

# **Effectiveness of Postfire Seeding to Reduce Cheatgrass (*Bromus tectorum*) Growth and Reproduction in Recently Burned Sagebrush Steppe**

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## **Introduction**

Recent invasions by non-native grasses have increased the amount and continuity of fuels which has increased the frequency of fire in a variety of ecosystems worldwide (D'Antonio and Vitousek 1993, Brooks 1999, Brooks et al. 2004). In sagebrush steppe of the Great Basin desert, the expansion of non-native annual grasses, cheatgrass (*Bromus tectorum*) in particular, during the 1900s has decreased fire return intervals from 30 to 100 years to <5 years in many areas (Whisenant 1990). Where these dramatically shortened fire return intervals occur, sagebrush steppe cannot persist. In contrast, non-native annual grasses can recover to prefire amounts within a few years after burning, producing fuelbeds that set the stage for recurrent fire (Brooks and Pyke 2001).

The positive grass/fire cycle (sensu D'Antonio and Vitousek 1992) often leads to type-conversion of native sagebrush steppe to non-native annual grassland, a phenomenon that has been documented in the Great Basin since the 1930s (Pickford 1932, Piemeisel 1951, Young and Evans 1978, Whisenant 1990). Vegetation type-conversions associated with altered fire regimes

can have effects that resonate to higher trophic levels and throughout ecosystems, and are very costly to reverse (Brooks et al. 2004).

Management of the highly flammable fuelbeds created by non-native annual grasses is a necessary first step to break the grass/fire cycle and restore native sagebrush steppe vegetation (Brooks et al. 2004). Postfire landscapes are often seeded to suppress the growth and reproduction of cheatgrass and other non-native annual grasses. One of the most frequently seeded species is another non-native grass, the perennial crested wheatgrass (*Agropyron* spp.). One of the primary reasons this species has been used is because it is relatively inexpensive and readily available for seeding compared to most other species.

The basic logic of attempting to replace one dominant non-native plant with another is that some non-native species may be able to compete with and suppress the growth of other less desirable non-native species, while not having the extreme negative ecological effects of those other species. For example, non-native annual grasses produce more continuous fuelbeds with lower fuel moisture levels during the heat of the summer fire season compared to non-native perennial grasses which grow more discontinuously and remain alive throughout the year resulting in higher fuel moisture levels. As a result, it is believed that replacement of non-native annual grasses with perennial grasses may increase the fire return interval to the point where native vegetation adapted to longer return intervals can recover.

Although seedings of non-native perennial grasses are often used in postfire landscapes to compete with other less desirable non-native plants, relatively little is known about the effectiveness of these treatments. Some older publications provide evidence that non-native perennial grass seedings can suppress cheatgrass (Robertson and Pearse 1945, Hull and Pechanec 1947, Hull and Stewart 1948, Hull and Holmgren 1964, Hull 1974). However, these studies are very limited, and rely largely on observational data. In addition, it is commonly assumed that non-native perennial grasses compete more effectively with cheatgrass than do native perennial grasses, yet no experimental evidence exists comparing non-natives versus natives.

Invasive annual grasses also respond positively to naturally high, or artificially increased, levels of nitrogen and phosphorous in desert regions (Wilson et al. 1966, DeLucia et al. 1989, Brooks 1999, 2003). Fires often increase the availability of these nutrients (DeBano et al. 1998), which can benefit invasive grasses (M. Brooks unpublished data). Thus, soil fertility should affect the growth and reproduction of cheatgrass, and may affect the ability of seeded species to suppress cheatgrass.

In this project we evaluated the responses of cheatgrass and other invasive grasses to postfire seeding of native vs. non-native perennial grass species, applied along with increased vs. decreased levels of soil nutrients.

## Study Design

The study site was within the perimeter of the Cannon Fire (22,750 acres, June 2002) near Walker, CA. Dominant vegetation before the fire included mountain big sagebrush (*Artemisia tridentata* ssp. *vaseyana*), perennial grasses (*Elymus elymoides*) and various forbs. After burning, the invasive alien perennial grass bulbous bluegrass (*Poa bulbosa*) dominated the site along with lesser amounts of cheatgrass and red-stemmed filaree (*Erodium cicutarium*)

Seeding treatments were applied 5 months postfire during November 2002. The native seed mix included equal pure live seed proportions of bluebunch wheatgrass (*Pseudoregneria spicata*), bottlebrush squirreltail (*Elymus elymoides*), and Indian ricegrass (*Achnatherum hymenoides*). The non-native seed mix included equal proportions of hycrest crested wheatgrass

(*Agropyron cristatum*), Siberian wildrye (*Agropyron fragile*), and Russian wildrye (*Psathyrostachys juncea*). Seed was dispersed manually with a backpack spreader then covered by a single pass of a rangeland drill. The two seeding treatments each resulted in 30 live seeds/ft<sup>2</sup>.

Nutrient treatments were applied just after snowmelt in late winter 2002 and 2003. The increased nutrient treatment was comprised of 3 g/m<sup>2</sup> of N in the form of NH<sub>4</sub>NO<sub>3</sub>, plus 20 g/m<sup>2</sup> of P in the form of NaH<sub>2</sub>PO<sub>4</sub>. The decreased nutrient treatment was comprised of 100 g/m<sup>2</sup> of C in the form of C<sub>6</sub>H<sub>12</sub>O<sub>6</sub> to decrease available nitrogen, plus 50 g/m<sup>2</sup> of CaCO<sub>3</sub> to decrease available phosphorous.

Post-treatment plant cover and diversity measurements began in spring 2003 and were repeated in spring 2004. Seedbank samples were collected in fall 2003, and 2004, and grown out in a greenhouse during each subsequent winter. Seedbank composition was evaluated by growing out samples in a greenhouse using standardized methods (T. Esque et al. unpublished manuscript).

## Results and Conclusions

The ecological effects of seeding native vs. non-native perennial grasses were not readily apparent during the first two post-treatment years due to the low establishment rates of seeded species. During the first post-treatment spring of 2003, cover of native seeded species was 1.8% and of alien seeded species was 1.1%. During 2004, cover of native seeded species remained 1.8% and cover of alien seeded species increased to 2.7%. Low establishment rates may have been partly due to below average rainfall prior to the first post-treatment summer, and only average rainfall during the winter prior to the second post-treatment summer. During subsequent years, after the seeded species have grown to maturity and begin to reproduce, the differential effects of the two seed mixes on plant community composition may become more evident. We plan to resample these experimental study plots during the spring (above-ground vegetation) and fall (soil seedbanks) of the fifth post-treatment year (FY06).

The act of seeding, regardless of the seed mix, effected plant community composition more than any other variable tested during the first two post-treatment years. Apparently, the physical turning of the soil with the rangeland drill was the causative factor.

Seeding reduced total cover 15% and native cover 50% compared to unseeded/untilled controls during the first post-treatment year. By the second year, native cover increased slightly, but remained less than the controls. Native cover and richness were dominated by perennial species which responded negatively to seeding. In contrast, the less dominant native forbs, increased in cover and diversity in response to seeding.

Seeding increased cover and species richness of non-native plants. Non-native cover was 10% greater than controls in 2003, and 20% greater in 2004. Bulbous bluegrass and *Erodium cicutarium* were the two most dominant non-native species, with cheatgrass less abundant. Seed density of native perennial grasses was greatest where no seeding occurred, whereas seed density of alien annual grasses, alien perennial grasses, and native forbs was greatest in seeded plots. The particularly strong positive effect of seeding on bulbous bluegrass likely resulted from an effect of the rangeland drill that was unique to this species at this site. Turning the soil likely divided and dispersed its perennating root tissue, increasing the density and cover of this species.

Bulbous bluegrass appears to have been in the Intermountain West region at least since the 1920s, and its range includes all of the western United States. However, land managers generally consider it to be less of a threat than cheatgrass or medusahead (*Taeniatherum caput-*

*medusa*) to the economic and ecological integrity of rangelands (Personal communication Roger Rosentreter, Botanist Idaho BLM). Concern has been expressed by at least one scientist (Steve Novak, Boise State University) who indicated that this species possesses high reproductive capacity and unusually diverse genetic variability for a clonal perennial grass, the combination of which increases the potential of this species to become an invasive weed.

Nutrient treatments did not significantly influence the effects of the seeding treatments. This lack of an interactive effect was likely due to the overall low seeding success rate observed in this study. Overall, increased levels of soil nutrient increased cover of invasives, which is consistent with previous studies (Wilson et al. 1966, DeLucia et al. 1989, Brooks 1999, 2003).

Seedbanks generally mirrored the above-ground vegetation cover and species richness results, however the differences among treatments were rarely significant. Seedbank responses may lag behind above-ground vegetation responses based on growth and reproductive rates.

### **Preliminary Results**

- Effects of native vs. non-native seeding treatments may not be evident until mature plants become established.
  - Cover of seeded species was relatively low during the first two post-treatment years.
  - The competitive effects of seeded species on invasive plants may have been negligible during this time due to their small sizes.
- Soil disturbance created by the seeding process generally had undesirable effects on plant communities during the first few post-treatment years, irrespective of whether native or non-native species were seeded.
  - Seeding reduced total plant cover and native cover, primarily of perennial grasses.
  - Seeding increased non-native plant cover, especially that of bulbous bluegrass, and to a lesser degree cheatgrass and red-stemmed filaree.
  - Seeding increased cover of native annual forbs.
  - Seeding reduced native perennial species richness, and increased richness of native annuals and non-native forbs and grasses.
- Increased nutrient levels increased cover of invasives, but did not significantly interact to influence the effects of seeding natives vs. non-natives.
  - This lack of interaction was due to a lack of a main effect difference between natives and non-natives in this study.
- Seedbank responses may not become evident until differential growth and reproduction of above-ground vegetation among treatments causes directional shifts.
- Sampling will be repeated in spring (vegetation) and fall (seedbank) 2006 to document changes after five post-treatment years.
  - We will re-evaluate the effects of native vs. non-native seeding treatments after the seeded species have become established as mature plants.
  - We will determine if the negative effects of soil disturbance caused by the seeding process persisted beyond the first two post-treatment years.

## **Preliminary Recommendations**

- Do not till the soil when increasing the dominance of bulbous bluegrass is a concern.
- Monitor postfire seeding treatments for more than 2 years.
- Evaluate interactions between bulbous bluegrass and cheatgrass.
- Conduct more research comparing the effects of postfire seedings using native and non-native species.

## **Product Summary**

### **Publications**

Brooks, M.L. 2005. To seed or not to seed: Effects of seeding native vs. non-native grasses on plant communities in recently burned sagebrush steppe. US Geological Survey, Western Ecological Research Center, Fact Sheet.

Brooks et al. In preparation. Effects of postfire seeding treatments on dominance by invasive non-native plants in sagebrush steppe.

Brooks et al. In preparation. Effects of soil nutrient levels on dominance by invasive non-native plants in sagebrush steppe.

### **Website**

[www.werc.usgs.gov/fire/lv/postfireseeding/greatbasin](http://www.werc.usgs.gov/fire/lv/postfireseeding/greatbasin)

### **Field Trip**

USGS and BLM staff led the JFSP Board of Directors and other Federal land managers and University Scientists on a field trip to this study site to discuss the results and management applications of this and other related research projects.

### **Presentations (most recent listed first)**

Brooks, M.L. 2004. Fire and fuels management in the intermountain west. Bureau of Land Management, Idaho State Office, Science Seminar, 3 November, Boise, ID.

Brooks, M.L. 2004. Desert fire ecology and the integrated management of fire and invasive plants. Humboldt State University, Fire Ecology Seminar Series, 11 October, Arcata, CA.

Brooks, M.L. 2004. Integrated management of invasive plants and fire. Department of the Interior Science Seminar, 16 April, Boise, ID.

Brooks, M., B. Lair, T. Esque, A. Halford, M. Pellant. 2004. Postfire seeding to reduce growth of invasive alien grasses in postfire sagebrush steppe. Joint Fire Science Program Principal Investigator Workshop. 7 March, Phoenix, AZ.

Brooks, M.L. 2003. Management of Invasive Plant and Fire in the Deserts of North America. USFWS Brown Bag Seminar Series, Region 1 Headquarters, 4 August, Sacramento, CA.

Brooks, M.L. and T.C. Esque. 2003. Invasive Plant and Fire Research in the Southwestern Deserts. USGS-BLM Science Briefing, BLM Headquarters Office, 7-8 May, Washington D.C.

Brooks, M.L., T. Esque, M. Pellant, and M. Whalen. 2003. Effectiveness of post-fire seedings to reduce cheatgrass. 2003 Intermountain Restoration Coordination Meeting, 31 March to 1 April, Boise, ID.

Brooks, M.L. 2002. Plenary Session Introduction – The challenge of implementing fuels management treatments in the western United States. Fire Conference 2002: Managing Fire and Fuels in the Remaining Wildlands and Open Spaces of the Southwestern United States. Co-hosted by the Association for Fire Ecology and the Western Section of the Wildlife Society. 2-5 December, San Diego, CA.

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