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Cheatgrass Die-Offs: A Unique Restoration Opportunity in Northern Nevada

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On the Ground

- The phenomenon of cheatgrass die-off is a common and naturally occurring stand failure that can eliminate the presence of this annual grass for a year or more, affecting tens of thousands of hectares in some years.
- We designed a study to determine if the temporary lack of cheatgrass caused by die-offs is a restoration opportunity. We seeded native perennial species at three die-offs in the Winnemucca, Nevada, area.
- Native grass establishment in die-offs was almost three times higher in the first season at all sites, relative to adjacent areas without die-off. Establishment was five times higher in the die-off at two sites in the second season, and plants produced dramatically more culms in the die-off at the third site in the third season.
- Increasing seed rates led to more seedlings establishing in both die-offs and controls, with the strongest effect in the second season.
- We suggest that landowners and managers consider targeting die-offs as efficient locations to focus native restoration efforts and that restoration practitioners should consider increasing seeding rates to maximize success.

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Cheatgrass (*Bromus tectorum*) is one of North America's most ecologically significant invasive species, growing in impressively dense near-monocultures across many parts of the West. Because it is highly competitive, it is a severe barrier to the survival of seedlings of perennial plants, especially in sagebrush steppe communities.[1] Cheatgrass "die-off," or stand replacement failure, is a naturally occurring phenomenon in which a seemingly healthy stand of cheatgrass fails to replace itself.[2] Die-offs result in the complete elimination of cheatgrass at a site for one or more growing seasons (Fig. 1). The cause of this phenomenon is under investigation[4] and likely involves one or more pathogens reaching epidemic levels under certain conditions. Only actively growing seeds are affected, so dormant cheatgrass seeds remain in the soil during and after the die-off, often resulting in a return to cheatgrass dominance within a year or two.[2,5]

Because these die-offs occur in remote areas, it can be difficult to understand how common they are. However, their distinct color and patterns make them perfect for detection with aerial or satellite imagery. In a recent remote sensing study focused on a highly invaded region of north-central Nevada centered on Winnemucca, we found that over 100,000 hectares of die-off have occurred over the last 31 years (Fig. 2).[6] Throughout the 1.7 million hectare study area, some years produced no die-off, around one-third of years produced 4,800 ha or more, and three years each produced over 40,000 ha of die-off. This study also found that certain areas (totaling around 15,000 ha) are "hotspots" that have experienced die-off four to nine times during the 31-year period. Cheatgrass die-off has also been observed in other arid shrublands in the west, including Washington, Utah, Idaho, and Oregon (O. Baughman, personal observation), and areas of unexpectedly low productivity of cheatgrass that could be die-offs have been remotely sensed throughout much of the northern Great Basin.[7] These die-offs can cause problems for land users because these areas may experience increased soil erosion, invasions of other weed species, and a sudden loss of spring forage. However, die-offs may also represent excellent opportunities for establishing seedlings of perennial plants, which is what we investigate here

Can Die-offs Increase Restoration Success in Areas Where There Are Few Options?

Compared with other forms of temporary cheatgrass control, such as herbicide or targeted grazing, the die-off phenomenon is not costly or labor intensive, but it still provides conditions that

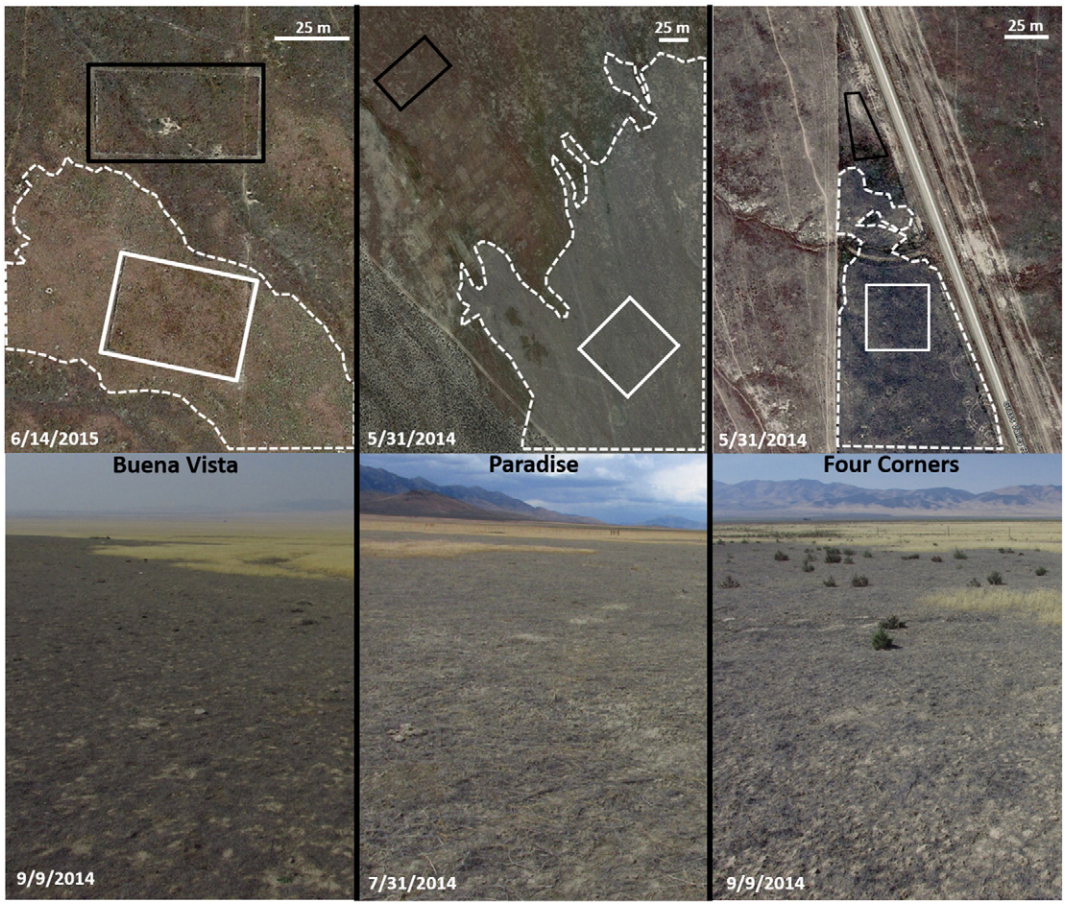

Figure 1. Many cheatgrass die-offs are so devoid of vegetation that they can be seen from far away, as well as in satellite imagery. Photos are satellite imagery[3] (top images) and ground-level views (bottom images) of the three sites used in this experiment. Satellite images show the die-off boundary (dashed outline) and experimental fields in the die-off (light boxes) and control (dark boxes), all of which were fenced soon after seeding. In the ground-level views, the characteristic gray litter of a recent die-off in the foreground contrasts with the light yellow of dried cheatgrass in the background. Note that the date (lower left of each panel) and scale (upper right of each satellite panel) vary.

may help native plants grow. For example, soil moisture, plant-available nitrogen, and other essential nutrients are higher in recent die-off soils than soils of nearby areas that did not experience die-off.[8–10] We conducted a precision seeding study to test how die-offs affected perennial grass seeds at a die-off in Pershing County, Nevada, in 2012.[5,8] We planted Sandberg bluegrass (*Poa secunda*) and bottlebrush squirreltail (*Elymus elymoides*) into a recent die-off as well as an adjacent intact cheatgrass stand (control). The die-off supported more bluegrass and squirreltail through 2 years of monitoring, and seedlings in the die-off had significantly greater growth and vigor late in the growing season than those in the control. These findings were promising, especially considering the competitive pressure exerted on these native seedlings by cheatgrass, which was common and returning to dominance during the study.

These promising results suggested that cheatgrass die-offs can increase restoration success in highly invaded areas, but our seeding was limited to only one site and two native species and used a nontypical method of hand-seeding. Therefore, researchers at the University of Nevada, Reno and managers at the Bureau of Land Management initiated this follow-up study to determine if similar results would be found across multiple die-off sites, seeding a greater diversity of native species and using typical drill-seeding methods. Additionally, we were interested in whether simply increasing the seeding rate could improve native establishment. The questions of our study were as follows:

1. Do recent cheatgrass die-offs support higher establishment of native grass, forb, and shrub seeds after mechanical seeding?
2. Do higher seed rates result in higher establishment of native grass, forb, and shrub seeds, in or out of cheatgrass die-offs?

Sites, Seeding, and Monitoring

Three sites that contained an area of complete stand failure (die-off) as well as an immediately adjacent stand of cheatgrass (control) were selected for seeding (Fig. 1). Buena Vista and Paradise were formerly dominated by Wyoming sagebrush (*Artemisia tridentata* ssp. *wyomingensis*), while Four Corners was likely dominated by a mix of Wyoming sagebrush and salt desert scrub species. At the time of seeding, all sites had been dominated by cheatgrass for over a decade, with a mix of other exotic and native species existing at much lower levels. Die-off and control