Mowing, Mulching and Seeding to Control False-brome on the Eugene District, BLM, Oregon

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Status 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 whose mission is conservation of native ecosystems through restoration, 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.

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INTRODUCTION

False-brome (*Brachypodium sylvaticum* (Huds.) Beauv.) is an invasive perennial grass which is quickly spreading through the Pacific Northwest. It is listed by the Oregon Department of Agriculture as an invasive species (B List). New populations of the grass have recently been reported from San Mateo County, California and Beacon Rock State Park, Skamania County, Washington. The grass is designated as an A list species in California and is proposed as a Class A noxious weed for 2009 by the Washington State Noxious Weed Control Board. The earliest record of the species in North America is a 1939 collection from near Eugene in Lane County, Oregon. By 1966 the species grew in at least two large colonies in the Corvallis-Albany area of Benton County, Oregon, where it was apparently thoroughly naturalized (Chambers 1966). It is capable of completely dominating understory and open habitats to the exclusion of most other native species and its palatability to wildlife is very low. It appears to inhibit tree seedling establishment and may displace endangered species, such as Kincaid's lupine (*Lupinus sulphureus* ssp. *kincaidii* [C.P. Smith] L. Phillips), host plant for the endangered Fender's blue butterfly (*Icaricia icariodes fenderi* [Lycaenidae]) as well as the threatened roadside plant, wayside aster (*Eucephalus vialis* (Bradshaw)).

New populations of false-brome are being reported across western Oregon at a rapid rate. This species establishes in disturbed habitats as vehicles and equipment spread the seed to new areas. Since road systems are frequently disturbed, they serve both as a source of seed dispersal as well as likely locations for the establishment of new populations. We expect that false-brome expansion can be slowed by mowing the grass before it sets seed, covering the occupied sites with mulch, and establishing competitive native vegetation.

Past experiments have shown that mowing can halt seed production for one year, while mulching in combination with mowing may reduce false-brome abundance and seed production for periods of up to two years (Blakeley-Smith and Kaye, 2006). Although blue wildrye straw is an effective mulch that is available commercially, it is expensive. BLM has a large source of both cottonwood and Douglas-fir mulch that they wish to test as a roadside mulch to suppress weeds. It is unknown how effective these other sources of mulches are at preventing re-growth of false-brome. Additionally, establishing native vegetation on roadsides has been a difficult task due to compacted soil, availability of native seed, and the presence of aggressive introduced species. This project aims to develop effective control methods for false-brome with an emphasis on reducing spread of the species along roadways.

Roadside mowing is a proposed method to contain the spread of false-brome. There is potential to do more harm than good if mowing occurs too late in the season; when seed has matured mowing may spread this species. However, mowing too early in the season could be a waste of money since the species may re-sprout and produce seed later in the year. We established a second experiment that aims to determine the "window of opportunity" for mowing false-brome.

<u>Species Description</u>

Brachypodium sylvaticum has broad (4-10 mm) lax leaves, pubescence on at least the lower part of the culms and leaf margins (Hitchcock and Cronquist, 1973), and a long-lasting bright green color (i.e., it is still quite green in November). It differs from native perennial *Bromus* species in having sheaths open to the base and spikelets subsessile or short-pedicellate. In contrast, our perennial bromes have sheaths closed >1/4 of their length and their spikelets are generally strongly pedicellate.

<u>Geographic Range</u>

False-brome is a perennial grass native to Europe, Asia, and North Africa. The species has become well established locally in western Oregon and has recently spread to Washington and California. There is a major population center around the Corvallis area and another east of Jasper (5 miles southeast of Springfield). Within Oregon there are additional populations reaching as far south as Josephine County and as far north as Columbia County. There are a few coastal populations as well as at least one population reported from the east side of the Cascades at the headwaters of the Metolius River. In 2007 the first record for Washington was reported from the Hamilton Mountain trail, which is near Beacon Rock, a popular recreation area in the Columbia River Gorge. In California false-brome is limited to San Mateo County where it has been listed as an A-level noxious weed by the state of California and is being aggressively treated with hopes of eradication (CA Dept. of Food and Ag.).

<u>Habitat</u>

Brachypodium sylvaticum has an exceptionally broad ecological amplitude, occupying forest floor and open environments at elevations between 200 and 3,500 feet. Populations are known from riparian forests as well as upland hardwood and conifer forests under closed canopy. Vigorous populations also occupy forest edges and upland prairies in full sun. When invading an area, it may first disperse along roadsides or forest edges, then move out into undisturbed areas or clearcuts.

In the Willamette Valley, this species may occur with native perennial grasses such as *Bromus vulgaris* (Hook.) Shear, *Festuca subulata* Trin., and *Melica subulata* (Griseb.) Scrib. in forest understories, and *Elymus glaucus* Buckl., *Bromus carinatus* Hook. & Arn., *Danthonia californica* Boland., and *Festuca californica* Vasey, in open areas such as upland prairies and along forest edges. Other species that may be confused with *Brachypodium sylvaticum* include *Hierchloe odorata* (L.) Beauv., *Bromus vulgaris* (Hook.) Shear and *Holcus lanatus* (L.).

<u>Reproductive Biology</u>

False-brome is a caespitose perennial grass that regenerates mainly by seed, with little vegetative spread, except possibly under shaded conditions (Grime et al. 1988). In Europe, plants in shade may fail to flower or produce only a few seeds (as few as 30 seeds per tussock), whereas plants in sunny habitats tend to produce many seeds. Grime et al. (1988) report of one clump in an upland scree habitat that produced as many as 2700 seeds. Biologists in Europe report that the species does not maintain a persistent seed bank (Grime et al. 1988). However, this observation has not been confirmed for populations in North America. IAE and The Nature Conservancy initiated a study on seed longevity in 2003 in order to address this important question.

<u>Concerns</u>

Brachypodium impacts thousands of acres of land managed by the Eugene District, BLM. According to foresters false-brome competes with Douglas-fir seedlings for water, nutrients and light. Additionally, heavy thatch buildup of false-brome provides habitat for voles, who eat the cambium of newly planted Douglas-fir seedlings. The presence of false-brome also poses a serious threat to native plant species in different habitats, including prairie, deciduous forest and conifer woodlands. False-brome is found locally on the BLM Eugene District amongst populations of BLM Bureau Sensitive Species such as *Eucephalus vialis*, *Lathyrus holochlorus*, *Sidalcea campestris*, and *Sisyrinchium hitchcockii*. Additionally, high cover of false-brome results in the accumulation of dense thatch which can potentially alter fire regimes in western forests. The change in vegetation composition caused by false-brome could alter habitat for small mammals, native insects, reptiles, song birds and other wildlife. Based on its ability to grow in open and shaded conditions as well as its observed capacity to spread rapidly and form monotypic stands, there is good reason to expect that native vegetation is in jeopardy over large tracts of public and private lands due to false-brome invasion. We suspect that false-brome is spread by seed via vehicles, logging equipment, mowers, ATV's, animals and humans.

We chose techniques that do not include herbicides for the following three reasons: 1) herbicides may damage or eliminate non-target native species, 2) BLM has policies limiting their ability to use herbicides, making non-chemical treatments especially important on federal lands, and 3) mowing is commonly used to manage roadside vegetation and the results from these experiments will be useful to a wide audience.

Objectives and Research Questions

The purpose of this project is to develop effective non-herbicide control methods for false-brome, with an emphasis on reducing spread of the species along roadways via seed dispersal. We developed one experiment that evaluated the effectiveness of mowing, mulching, and seeding with native grasses to control false-brome. A second experiment assessed the window of opportunity for mowing false-brome. Results from these experiments may be used by land managers to reduce false-brome abundance along roadways and allow for the reestablishment of native plant communities. Invasive species control and revegetation is intertwined with controlling surface erosion, sedimentation, and roadside stabilization.

We asked four specific research questions:

1. How well do different types of mulches inhibit regrowth of false-brome?

2. How long does a single treatment last, or how frequently do treatments need to be reapplied?

3. Are the mulching and seeding treatments effective at establishing native blue wildrye (*Elymus glaucus*) and Columbia brome (*Bromus vulgaris*) as a competitive bio-barrier to false-brome?

4. Over what time period can false-brome be mowed to achieve effective reduction in false-brome seed production?

METHODS

Study site

Figure 1. BLM crew mowing the research plots.

This report contains information from two separate roadside experiments. The first experiment, started in 2007, focused on the efficacy of three different mulches. Experimental plots were installed on BLM Road 18-1-19.1 on the Eugene BLM, Willamette Resource Area (see driving directions, below). For this report, the site is referred to as the Little Fall Creek site.

The second experiment, started in 2008, aimed at finding the window for mowing false-brome. Experimental plots were installed on BLM Road 18-1-31. This site is referred to as the Fall Creek Reservoir site. The final site, also focusing on the timing of false-brome mowing, was established in the McDonald-Dunn Forest on OSU Road 600. This site is referred to as the McDunn Oak Creek site.

Driving Directions

Little Fall Creek site - T18S R1W section 19

From the town of Jasper (5 miles southeast of Springfield) drive south on Jasper Road. Turn left onto the Jasper-Lowell Road and continue to the end of the road (about 5 miles) which is marked by a Weyerhaeuser gate. Bring a BLM and Weyerhaeuser gate key. Pass through the gate and after a hundred yards you will reach the paved haul road. From this junction take gravel road 18-1-25 uphill to another locked gate. Continue uphill for about a mile until you reach a small gravel quarry. Turn right here and drive for just under a mile to a small overgrown spur road on the right 18-1-19.1. Park here. This is also the site of the old false-brome Waipuna trials.

Fall Creek Reservoir site - T18S R1E section 31

From the town of Lowell drive north on the Jasper-Lowell Rd (also North Moss Street) for about 2 miles. Just before the covered bridge, turn right on Winberry Creek Road and bear left on Big Fall Creek Road (crossing the river). Continue for 2.6 miles and look for BLM Road 18-1-31 on the left side of the road. Follow the gravel road for about half a mile. Just after passing a spur road on the right (BLM Road 18-1-31.3), look for labeled 5-foot metal pipes marking the plots on both sides of the main road.

McDunn Oak Creek site - T11S R5W section 17

From the town of Corvallis, drive west on NW Harrison Dr. until it turns into NW Oak Creek Rd. Continue driving on NW Oak Creek Rd until reaching a locked gate at the OSU McDonald-Dunn Forest. Pass through the locked gate and continue on Road 600 for about half a mile, until the intersection with OSU Road 670 on the right. The research plots are located in the prairie about 25 meters before the intersection with Road 607.

Plot Set-up and Treatment Description

Prior to implementing all of the treatments, ocular estimates of percent cover for all vascular plant species were made for each unit using a 1 x 0.5-m quadrat frame. In addition, the number of false-brome flowering stems were recorded in each 0.5-m^2 quadrat. Metal conduit pipes were labeled and painted red to mark the beginning and end of each group of plots. All plots were revisited in 2008 to record treatment responses.

Little Fall Creek site
The Little Fall Creek site consists of 40 treatment plots, which include eight replications for each of the five treatments. The plots begin on the south (right) side of the road about 75 m from the road junction. There are three groups of plots since the cover of false-brome was not continuous. A meter tape was stretched between two metal pipes to form one edge of the treatment units. Each treatment unit is 2 meters wide (parallel to the road) and at least 1.5-m deep (perpendicular to the road). The sampling plots were positioned 0.5-m below the meter tape, 0.75-m from adjacent treatment plots, and a variable distance from the road (see Figure 2). Each plot was randomly assigned one of five treatments (see Table 1). These treatments were: (1) Control. No mowing, mulching, but yes native grass seeding, (2) mowing, no mulching, but yes grass seeding, (3) mowing, cottonwood mulch, and grass seeding, (4) mowing, Douglas-fir mulch, and grass seeding, and (5) mowing, blue wildrye mulch, and grass seeding. On July 3, 2007 the plots were mowed by BLM using hand-held weed eaters (Figure 1). The operators attempted to mow all vegetation to about 2 inches above ground level. Mulch was then laid approximately two inches thick immediately after mowing was completed (see Figures 9 & 10). On December 11th, 2007 the plots were seeded with 0.16 oz. of *Elymus glaucus* and 0.16 oz. of *Bromus vulgaris*. This is equivalent to seeding at a rate of 20 pounds per acre, as recommended by the NRCS Plant Materials Center (Darris 2001; Darris 2007; Kingery et al. 2003). The plots were revisited and sampled on August 6, 2008.

Table 1. Mowing, mulching, and seeding treatment descriptions.

No.	Treatment description
1	Control. No mowing or mulching, but yes, native grass seeding
2	Mowing, no mulch, and native grass seeding
3	Mowing, cottonwood mulch, and native grass seeding
4	Mowing, Douglas-fir mulch, and native grass seeding
5	Mowing, blue wildrye mulch, and native grass seeding

Fall Creek Reservoir site

The Fall Creek Reservoir site consists of 37 treatment plots. Each treatment was replicated seven times, except the May mowing, which was replicated nine times (see table 4). The plots begin on the right side of the road about 150 meters past the junction with spur Road 31.3. There are three groups of plots since the cover of false-brome was not continuous. Attach a meter tape to the uphill post on the right-hand side of the road and stretch it to the final post at 58 meters. There is an additional post at the 22 meter mark where the road curves slightly. There are 23 plots contained in this group and 16 plots that are skipped due to low cover of false-brome. It is therefore very important to follow the meter marks on the data sheet to ensure sampling occurs at the right location. The second group of plots is located on the left side of the road. Attach the meter tape to the uphill post and stretch it to the next post at 10 meters (use the post closest to the road). The starting post for the next group of plots is adjacent to the end-post of the previous group, but is closer to the forest. Stretch the meter tape from this post to the end-post at 19.5 meters.

Each treatment unit is 1.5 meters wide (parallel to the road) and at least 1.5-m deep (perpendicular to the road). Due to space limitations, this treatment size is different from the Little Fall Creek site. The short end of the 0.5-m^2 quadrat frame was positioned along the meter tape, 0. 5-m from adjacent treatment plots, and a variable distance from the road (see Figure 3). Each plot was randomly assigned one of five treatments (Table 2). These treatments were: (1) Control. No mowing, (2) mowing on May 21st, 2008, (3) mowing on June 3rd, 2008, (4) mowing on June 16th, 2008, and (5) mowing on July 8th, 2008.

The plots were mowed by BLM using hand-held weed eaters. The operators attempted to mow all vegetation to about 2 inches above ground level. The plots were revisited and sampled on October 21st, 2008.

McDunn Oak Creek site

Plot establishment at the McDunn Oak Creek site is the most straightforward. There are a total of 25 plots in one continuous strip. Two metal rods and two fiberglass poles mark the starting and ending points to this group of plots. A meter tape was stretched 37.5 meters between the starting and ending posts. A second meter tape can be used to form the upper boarder of the plots. A buffer of about 1 meter was mowed around the experimental area to reduce the likelihood of seed rain. Each treatment unit was 1.5 meters wide and1 meter deep. The short end of the 0.5-m^2 quadrat frame was positioned along the meter tape, 0.5-m from adjacent treatment plots (see Figure 4). Each plot was randomly assigned one of four treatments (see Table 4). These treatments were: (1) Control (no mowing), (2) mowing on June 2rd, 2008, (3) mowing on June 18th, 2008, and (4) mowing on July 9th, 2008. Unlike the Fall Creek Reservoir site, there was no May mowing treatment. The plots were mowed two inches above the ground by IAE staff using hand-held weed eaters. The plots were revisited and sampled on November 7th, 2008.

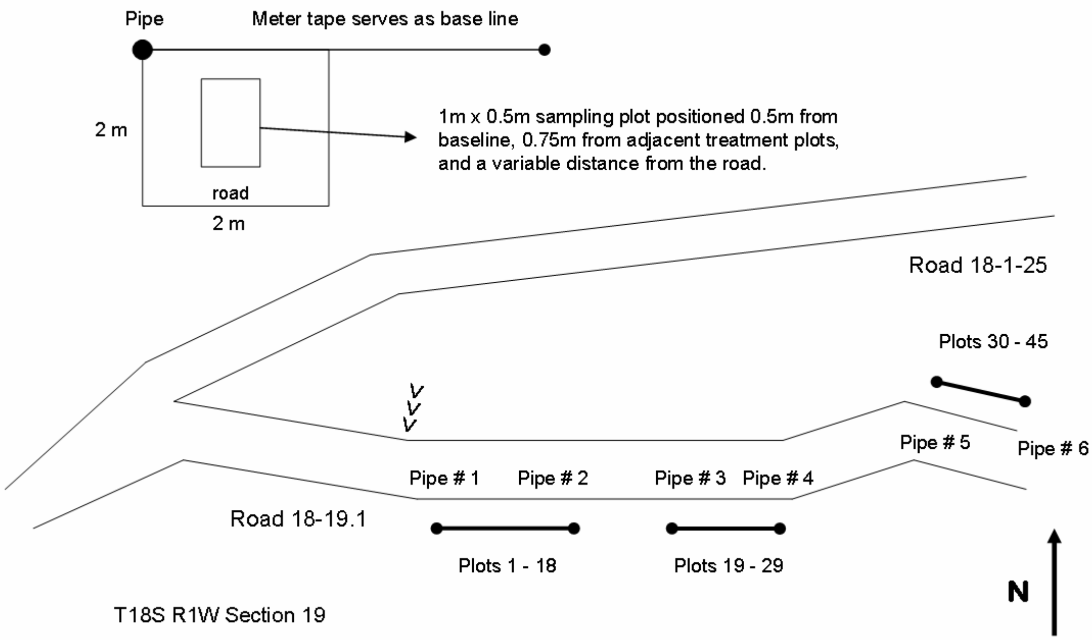

Figure 2. Plot setup for the 2007 mowing, mulching, and native grass seeding experiment at the Little Fall Creek site.

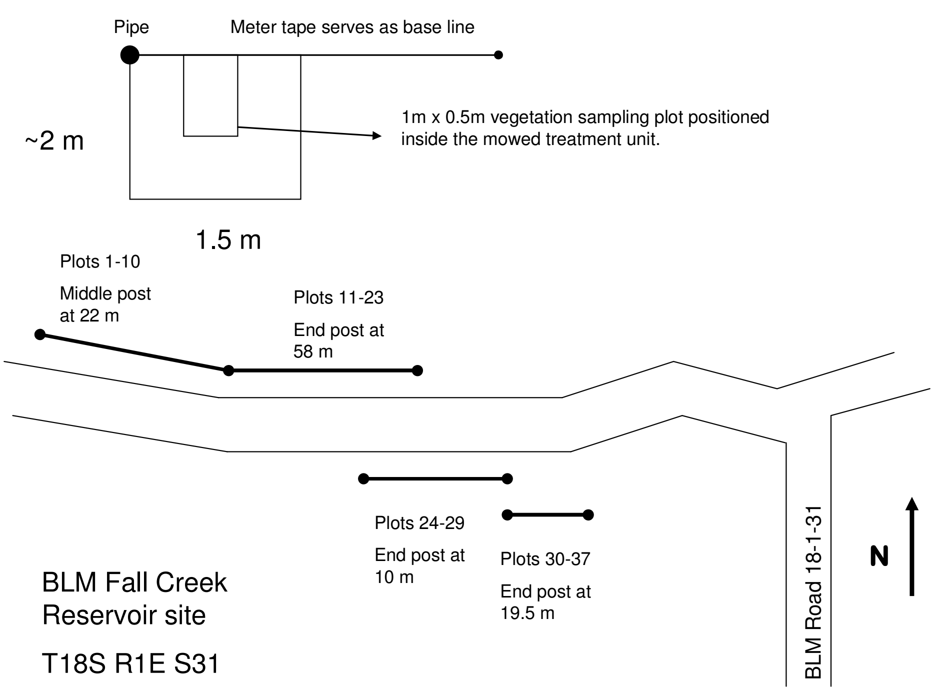

Figure 3. Map of experimental mow units established in 2008 at the Fall Creek Reservoir site.

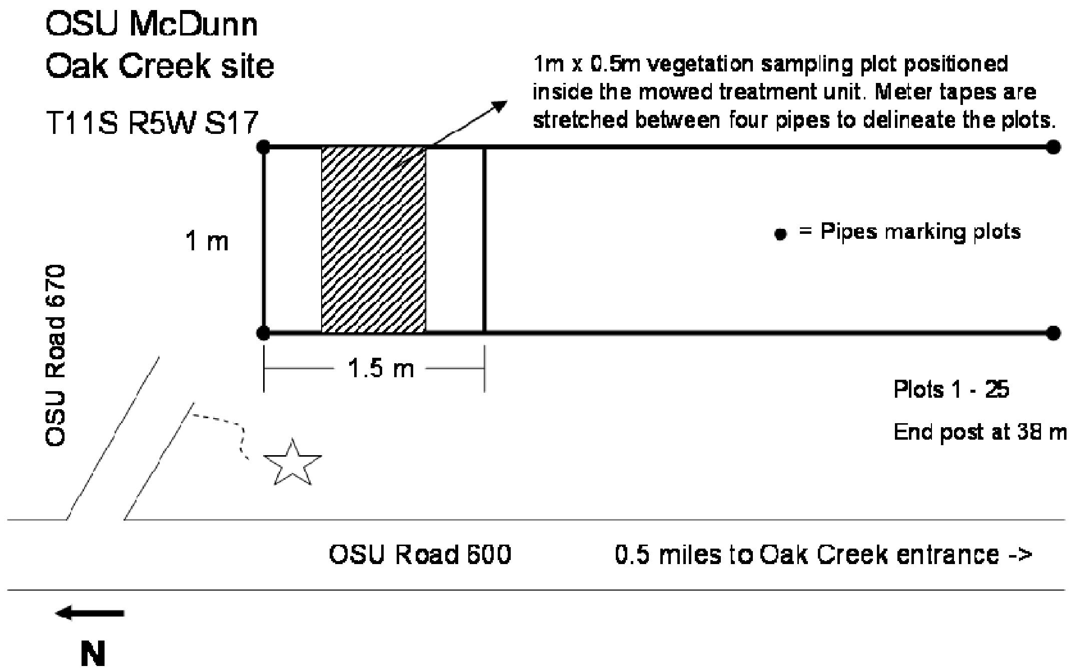

Figure 4. Map of the 2008 mowing experimental units in the OSU McDonald-Dunn Forest.

ANALYSIS

Percent cover and number of flowering stems of false-brome were recorded prior to treatment and one year following treatment. Analysis of variance was used to test whether there was a difference in the starting condition of all of the plots for both variables. A Dunnett's procedure was included in the analysis to incorporate the correct amount of error when multiple comparisons were made to the reference plots. The LSD adjustment was used when multiple comparisons were made without concern for the reference plots. Means are presented and their corresponding lower and upper 95 % confidence intervals are listed in parenthesis. All analyses were performed using SAS statistical software version 9.2.

RESULTS and DISCUSSION

1. How well do different types of mulches inhibit regrowth of false-brome?

Prior to implementation of the mowing and mulching treatments there was no significant difference in false-brome cover (p=0.25) between all of the treatment plots. Flowering stems could not be recorded preceding the treatment since the plants were mowed prior to flowering.

There was a dramatic reduction in percent cover of false-brome one year after mowing and mulching (p<0.0001). Control plots averaged 67.5% (95% CI: 59.3 to 75.7), plots that were mowed but not mulched averaged 43.1% (95% CI: 34.9 to 51.3), plots mowed and mulched with cottonwood averaged 5.0% (95% CI: 0 to 13.2), plots that were mowed and mulched with Douglas-fir averaged 3.5% (95% CI: 0 to 11.7), and plots that were mowed and mulched with blue wildrye straw averaged 0.6% (95% CI: 0 to 8.8) (see Figure 5).

One year after mowing and mulching there were significant differences in the number of false-brome flowering stems between the five treatments (p<0.0001). Multiple comparisons were used to highlight what those differences were. There was no significant difference in the number of false-brome flowering stems between the three types of mulches (p>0.05). There was a difference between the control and the plots that were mowed but not mulched (p<0.05). Control plots averaged 77.4 flowering stems per plot (95% CI: 63.7 to 91.1), plots that were mowed but not mulched averaged 57.8 (95% CI: 44.1 to 71.5), plots mowed and mulched with cottonwood averaged 4.9 (95% CI: 0 to 18.6), plots that were mowed and mulched with Douglas-fir averaged 3.4 (95% CI: 0 to 17.1), and plots that were mowed and mulched with blue wildrye straw averaged 0.25 (95% CI: 0 to 14.0) (see Figure 6).

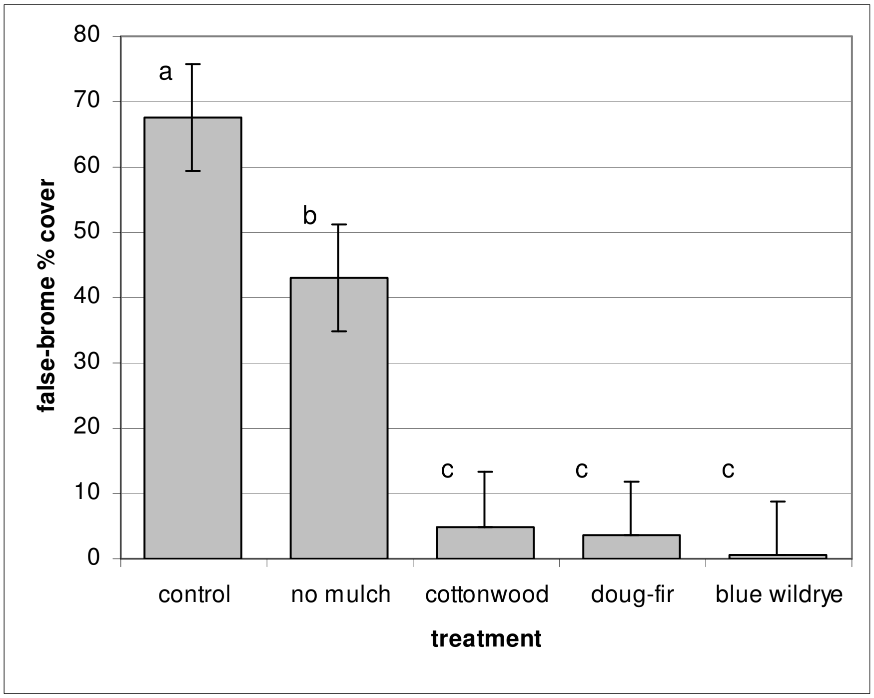

Figure 5. Percent cover of false-brome one year after mowing and mulching at the Little Fall Creek site. Bars with different letters are significantly different from each other (p<0.05).

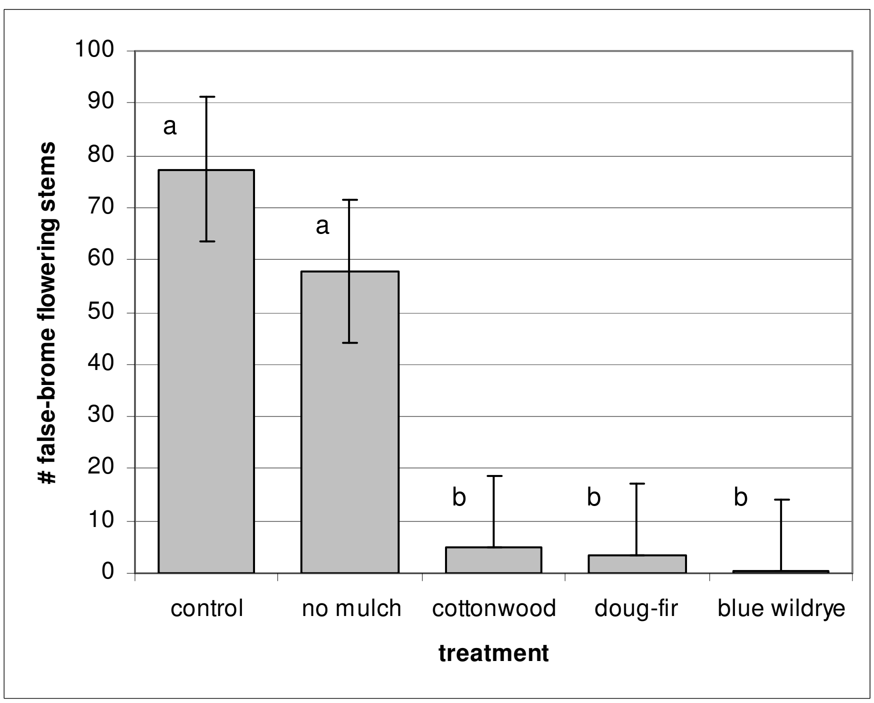

Figure 6. Number of false-brome flowering stems one year after mowing and mulching at the Fall Creek Reservoir site. Bars with different letters are significantly different from each other (*p*<0.05).

2. How long does a single treatment last, or how frequently do treatments need to be reapplied?

Our findings thus far indicate that mowing once during the month of June can fully eliminate seed production for one season. Mowing once and mulching can result in two years of seed suppression, with an average of less than 5 flowering stems per plot (0.5 m^2). Plots that were mowed but not mulched quickly recovered after one year, but did afford one year of seed control. We must continue to monitor the treatment plots for a number of years in order to fully understand the recovery of the mulch plots.

3. Are the mulching and seeding treatments effective at establishing native blue wildrye (*Elymus glaucus*) and Columbia brome (*Bromus vulgaris*) as a competitive bio-barrier to false-brome?

There was a significant difference in percent cover of established grasses one year following seeding ($p<0.0001$). The grasses did not flower in 2008 so we were not able to distinguish between the two species seeded. The cover values reported are therefore a sum of the two species. From the multiple comparisons analysis, there was no significant difference in grass establishment between the control plots and the mow/no mulch plots, nor was there a significant difference between the three mulch types (analyzed seperately). However, there was a significant difference in grass establishment between the control plots and the three mulch plots. Seeded grass establishment in the control plots averaged 0.5% per plot (95% CI: 0 to 1.5), plots that were mowed but not mulched averaged 0.8% (95% CI: 0 to 1.8), plots mowed and mulched with cottonwood averaged 3.4% (95% CI: 2.4 to 4.4), plots that were mowed and mulched with Douglas-fir averaged 3.8% (95% CI: 2.7 to 4.8), and plots that were mowed and mulched with blue wildrye straw averaged 4.5% (95% CI: 3.5 to 5.5) (see Figure 7). Establishment of native grasses was so low that it is unlikely that there will be sufficient biomass to form the "bio-barrier" that we hoped for. An effective competitor would require a minimum of 50% cover, with values in the 90's being preferable for true false-brome suppression.

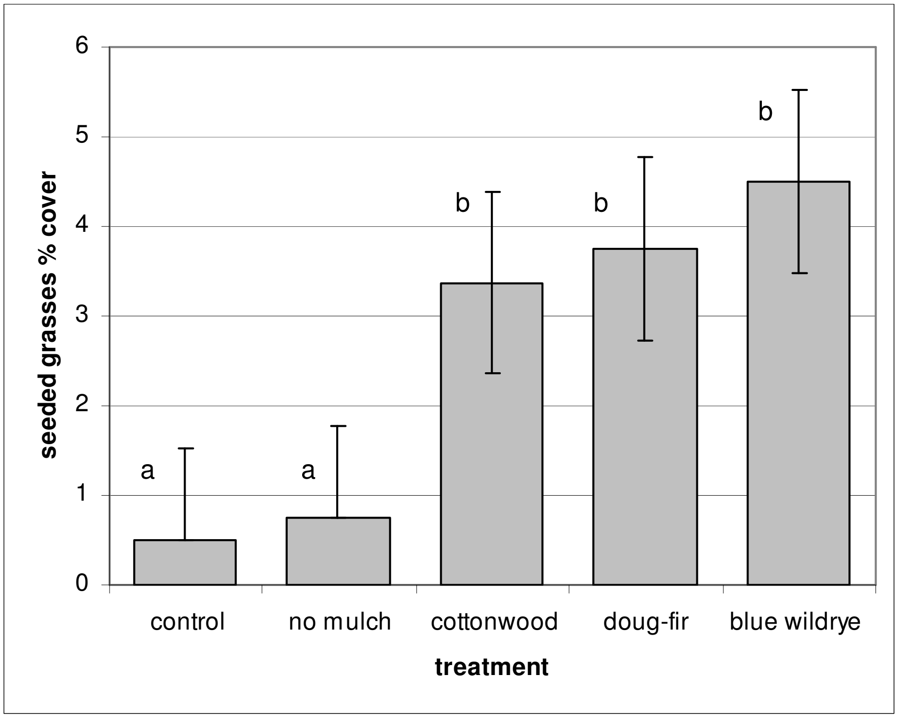

Figure 7. Percent cover of seeded grasses one year after treatment at the Little Fall Creek site. Bars with different letters are significantly different from each other (p<0.05).

4. Over what time period can false-brome be mowed to achieve effective reduction in false-brome seed production?

We established mowing experiments at two locations to improve our ability to generalize on the window of opportunity (dates) for halting seed production of false-brome. There was no significant difference in false-brome cover prior to mowing at the BLM Fall Creek Reservoir site ($p = 0.51$) and the OSU McDunn Oak Creek site ($p = 0.47$). BLM plots that were mowed on May 21st, 2008 resprouted and were not significantly different from controls in the number of false-brome flowering stems following mowing ($p = <.05$). The plots that were mowed on June 3rd, June 16th, and July 8th, 2008 were unable to resprout and had significantly less false-brome flowering stems than the controls ($p = <.05$).

For the BLM Fall Creek Reservoir site false-brome flowering stems averaged 46.1(95% CI: 37.9 to 54.4) in the controls, 30.8 (95% CI: 23.5 to 38.0) for the May 21st mowing, 0.9 (95% CI: 0 to 8.2) for the June 3rd mowing, 0 (no variance) for the June 16th mowing, and 0 (no variance) for the July 8th mowing (see Figure 8). A sub-sample of flowering stems was collected after being mowed on July 8th. These stems were stored in a dry paper bag and checked for seed development in October 2008. No viable seed was produced by these flowering stems.

For the OSU McDunn Oak Creek site false-brome flowering stems averaged 152.8 (95% CI: 122.5 to 183.2) in the controls, 8.5 (95% CI: 0 to 30.4) for the June 6th mowing, 2.0 (95% CI: 0 to 28.1) for the June 18th mowing, and 0 (no variance) for the July 9th mowing (see Figure 8).

The findings from these two experiments suggest that mowing false-brome anytime during the month of June can result in near elimination of seed production for the entire growing season. Despite the fact that the best control was attained on July 6th and 8th, we recommend taking a conservative approach by avoiding mowing in July since site to site variability could result in the production of viable seed by some early flowering individuals. Mowing false-brome after seed production would have disastrous consequences, since the seed would be distributed over the entire area mowed. Our findings also indicate that false-brome re-sprouts and will produce viable seed if mowing occurs too early in the season. It would be wise to check how synchronized flowering is throughout the BLM district so as to increase the likelihood of success. False-brome may flower at different times given differing light availability, soil moisture, elevation, etc.

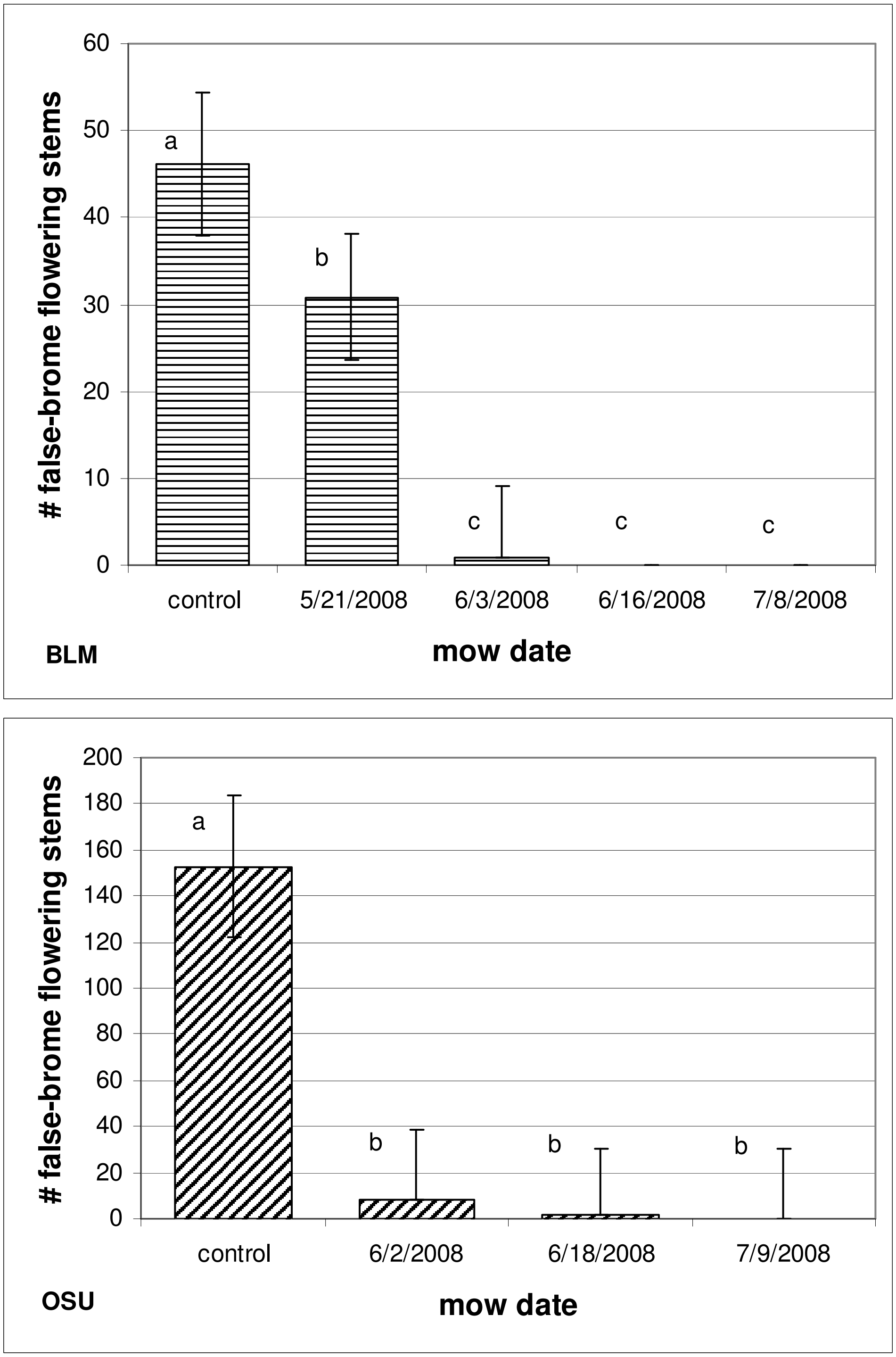

Figure 8. Number of flowering stems recorded in November 2008 following mowing treatments at the BLM Fall Creek Reservoir site (upper) and the OSU McDonald-Dunn site (lower). Bars with different letters are significantly different from each other (*p*<0.05).

Figure 9. Comparison of poplar mulch (left) and Douglas-fir mulch (right) on 12/11/07, approximately 4 months after mowing and mulching occurred. Note the emergence of *Rubus ursinus*.

Figure 10. Comparison between mowing and mulching with blue wildrye straw (left) and a no-mow/no-mulch control (right) on 12/11/07, approximately 4 months after treatment.

Figure 11. Photo of a false-brome plot that was mowed in June (bottom half of photo) and a control plot that has gone to seed (center of photo).

MANAGEMENT RECOMENDATIONS

This report contains the findings from two experiments which address the ability to control seed production of false-brome by mowing, mulching and seeding with native grasses. Mowing false-brome during the month of June to a height of about two inches above ground level arrested seed production for the entire growing season. The immediate addition of mulch to these mowed areas resulted in an additional year of near complete seed suppression. Although blue wildrye mulch was the most effective at suppressing false-brome growth, Douglas-fir and cottonwood mulch provided statistically similar results when put down at a depth of about 2 to 3 inches. Treatment areas that were simply mowed and not mulched quickly returned to cover levels similar to those of control units. Similarly, false-brome that was mowed too early in the growing season re-sprouted, while mowing after the on-set of seed production would be devastating since seed would be spread throughout the road system. We therefore recommend that roadsides be mowed during the month of June and any of the three mulches be placed down immediately following mowing.

Establishment of native species following weed control was very poor despite using high seeding rates (about 20 pounds per acre). There are very few species that are commercially available that will grow in the challenging conditions found on disturbed roadsides. We recommend that initiation of a seed collection program that would be used to establish seed production fields. This would create a source of plant material that could replace false-brome once it was removed. Past seed increase projects conducted by the Native Seed Network indicate that three to five years are needed to produce large enough quantities of seed for large restoration projects. An additional challenge is that many forest species reproduce primarily by vegetative means, not from seed. Successful roadside revegetation may require planting nursery grown plugs made from divisions. Instead of collecting seed, a crew would collect cuttings of aggressive shrubs and rhizomatous forbs. These cuttings would require about two years to develop sufficiently strong root systems prior to outplanting.

If herbicides are incorporated into the control of roadside populations of false-brome, one might consider planting only broadleaves so as to enable the use of grass-specific herbicides to allow for continued control of recalcitrant grasses.

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APPENDIX A

Table 2. Treatment assignments for the mowing, mulching, and native grass seeding experiment at the Little Fall Creek site.

plot #	group	treatment
1	1	mow and cottonwood mulch
2	1	mow and Elymus mulch
3	1	mow and Doug-fir mulch
4	1	control
5	1	mow and cottonwood mulch
6	1	mow and Elymus mulch
7	1	mow and no mulch
8	1	control
9	1	mow and cottonwood mulch
10	1	mow and Elymus mulch
11	1	skip - not enough BRSY
12	1	mow and Doug-fir mulch
13	1	control
14	1	skip - not enough BRSY
15	1	skip - not enough BRSY
16	1	mow and Elymus mulch
17	1	mow and cottonwood mulch
18	1	Control
19	2	mow and cottonwood mulch
20	2	mow and no mulch
21	2	mow and no mulch
22	2	mow and Doug-fir mulch
23	2	control
24	2	mow and Doug-fir mulch
25	2	mow and Elymus mulch
26	2	mow and Elymus mulch
27	2	control
28	2	mow and Doug-fir mulch
29	2	mow and no mulch
30	3	mow and Doug-fir mulch
31	3	mow and cottonwood mulch
32	3	mow and Doug-fir mulch
33	3	skip - not enough BRSY
34	3	mow and no mulch
35	3	mow and Doug-fir mulch
36	3	mow and no mulch
37	3	mow and Elymus mulch
38	3	mow and cottonwood mulch
39	3	control
40	3	mow and no mulch
41	3	mow and no mulch
42	3	mow and cottonwood mulch
43	3	skip - not enough BRSY
44	3	mow and Elymus mulch
45	3	control

Table 3. Treatment assignments for the mowing experiment at the BLM Fall Creek Reservoir site.

plot #	mow date	site
1	7/8/2008	BLM
2	5/21/2008	BLM
3	control	BLM
4	control	BLM
5	6/3/2008	BLM
6	6/16/2008	BLM
7	6/16/2008	BLM
8	6/16/2008	BLM
9	7/8/2008	BLM
10	5/21/2008	BLM
11	control	BLM
12	6/3/2008	BLM
13	5/21/2008	BLM
14	5/21/2008	BLM
15	6/3/2008	BLM
16	7/8/2008	BLM
17	5/21/2008	BLM
18	6/16/2008	BLM
19	control	BLM
20	control	BLM
21	6/16/2008	BLM
22	6/3/2008	BLM
23	7/8/2008	BLM
24	5/21/2008	BLM
25	7/8/2008	BLM
26	7/8/2008	BLM
27	control	BLM
28	5/21/2008	BLM
29	5/21/2008	BLM
30	6/3/2008	BLM
31	6/16/2008	BLM
32	5/21/2008	BLM
33	6/16/2008	BLM
34	7/8/2008	BLM
35	6/3/2008	BLM
36	control	BLM
37	6/3/2008	BLM

Table 4. Treatment assignments for the mowing experiment at the OSU McDonald-Dunn site.

plot #	mow date	site
101	7/9/2008	OSU
102	6/2/2008	OSU
103	control	OSU
104	6/2/2008	OSU
105	6/18/2008	OSU
106	7/9/2008	OSU
107	7/9/2008	OSU
108	6/18/2008	OSU
109	6/2/2008	OSU
110	control	OSU
111	6/18/2008	OSU
112	7/9/2008	OSU
113	control	OSU
114	6/18/2008	OSU
115	6/2/2008	OSU
116	7/9/2008	OSU
117	6/18/2008	OSU
118	6/2/2008	OSU
119	control	OSU
120	6/18/2008	OSU
121	control	OSU
122	control	OSU
123	7/9/2008	OSU
124	6/18/2008	OSU
125	6/2/2008	OSU