

# **Management of Fuel Loading in the Shrub-steppe**

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# Management Guide Summary

We investigated the effect of herbicides, their concentrations, repeated herbicide application, fire, and seeding on fuels loads and ecological restoration in the shrub-steppe. In addition, we determined the relationship among community types (fuel loading), wind, and the probability of a carrying fire. The results can be used to determine a cost effective and the least damaging protocol (for native plants) for reducing fuels in the shrub-steppe. The results will be applicable to land managers, agency fire and fuel managers and planners, and fire technicians in the Columbia Basin and elsewhere in the Intermountain West.

***Bromus tectorum* cover mapping and fire risk:** Fire risk in western North America has increased with increasing cover of *Bromus tectorum*, an invasive alien annual grass. The relationship between *B. tectorum* cover and fire risk was determined in a historically burned *Artemisia tridentata* – *Poa secunda* shrub-steppe community where *B. tectorum* cover ranged from 5 to 75%. Fire risk ranged from about 46% with an average of 12% *B. tectorum* cover to 100% when *B. tectorum* cover was greater than 45% based on prediction confidence limits. There was no relationship between wind speed and fire risk at wind speeds less than 16 km h<sup>-1</sup>. Reflectance of the green and red bands of aerial photographs, were related to senescent *B. tectorum* cover to create fine resolution *B. tectorum* cover and fire risk maps. This assessment technique will allow land managers to prioritize lands for restoration to reduce fire risk in the shrub-steppe. The methods used in this study can be applied in other landscapes to map *B. tectorum* cover and associated fire risk. This approach will allow land managers to determine the costs of fuel reduction as a function of fire risk in semi-arid western regions of North America.

**Fire risk of restored shrub-steppe plant communities:** Fire frequency and size in western North America has increased with increasing cover of *Bromus tectorum*, an invasive alien annual grass. We determined the fire risk of shrub-steppe ecosystems restored with large bunchgrasses eight and 18 years after drill seeding. Fire risk of two communities eight years after establishment of large bunchgrasses was 76 and 78% while fire risk was 66% in a community 18 years after restoration. After 18 years, *B. tectorum* cover was  $2.8 \pm 2.1$  % with *Elymus wawawaiensis* (large bunchgrass) density of 2.77 plants m<sup>-2</sup>. Fire risk of communities dominated by small bunchgrasses (*Poa secunda*, Sandberg's bluegrass) was not different from fire risk in communities dominated by large bunchgrasses. Prescribed burns, herbicides, seed, and drill seeding are the primary costs of reducing fire risk in the shrub-steppe where drill seeding is possible. The savings associated with reducing fire risk from 100% to 66% may be enough to cover the costs of restoring shrub-steppe ecosystems. This is especially true if the savings are computed over a number of years.

**Effect of prescribed fire on a shrub-steppe plant community infested with *Bromus tectorum*:** Prescribed fire has been used to manipulate plant communities and is used to remove plants and litter for efficient application of pre-emergent herbicides to the soil. An experiment was conducted to determine if prescribed fire in the fall would have a significant impact on plant

community structure in the shrub-steppe. Fire effects were compared with those in unburned plots. Fire increased frequency of *Descurainia* species only in the year after the fire. Cover of *Bromus tectorum* was reduced, while cover of *Sisymbrium altissimum* and *Poa secunda* increased in the year after the fire. These effects were gone in the second year. Soil cover increased and litter cover decreased in both years after the fire. There was no effect of the fire on native species cover or richness. The index of very abundant species and the evenness index were greater in burned plots than in unburned plots only in the year after the fire. Prescribed fire in the fall can be used to prepare surfaces for efficient application of pre-emergent herbicides in areas with 50% *B. tectorum* cover or less. Prescribed fire, under the conditions of the test, does not have a lasting effect on native flora.

#### **Effects of herbicides on a shrub-steppe plant community after a prescribed fire:**

Herbicides are often used to reduce fuel loading by invasive species in the western United States. We investigated the effect of two herbicides, their concentrations, and repeated herbicide application after a prescribed fire on native and invasive alien plant species in the shrub-steppe.

Imazapic did not harm native vegetation. It increased native vegetation cover about 10% two years after application. The number of native increasers increased from ten after natural effects and fire to 17 after natural effects, fire and imazapic application. There was a positive relationship between native species richness and concentration the second year after application. Alien species cover was reduced by about 40% at 0.56 kg ha<sup>-1</sup> in the year after application and alien species richness ( $4.73 \pm 0.26$ ) was significantly lower than with glyphosate ( $5.47 \pm 0.18$ ).

Glyphosate negatively affected native species by reducing their frequency. The number of decreasing native species increased with glyphosate whether applied one (5) or two (7) times. Cover of native species increased with glyphosate, but was mostly the native annual, *Epilobium brachycarpum*. *Poa secunda* cover decreased with increasing glyphosate concentration in the second year of repeated application. The number of alien species decreasers increased with increasing application frequency. Alien cover was reduced with increasing glyphosate concentration in the first year of application, but the effect was small. Reduction in alien species cover was stronger after two applications and was mostly associated with *Bromus tectorum*, which was reduced from about 32% to near 0% at 0.14 kg ha<sup>-1</sup>.

While both herbicides reduce alien species cover, imazapic positively affects native species. Glyphosate had negative effects on native species. Under the conditions of the test, imazapic is the better herbicide.

Imazapic should be used with caution where rare native mustards (Cruciferae) are present, because mustards are thought to be very sensitive this herbicide. In our study, the native mustard, *D. pinnata*, increased frequency after imazapic application. Further testing should be done on the sensitivity of rare native mustards and other rare native annuals and biennials to imazapic.

Our results can be applied in similar ecosystems in the shrub-steppe, but should be used with caution in differing ecosystems especially where rare annuals and biennials occur.

**Effect of herbicide and herbicide concentration on *Elymus wawawaiensis* establishment in the shrub-steppe:** Drill-seeding native bunchgrasses after prescribed fire and herbicide application is a technique used to restore shrub-steppe ecosystems infested with alien species. We conducted an experiment to determine the herbicide type (imazapic, glyphosate), minimum application rate, and application frequency that will result in high establishment of

*Elymus wawawaiensis* in a shrub-steppe ecosystem infested with *Bromus tectorum*. The minimum concentration of imazapic needed for high establishment (0.55 plants m<sup>-2</sup>) was 0.28 kg ha<sup>-1</sup>. At this concentration and higher, soil cover was greater than 25% and alien species cover less than 38%, levels that likely reduced competition below a critical level needed for high establishment. Glyphosate resulted in lower establishment whether applied one time or repeated in a second year. Percent of seedlings in flower and height was about 47% and 51 cm at 0.56 kg ha<sup>-1</sup> of imazapic, compared with about 8% and 32 cm for glyphosate at the same concentration applied one time. Under the conditions of the test, imazapic is the better herbicide. It may be possible to achieve greater densities like that of the adjacent field (2.77 plants m<sup>-2</sup> after 18 years) by drill seeding in the fall and/or using more seed.

**Shrub-steppe restoration:** This final section is a review of restoration methods for the shrub-steppe. This section should be useful for land managers as a resource when designing restoration strategies in the shrub-steppe.