# Semi-Annual Progress Report, 8

***7 July 2011***

*ARestoring Natural Fire Regimes at Golden Spike National Historic Site by Developing a Healthy Sagebrush/Grassland Vegetation Community to Prevent the Cheatgrass-Wildfire Cycle/Evaluating Restoration Seeding Techniques Using Native Herbaceous Species in Cheatgrass-Dominated Communities at Golden Spike National Historic Site@*

RM-CESU Cooperative Agreement Number: H1200040001


Submitted by: Eugene W. Schupp
Department of Wildland Resources
Utah State University
Logan, UT 84322-5230


Submitted to: Kathy Tonnessen
RM-CESU Research Coordinator

Tammy Benson
Chief of Operations
Golden Spike National Historic Site

## 1. Progress to Date

The project was initiated on 1 September 2007. To date we have initiated three distinct research projects relevant to the goals of the cooperative agreement. One graduate student is completing final edits on her thesis; a second student started on the project spring 2009 and will finish in the next year.

### 1.1. Seeding by seed-caching rodents

No work was completed on this part during the period covered by this report.

### 1.2. Seeding into existing sagebrush stands, and
### 1.3. Restoration of cheatgrass stands

I combine the second and third projects because the accomplishments are the same.

I. Accomplishments and new preliminary results:
   - A. An M.S. thesis has been successfully defended, the thesis is undergoing final revisions, and manuscripts are in preparation. At the end of this report I append the Concluding chapter of that thesis. When the thesis is finalized a copy will be delivered to Golden Spike for their library.
   - B. Seeded plots were censused again in June 2011. Data are being entered.
   - C. The final set of nutrient probes were collected and analyzed.
   - D. The seed pool study is nearly completed. The last unidentified plants have begun flowering and are being keyed out.

## 2. Plans For Ninth Reporting Period, 1 July 2011 B 31 December 2011

### 2.1. Seeding by seed-caching rodents

We do not plan to work on this aspect of the project during the next 6 months.

### 2.2. Seeding into existing sagebrush stands, and
### 2.3. Restoration of cheatgrass stands

In the coming 6-month period we will:

I. Work on manuscripts on treatment effects on cheatgrass and on treatment effects on nutrient dynamics.
II. Finish greenhouse portion of seed pool study and begin analyses.
III. Re-census sampling plots for perennial grasses and cheatgrass.
IV. Begin analyses of perennial seedling emergence and establishment.

Appendix: Concluding Chapter of M.S. thesis: Summerhays, J.C.R. 2011. Effects of non-

surface-disturbing treatments for native grass revegetation on cheatgrass (*Bromus tectorum* L.) metrics and soil nutrient availabilities. Utah State University, Logan, UT

## CHAPTER IV

## CONCLUSION

Cheatgrass invasion in sagebrush shrub ecosystems has increased fire frequencies and intensities, resulting in a loss of sagebrush overstories and herbaceous perennial species in these areas (Whisenant 1990; Knapp 1996). The reestablishment of fire-resilient perennial grass species into cheatgrass-invaded areas may be necessary to interrupt the cheatgrass-wildfire cycle and to protect these areas from conversion to cheatgrass monocultures. However, this will most likely require reducing competitive pressure from cheatgrass as well as addressing changes to soil nutrient availabilities that accompany its invasion. In this thesis I described the effects of non-surface-disturbing techniques aimed at altering the resource environment in ways that could increase the success of seeded perennial species. Specifically, I examined how these treatments alter cheatgrass metrics (Chapter II) and soil nutrient availabilities (Chapter III), as this information may be crucial for the understanding of conditions that facilitate or inhibit perennial seedling establishment. Treatments were tested in two experimental areas, one with an intact sagebrush overstory with a degree of cheatgrass invasion and one in a near-monoculture of cheatgrass that was type-converted by fire in 1998.

In Chapter II I describe the effects of herbicide application (140 $g \cdot ha^{-1}$ and 210 $g \cdot ha^{-1}$), burning, sagebrush 50% and 100% thinning, sucrose addition, activated carbon (AC) addition, and respective control treatments on cheatgrass metrics for two growing seasons. Herbicide application reduced cheatgrass weights and tiller and spikelet numbers during the first season after application, and these effects were generally greater in plots that were also burned or cleared of sagebrush overstories. In the second season after application, cheatgrass in herbicide-treated plots were larger and with greater tiller and spikelet numbers than in no herbicide plots. Partial (50%) thinning of sagebrush overstories did not result in any significant changes to cheatgrass metrics in either growing season. Total (100%) thinning of sagebrush overstories resulted in increases in cheatgrass weights and tiller and spikelet numbers both seasons, as well as increased densities during the second growing season. Burning decreased cheatgrass densities but increased individual cheatgrass weights and tiller and spikelet numbers during both growing seasons. Sucrose addition reduced cheatgrass weights and tiller and spikelet numbers during the first season after treatment, but these metrics were increased in sucrose addition subplots during the second growing season. There was some indication AC sequestered herbicide and lessened some of its negative effects on cheatgrass during the first growing season, but AC itself was not believed to have direct effects on cheatgrass metrics.

In Chapter III I describe the effects of these same treatments (herbicide treatment and 50% sagebrush thinning omitted) on the availabilities of micronutrient, macronutrient, and heavy metal soil ions. We used *in situ* burials of plant root simulator (PRS) probes (Western Ag Innovations, Saskatoon, SK, Canada) to assess the supply rates of these nutrients over three time periods following treatment applications. During the first time period, which occurred from November 2008 to March 2009, availabilities of nitrate ($NO_3^-$), phosphate ($H_2PO_4^-$), sulfate ($SO_4^{2-}$), potassium ($K^+$), and manganese ($Mn^{2+}$) were increased in burned plots and availabilities of $NO_3^-$ and $H_2PO_4^-$ were decreased in sucrose- treated subplots. Sucrose addition subplots in burned plots had availabilities of $NO_3^-$ and $H_2PO_4^-$ that were not significantly different than in unburned (no manipulation) plots. In the second time period, which occurred during the first growing season after treatments (March to June 2009), availabilities of $NO_3^-$ were still greater in burned plots, and availabilities of ammonium ($NH_4^+$), aluminum ($Al_3^+$), and lead ($Pb^{2+}$) were now also greater in burned plots. $NO_3^-$ availabilities were also still lower in sucrose addition subplots, and availabilities of $Mn^{2+}$ and copper ($Cu^{2+}$) were now significantly greater in sucrose addition subplots. Sucrose addition subplots in burned plots had availabilities of $NH_4^+$, calcium ($Ca^{2+}$), and iron ($Fe^{3+}$) that tended to be higher than in regular aerial seeding subplots in burned plots, although differences were not significant. During the third time period, which occurred over the second winter post-treatment (November 2009 to March 2010), only availabilities of $NO_3^-$ and $NH_4^+$ were assessed. Burned plots still had greater availabilities of $NO_3^-$, but no other treatment effects or interactions were significant. There was some indication from comparisons between the first and third time periods that $NO_3^-$ availabilities increased a great deal in sucrose addition subplots, although this trend was not significant. There was no effect of 100% sagebrush thinning or AC addition on any of the soil nutrients during any of the time periods.

The results of these studies indicate that some of the treatments were effective at altering the resource environment in ways that could potentially affect seeded perennials, while some were not. As herbicide treatment reduced cheatgrass presence for a year following application, this treatment could provide a short window for perennial grass establishment. Burning reduced densities and increased the availabilities of some soil nutrients ($NO_3^-$, $NH_4^+$, $H_2PO_4^-$, $SO_4^{2-}$, $K^+$, $Mn^{2+}$, and $Al^{3+}$), which probably accounted for much of the increases in individual cheatgrass weights and tiller and spikelet numbers observed during both growing seasons after treatment. If cheatgrass could be prevented from taking advantage of increased soil nutrients and growing to larger sizes, well-timed burning could also provide a window of opportunity for seeded perennial establishment. Sagebrush 50% thinning did not result in any changes to cheatgrass metrics or soil ion availabilities, but 100% thinning increased cheatgrass mean densities, weights, and tiller and spikelet numbers during all seasons without alterations to soil ion availabilities. This treatment would therefore not be recommended for use in perennial grass seeding establishment in cheatgrass-invaded areas. Sucrose addition was successful at immobilizing soil nutrients, namely $NO_3^-$ and $H_2PO_4^-$, and reducing cheatgrass mean weights and tiller and spikelet numbers through the first growing season after application. However, during the second winter, $NO_3^-$ availabilities tended to be greater than before sucrose treatment, indicating an end of immobilization and a re-release of this nutrient. This fact, coupled with decreased cheatgrass densities, may have accounted for increased cheatgrass individual metrics observed during the second growing season. As with herbicide treatment, sucrose addition may be a valuable tool for temporarily disadvantaging cheatgrass and providing a short window for perennial grass reestablishment. AC addition was not found to alter soil ion availabilities or to affect cheatgrass directly in any way, although there was some indication that it lessened the effect of herbicide on cheatgrass via sequestration. Surface application of AC is also therefore not recommended for use in areas where herbicide will also be used to control cheatgrass or other invasives. We hope the results of these experiments will be useful to land managers and restoration practitioners attempting to reestablish perennial grasses into cheatgrass-invaded areas to disrupt the cheatgrass-wildfire cycle.

## LITERATURE

Knapp, P. A. 1996. Cheatgrass (*Bromus tectorum* L.) dominance in the Great Basin Desert - History, persistence, and influences to human activities. *Global Environmental Change-Human and Policy Dimensions* 6:37-52.

Whisenant, S. G. 1990. Changing fire frequencies on Idaho 's Snake River plains: ecological and management implications. *In*: McArthur, E. D., E. M. Romney, S. D. Smith, and P. T. Tueller [EDS.]. Proceedings of a symposium on cheatgrass invasion, shrub die-off, and other aspects of shrub biology and management; 5-7April 1989; Las Vegas, NV, USA. Ogden, UT, USA: US Department of Agriculture, Forest Service, INT- GTR-276. p. 4-10.