

Title: Competitive dynamics of two non-native grasses (*Bromus tectorum* and *Ventenata dubia*) and cause for concern for secondary invasion in the Greater Yellowstone Ecosystem  
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Non-native annual grasses have modified the landscape of the Greater Yellowstone Ecosystem (GYE). The winter annual grass *Bromus tectorum* (cheatgrass) is a focus of continued management throughout the region, as it has been present for nearly 150 years. It invades grasslands and rangelands following disturbance, where it can form dense monocultures and reduce habitat quality. In recent years, another winter annual grass *Ventenata dubia* (ventenata) has begun to increase in abundance throughout the region, sometimes in areas that were once invaded by *B. tectorum*. *Ventenata dubia* has also been shown to form dense monocultures and diminish habitat quality. Further, *V. dubia* is inaccessible forage early in the season and high in silica content later in the season, decreasing its forage quality relative to *B. tectorum* and native grasses. While both species are causing problems in the GYE, *B. tectorum* is more understood and more abundant than *V. dubia*. Secondary invasion, or the increase in dominance of a once sub-dominant invader after the removal of a dominant co-occurring species, is a major problem in invasive species management. Secondary invasion may occur following management efforts to remove the dominant invader or due to a shift in environmental conditions. Secondary invasions have been shown to occur more often when the co-occurring invaders are closely related or follow similar life history patterns. As winter annual species, *B. tectorum* and *V. dubia* are phenologically similar in their germination and senescence timing, making secondary invasion possible. The goal of this research is to elucidate competitive dynamics between the two species, so that *B. tectorum* management decisions are made that avoid a secondary invasion of *V. dubia*. This study sought to quantify the impacts of intraspecific competition of *B. tectorum* and *V. dubia* as density of conspecifics increases and quantify the impacts of interspecific competition between the two at varying proportions when grown in a controlled setting.

*Bromus tectorum* and *V. dubia* were grown in varying densities and proportions (addition series) for 10 weeks. At the end of the growth period, aboveground biomass was harvested and weighed. We derived the intra- and interspecific competitive effects on each species with a non-linear analysis. *Bromus tectorum* was negatively impacted by intraspecific competition. However, there was little evidence of interspecific competition as *V. dubia* did not have a negative impact on *B. tectorum* biomass. For *V. dubia* the opposite was true, increasing *V. dubia* density did not reduce *V. dubia* biomass, but increasing density of *B. tectorum* did. These results suggest that *B. tectorum* may be limiting further *V. dubia* invasion through competitive impacts on biomass. However, once *B. tectorum* is removed from the area, *V. dubia* may increase in abundance when it is released from this competitive pressure. Further research is being conducted to examine potential plant soil feedbacks that could be contributing to patterns observed in the field. These results may inform future non-native grass management decisions in the GYE.