Title: Resilience of High-elevation Sagebrush Steppe Plant Communities to Cheatgrass Management

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Abstract: Cheatgrass (downy brome, *Bromus tectorum*) is a widespread non-native plant management challenge across the western United States and an increasing concern across the Greater Yellowstone Ecosystem (GYE). Historically, cheatgrass has been less competitive in the northeastern region of the sagebrush biome, which includes parts of the GYE, due to ecological constraints. However, anecdotal evidence suggests cheatgrass abundance is increasing on steep, south-facing slopes in southwestern Montana. This study assessed the resiliency of high-elevation sagebrush plant communities and cheatgrass to two consecutive fall applications of post-emergent herbicide (a.i. imazapic, Plateau ®). Over four years we sampled 12 (~8ha) sites across two regions differentiated by their soil types: the Antelope Peak region with a silty clay/loam soil and the Eastern Sandhills with sand. Sampling occurred within the sprayed area and an adjacent non-sprayed, lightly infested reference community at each site. The reference community represented our target plant community, that is, the plant community we wished to achieve following treatment. In the area targeted for treatment the average pre-herbicide abundance of cheatgrass was 9%, ranging from 0 to 90%. We found that cheatgrass can be effectively but temporarily reduced in abundance by applying herbicide. At our sites cheatgrass remained low and similar to the reference site in the Eastern Sandhills but returned to pre-herbicide levels in the fourth year in the Antelope Peak region. Herbicide applications and reductions in cheatgrass abundance did not result in compositional changes, i.e., no difference in plant diversity nor native grass biomass, for high-elevation sagebrush plant communities. In this way we found these communities to be resilient to management. However, we also found these same communities to have less resiliency in response to seasonal precipitation and temperature variation. Explicitly, we found that increasing fall, spring, summer precipitation and decreasing winter precipitation along with warmer fall and summer temperatures and cooler spring temperatures resulted in decreased abundance of native perennial grasses and increased abundance of both native perennial forbs and cheatgrass. Our findings suggest that long-term monitoring will need to coincide with non-native plant management to assess the long-term efficacy of herbicide as we face greater climate uncertainty. We further suggest that monitoring be used within an adaptive management strategy that incorporates an active restoration component, e.g., restoration seeding, as it does not appear herbicide improves cheatgrass resistance in these communities.

Colter Mumford works as a vegetation ecologist for Yellowstone National Park. Most recently he has worked with Montana State University and the Greater Yellowstone Network to develop an ecosystem condition assessment framework for the Greater Yellowstone Ecosystem. He earned a PhD in Ecology and Environmental Science at Montana State University where he studied the effects of cheatgrass management and native plant communities in southwest Montana.