inconsistent results (review by Tanphiphat and Appleby 1990b). When glyphosate was applied at the 4 -5 or 6-7 leaf stage of *A. elatius* grown under greenhouse conditions, glyphosate significantly reduced corm formation and viability, controlling bulbous oatgrass growth (Tanphiphat and Appleby 1990b). In addition, a 24-hour period between glyphosate application (at the rate of 2.5 kg per ha) and removal of shoots was sufficient to cause maximum reduction in regrowth (Tanphiphat and Appleby 1990b). Researchers and growers in western Oregon have observed, however, that infestations of the bulbous oatgrass usually reappear the year after glyphosate application (Tanphiphat and Appleby 1990b). Tanphiphat and Appleby (1990b) hypothesized that dormant corms without leaves may not accumulate a lethal dosage of glyphosate, leading to regrowth and persistence of *A. elatius* var. *bulbosum* as a pest.

Mowing

Mowing, like burning, is widely used for vegetation management in the Willamette Valley. Few studies, however, document the success or failure of mowing in controlling pest plants. Often mowing is done without consideration of timing or height of mowing. Differences in both heights and life-history timing between many pest plants and native herbaceous species provide opportunities for improving the effectiveness of mowing as a control technique while reducing its impact on favored plants and animals.

In its native habitat, *A. elatius* tolerates occasional mowing and in European hay meadows is often the dominant species (Pfitzenmeyer 1962). However, *A. elatius* does poorly at sites that are heavily grazed, such as pastures (Pfitzenmeyer 1962). On unshaded limestones scree on which tall oatgrass colonizes and is a dominant species, it will give way under grazing to *Festuca ovina* and *Festuca rubra* (Pfitzenmeyer 1962). Repeated cuttings decreases the persistency of most ecotypes (Rebischung et al. 1952 cited by Pfitzenmeyer 1962). Hewett (1985) reports that five years of mowing was necessary to control *A. elatius* var. *bulbosum*.

After three years of applying eight mowing regimes (different heights and times of mowing) to a degraded site dominated by *A. elatius* at Baskett Slough National Wildlife Refuge, the following three treatments were particularly effective at reducing cover of tall oatgrass, reducing cover of other non-native species, and increasing the cover of native species as compared to unmanipulated controls (Wilson and Clark 1997a):

- mowing at 10 cm - 15 cm in late spring
- mowing at 10 cm - 15 cm in early summer
- mowing at 10 cm - 15 cm in early fall

In addition, unmanipulated controls had the highest numbers of *A. elatius* seedlings and inflorescences, so mowing treatments also appeared to be slowing *A. elatius* regeneration (Wilson and Clark 1997a).

Of these treatments, mowing in early summer presents the best combination of biological effectiveness and suitability of application (Wilson and Clark 1997a). In areas with Kincaid's lupine and Fender's blue lupine, mowing should be delayed until July, after the flowering and flight seasons (Wilson and Clark 1997a).

Recovery of tall oatgrass may be slow after grazing or mowing too close to the ground because only a small number of basal axillary buds are available to regenerate new shoots (Pfitzenmeyer 1962). An alternative explanation for limited recovery is that in grasslands an important part of nutrients assimilated by plants is lost with removal of biomass by grazing or mowing (Berendse et al. 1992). Losses are particularly high with species such as tall oatgrass, which are characterized by high growth rates with fast tissue turnover, and rapid response of allocation upon clipping (Berendse et al. 1992, Schlaepfer and Ryser 1996, Vazquez De Aldana et al. 1996, Ryser and Notz 1996).

Biological control

Biological control is a widely used method for pest control. Successful biological control has the great advantage of requiring little maintenance. It has the disadvantage of high expense and complexity of development.

In the native habitat of tall oatgrass, several fungal pathogens of *A. elatius*, including rusts and bunts, have been identified (Pfitzenmeyer 1962, Ale-Agha 1995). Biological control using these fungal pathogens might prove to be inappropriate as they (e.g., *Claviceps purpurea*) are also pathogenic on important agricultural grasses of the Willamette Valley (e.g., *Dactylis glomerata* and *Festuca arundinacea*).

RECOMMENDATIONS FOR CONTROL OF TALL OATGRASS

Because of the potential lethal effects of herbicides on non-target native plants and on Fender's blue butterfly larvae, and because of the inconsistent results of herbicides in control of *A. elatius* var. *bulbosum*, herbicide application is not a top choice for tall oatgrass control. Limited use, however, on sites with no populations of Fender's blue butterfly and few native plant species could be considered.

Prescribed burning has several advantages: it appears not to promote the seedling establishment of *A. elatius*, although it promotes winter survival of seedlings. Burning could potentially control tall oatgrass in the same way as mowing does by removing biomass and additionally by increasing mortality of regenerative buds. Burning is also effective in preparing *A. elatius*-dominated sites for increased establishment of sowed seeds of native species. Unless burning, however, is initiated early in the summer, it will be ineffective in preventing seed dispersal and thus, spread of tall oatgrass. Moreover, burning has had mixed effects on survival and growth of other native species. So burning might a good choice to control tall oatgrass and establish new populations of native species at sites where few native species are present, but should be used with caution for sites that have a high proportion of native species.

At this time mowing is the optimal choice for both controlling existing stands of tall oatgrass and preventing seed dispersal. Mowing in early summer after the flowering of lupine and after the flight seasons of Fender's blue butterfly presents the best combination of reducing cover of tall oatgrass, reducing cover of other non-native species, and increasing the cover of native species (Wilson and Clark 1997a). It is also the most suitable time for application. A mowing program needs to continue for at least three to five years to get strong results (Hewett 1985, Wilson and Clark 1997a). These management recommendations should be considered tentative until long-term effects become clear from continuing research programs (Wilson and Clark 1995, 1996, 1997a).

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