Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Restoring habitat with super-absorbent polymer

Period Covered: January 1, 2019 – December 31, 2019

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In the western United States, successful restoration of degraded habitat is often hindered by invasion of exotic species and unfavorable climatic conditions. Cheatgrass (*Bromus tectorum* L.) is an especially aggressive competitor on disturbed lands and poses threats to restoration, including outcompeting desirable species, altering soil nutrient cycles, reducing species diversity, and decreasing the quality of forage and wildlife habitat. In addition, uncertainties of future climate and precipitation changes make planning for and implementing restorations difficult. With their ability to absorb moisture when soils are wet and slowly release it over time, superabsorbent polymers (SAP) may buffer seeded species against negative impacts of precipitation fluctuations. In a prior CPW study, incorporating SAP into the soil at the time of seeding was found to reduce cheatgrass cover by up to 50% initially, and effects persisted for four years.

Because SAP acts on existing soil moisture, its effectiveness is likely to depend on precipitation factors, such as total annual precipitation, seasonal timing, and size of precipitation events. In this study, we assess the repeatability of the prior study in two additional locations that have contrasting precipitation patterns: a Colorado Eastern Slope site (Waverly Ranch, Larimer County), and a Colorado Western Slope site (Dry Creek Basin State Wildlife Area, San Miguel County). We quantify how SAP influences soil moisture through time at these locations, and how drought, cheatgrass presence, and SAP interact to influence plant community development.

Experiments were implemented in fall 2013 at the Eastern Slope site and summer 2014 at the Western Slope site (Figure 1), and responses were measured until 2017. In 2019, we published the first paper in *Restoration Ecology* (available at https://onlinelibrary.wiley.com/doi/full/10.1111/rec.13083), and submitted the second paper to *Ecosphere.* Below are the abstracts.

Soil amendment interacts with invasive grass and drought to uniquely influence aboveground vs. belowground biomass in aridland restoration

Water-holding soil amendments such as super-absorbent polymer (SAP) may improve native species establishment in restoration but may also interact with precipitation or invasive species such as *Bromus tectorum* L. (cheatgrass or downy brome) to influence re-vegetation outcomes. We implemented an experiment at two sites in Colorado, USA in which we investigated the interactions of drought (66% reduction of ambient rainfall), *B. tectorum* presence (BRTE, 465 seeds m-2) and super-

absorbent polymer soil amendment (SAP, 25 g m-2) on initial plant establishment and 3-year aboveground and belowground biomass and allocation. At one site, SAP resulted in higher native seeded species establishment but only with ambient precipitation. However, by the third year, we detected no SAP effects on native seeded species biomass. Treatments interacted to influence aboveground and belowground biomass and allocation differently. At one site, a SAP × precipitation interaction resulted in lower belowground biomass in plots with SAP and drought (61.7 ± 7.3 g m-2) than plots with drought alone (91.6 ± 18.1 g m-2). At the other site, a SAP × BRTE interaction resulted in higher belowground biomass in plots with SAP and BRTE (56.6 ± 11.2 g m-2) than BRTE alone (35.0 ± 3.7 g m-2). These patterns were not reflected in aboveground biomass. SAP should be used with caution in aridland restoration because initial positive effects may not translate to long-term benefits, SAP may uniquely influence aboveground vs. belowground biomass, and SAP can interact with environmental variables to impact developing plant communities in positive and negative ways.

Invasive annual grass interacts with drought to influence plant communities and soil moisture in dryland restoration

Changes in precipitation may facilitate the spread of invasive species, such as the annual grass, *Bromus tectorum* (cheatgrass or downy brome). *B. tectorum* can alter soil moisture availability to hinder recruitment of native species in restoration projects. Understanding the synergistic effects of drought and invasive species on plant community development and soil moisture could provide valuable insight into the mechanisms hindering successful native plant establishment in dryland restoration projects that have success rates as low as 10%. We implemented a re-vegetation experiment at two sites in Colorado, USA (Western Great Plains (WGP), Cold Desert (CD)) to investigate the effects of drought (66% reduction of ambient growing-season rainfall), *B. tectorum* seed addition (BRTE, 465 seeds m^{-2}), and super-absorbent polymer soil amendment (SAP, 25 g m^{-2}) on plant community development and soil volumetric water content (VWC) at 5 cm and 30 cm depth.

Drought resulted in both higher (WGP) and lower (CD) *B. tectorum* cover. The higher cover of *B. tectorum* with drought at WGP is consistent with predictions for the region. At WGP, drought reduced seeded forb cover and interacted with BRTE to reduce seeded grass cover. At CD, drought and BRTE each decreased seeded species cover from approximately 8% to 3%. SAP increased overall seeded grass cover at WGP from 2.2% to 4.9%.

The effects of BRTE and drought on soil VWC varied by site and depth. Notably, at 5 cm depth at CD, BRTE treatment resulted in lower soil VWC than drought. In 2015 at 30 cm depth, BRTE with ambient precipitation resulted in both the highest (WGP) and lowest (CD) soil VWC. Our results demonstrate that *B. tectorum* and drought can uniquely interact at different sites to influence native plant establishment and soil moisture in dryland restoration settings.

Figure 1. Rainfall exclusion shelters induce artificial drought at the Western Slope site in 2014.