



From left: Figure 1. Noxious grass weeds, such as goatgrass and medusahead, can dominate grasslands and choke out most other species. Figure 2: Delayed spring growth of noxious weeds, compared to naturalized annuals (late April of 2008). In the foreground: a plot of goatgrass and medusahead, which have low aboveground biomass during early to mid-spring; their peak aboveground growth tends to occur mid-May to early June. In the background: a plot of naturalized annuals dominated by wild oats; these naturalized annuals have an earlier growth spurt from late-February through mid-April, and thus much higher aboveground biomass for most of spring. Photos: Valerie Eviner

California's Native Perennial Grasses Provide Strong Suppression of Goatgrass and Medusahead

by Valerie Eviner¹ and Carolyn Malmstrom² Photos: Valerie Eviner

Background

There has been long-term interest in the competitive dynamics between native and exotic grassland species in California. While many species of native grasses and wildflowers are present in today's grasslands, in most sites their cover is as low as 1–10% (Bartolome et al. 2007). Starting 250–300 years ago, native grasslands became invaded by a suite of exotic grasses and forbs, which now dominate these systems, covering over 90% of the area in most sites (Bartolome et al. 2007). While non-native, these naturalized grasslands support a high diversity of plants, and

nearly 90% of California's rare and endangered animal species. These ecosystems also provide 75% of the forage that supports the state's livestock industry (reviewed in Eviner 2007). In this article, we will refer to this suite of long-established exotic species as naturalized — species that maintain themselves over time in a non-native habitat (NRCS definition). These include species such as wild oats (*Avena* spp.), bromes (*Bromus* spp.), filaree (*Erodium* spp.), and ryegrass (*Festuca perennis*). In California's grasslands, these exotic naturalized species strongly suppress native grass growth and establishment at most sites (Bartolome and Gemmill 1981, Stromberg and Griffin 1996). However, in some cases, the restoration of native perennial grasses can decrease the prevalence of these naturalized species (Corbin and D'Antonio 2004).

A relatively new suite of noxious exotic grasses are invading California's grasslands, including barbed goatgrass (*Aegilops triuncialis*) and medusahead (*Elymus caput-medusae*). Areas invaded by these species show dramatic decreases in plant diversity (Figure 1) and experience a 50–75% decrease in livestock production (Peters et al. 1996) because these noxious grasses have lower biomass through much of the growing season (Figure 2), and once they increase their aboveground biomass, their forage quality is poor, leading to persistent thatch (Figure 1). Consistent

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management of these noxious weeds is challenging, particularly in our naturalized, annual-dominated grasslands, where competitive dynamics are reset each year as all plants emerge as seedlings (Eviner 2016).

While naturalized exotic species often suppress native grasses, native grasses could provide long-term suppression of the more recent noxious weed invaders, including goatgrass and medusahead. In general, control of weeds is most effective when they are suppressed by native species with similar traits (e.g., growth form, timing of growth, rooting depths, resource needs) (Funk et al. 2008). For example, in California grasslands, yellow star thistle (*Centaurea solstitialis*) was best controlled by native tarweed (*Hemizonia congesta* ssp. *luzulifolia*), which is similar in phenology, rooting depth, and growth form (Dukes 2002). In grasslands throughout the Western U.S., restoration of native perennials can decrease noxious invaders such as cheatgrass (*Bromus tectorum*) (Blank and Morgan 2012). In California’s grasslands, native grasses have the potential to compete with goatgrass and medusahead because these species are active in late spring (mid-May into June) (Peters et al. 1996) (Figure 3). In addition, the perennial nature of many native grasses can provide long-term suppression once they have been established (in contrast to competition resetting each year in annual-dominated grasslands, sensu Eviner 2016). This experiment was designed to test whether restoration of native perennial grasses can suppress invasion of the noxious weeds, goatgrass and medusahead, compared to when these noxious weeds are growing with the naturalized exotic annual grasses that dominate California’s grasslands.



Figure 3. Stands of native grasses remain green into the late spring (here, June 2017), while most naturalized annuals have senesced.

Our study design

In Davis, California, during the fall of 2007, we established 18 replicate plots of two treatments (36 plots total), where **noxious invasive weeds** (*A. triuncialis*, *E. caput-medusae*) were planted with either **native species** (*Stipa pulchra*, *E.s glaucus*, *E. triticoides*, *Bromus carinatus*, *Poa secunda*, *Festuca microstachys*, *Lupinus bicolor*, and *Acmispon americanus*) or **naturalized exotic species** (*Avena fatua*, *Bromus hordeaceus*, *F. perennis*, and *Trifolium subterraneum*). Plots were 1.5 x 1.5 m, with a 1-m buffer between plots. Every spring, plots were assessed for percent cover of species at two time-points: mid-spring when most annual grasses were at their peak flowering (late March to April), and late spring, when perennial grasses and the noxious grasses were at peak flowering (mid-May to early June). These plots have been measured for 10 years, across various rainfall years, including the strong drought of 2012–2015 (Figure 4).

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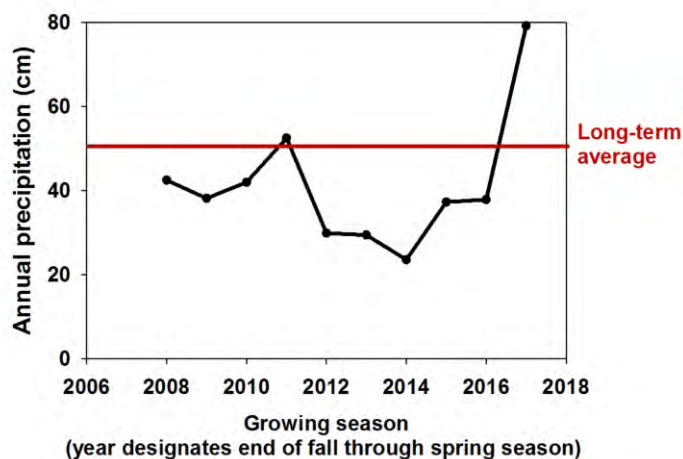


Figure 4: Annual precipitation for each growing season of the experiment. Each year on the graph denotes the end of a growing season (e.g., 2010 is the amount of rainfall that fell between August 1st 2009, and July 31st, 2010).

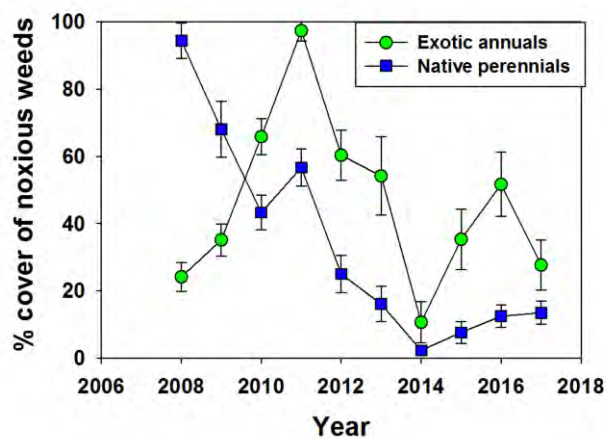


Figure 5. Percent cover of noxious grasses (goatgrass and medusahead) when grown with naturalized exotic grasses (green) vs. with native perennial grasses (blue).

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What we found:

Native grasses had a much stronger ability to suppress goatgrass and medusahead than naturalized grasses (Figure 4). When grown with naturalized annual grasses (dominated by *Avena fatua* and *Bromus hordeaceus*), the cover of noxious grasses fluctuated greatly year to year, varying from 20% cover in the most intense drought year, to 100% cover in the relatively wet 2010–11 growing season (see green line in Figure 5). Most of this variation was due to medusahead, which ranged from 10% to 90% cover when grown with naturalized annuals. Goatgrass cover also varied year to year, but ranged from 10 to 30% cover.

In contrast, when grown with natives (dominated by *E. glaucus* and *E. triticoides*), cover of noxious weeds was initially high (90% in the first year), and greatly decreased over time (Figure 2, blue line). After 6 years, noxious weed cover was consistently less than 20% cover. The prevalence of noxious weeds did vary year to year (being relatively higher in wet years, and lower in dry years), but these variations were far more muted than those seen when grown with naturalized annuals. Natives suppressed both goatgrass and medusahead to the same extent. As in the native plots, annual variability in noxious weed cover in the native plots was largely due to fluctuations in medusahead cover.

While natives did suppress noxious weeds, they did not suppress the naturalized annuals. When grown with natives, naturalized annual cover varied greatly year to year, ranging from 5 to 100% cover. Over the course of this experiment, naturalized exotic cover steadily increased and became dominant over the natives (data not shown). This is consistent with the fact that the naturalized annuals dominate California grasslands, and often limit the success of native grass restoration.

Implications for management

As seen in many other studies, our experiment showed that California's native grasses were out-competed by the naturalized exotics which dominate our grasslands. In most sites, successful restoration projects require long-term, aggressive management of naturalized annual exotics (Bartolome et al. 2007, Malmstrom et al. 2009). What is unique about our study is that it suggests that the effort put into restoring native grasses can be an effective long-term control method for goatgrass and medusahead. While perennial grasses will not eliminate these noxious weeds, they will prevent them from dominating the grassland. The suppressive effect of natives on noxious weeds increased steadily over time, and took 5–6 years to fully kick in — the noxious annuals dominated over the natives for the first few years of the study. In our study, no weed control was done — we planted the mix of natives and noxious weeds and then simply monitored competitive dynamics. It is probable that the suppressive effect of natives on noxious weeds occurs more quickly in restoration projects that have aggressive weed management in the first few years after planting the natives.

This will increase the speed of establishment and growth of natives. In our study, natives were able to “come from behind” and dominate the noxious weeds over time, but this may have only been possible due to the deep soils at our site. In other sites, intense weed management is likely to be critical for successful native establishment. It is also important to note that the plots in this study were not subjected to disturbances such as fire or grazing, which may alter the competitive balance between these species. On-going research is addressing these issues.

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