Prescribed burning controls barb goatgrass (*Aegilops triuncialis* L.) in Central Valley rangeland for up to five years

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Abstract

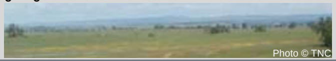
Barb goatgrass (*Aegilops triuncialis* L.) is an invasive annual grass from the Mediterranean region that can strongly decrease both native plant biodiversity and the forage value of grasslands in California. The Cosumnes River Preserve has used fire as a grassland management tool to control invasive grasses like barb goatgrass and to enhance biodiversity. In June 2005, The Nature Conservancy and CAL FIRE conducted a 120-ha prescribed burn at the Howard Ranch, a cattle ranch near Ione, CA. We established four paired study plots in burned and unburned areas to measure the response of the plant community to the fire. Additionally, we tested for percent germination of goatgrass seeds in burned and unburned plots. One year after the burn, goatgrass cover in burned plots was 3% compared to 21% in unburned plots. This reduction in goatgrass cover was still strong two years after the burn (burned = 6%; unburned = 27%) and weaker, but still significant for another three years. The burn also reduced percent germination of goatgrass seed by 99%. The native plant community responded positively to the burn treatment in the first year following the burn with 33% native cover in burned plots versus 13% cover in unburned plots, but the effect was not detectable in subsequent years. Our study shows that a single springtime burn can result in a short-term boost in native species cover, reduced seed germination of barb goatgrass to near zero and reduced cover of barb goatgrass for up to five years after the burn.

Introduction

Grasslands in California have biological and economic values that are threatened by invasive exotic plants. Many rare and endangered species and sensitive communities are found in California grasslands (Sawyer et al. 2009). Much of this land is also used for grazing livestock, partially supporting California's cattle industry, worth $1.69 billion in 2009 (NASS 2010). However, the biological and economic values of these grasslands continue to be threatened by invasive exotic annual grasses. Once introduced, these weeds dominate the grasslands and often form monotypic stands that drastically reduce the abundance of native species. These invasive grasses also reduce the carrying capacity of the land for livestock (George 1992), provide poor nutrition (Bovey et al. 1960), and/or injure animals with their long, stiff awns (DiTomaso 1994).

Barb goatgrass is a winter annual grass from the Mediterranean region. The inflorescence is spike-like, with leathery inflexible glumes encasing mature spikelets. The inflorescence is usually dispersed as a single unit, but spikelets remain intact even if separated from the spike. Most spikelets contain two seeds, with one about 2.5 times larger than the other (Dyer 2004). Both the large seed and the glumes can inhibit germination of the small seed, which may serve to ensure that a fraction of seeds remain in the soil seed bank (Dyer 2004).

Landscape-scale weed control methods in California grasslands are more limited than those available for control of spot infestations and include grazing, fire, and biological control. Grazing has rarely yielded satisfactory barb goatgrass control. Biocontrol agents have not been developed, and likely will not be pursued due to the close relationship between goatgrass and cultivated wheat.



Introduction (cont'd)

Prescribed fire successfully controlled goatgrass in Mendocino County if implemented in two consecutive years (DiTomaso et al. 2001), perhaps because small seeds from the pre-burn year were first inhibited by the glumes and large seeds, then insulated by soil during the first burn (DiTomaso pers. comm.). Prescribed fire is therefore an important tool for goatgrass control, but increasingly strict regulations reduce the likelihood of implementing a burn.

To investigate the efficacy of fire for controlling barb goatgrass, we burned four 12 x 15m macroplots within a larger 120-ha (300-ac) prescribed burn in early June at the Howard Ranch near Ione, CA. We measured the response of goatgrass as well as the rest of the plant community to the fire treatment compared to unburned controls.

We also monitored fire temperature in the burn treatments and tested seed germination of goatgrass seeds collected from burned and unburned plots. We expected goatgrass cover to decrease and native plant cover to increase in burned plots vs. unburned plots.

Materials and Methods

This study was conducted on a 5,000-ha parcel located in eastern Sacramento County, CA, USA (38°38'N, 121°02'W; elevation 75 m). The climate of this region is Mediterranean with average annual rainfall of 56 cm occurring between the months of October and May. Less than 2 cm of rain falls during the summer months. Prior to the burn, we established four burned and four unburned treatment plots within large patches of goatgrass on the site. Each plot was approximately 15 x 20m in size. Half of the plots received a single burn treatment in June 2005, which was conducted separately from the larger 120-ha burn. Within each burned and unburned plot, we monitored goatgrass cover along a 35cm-wide x 10m-long belt transect as well as overall plant cover within 35cm x 70cm permanent quadrats. We monitored the vegetation prior to conducting the burn in June of 2005 and at the same time of year for five years after the burn.

We recorded the highest temperature reached within each burned plot on two 1m tall copper pipes painted with heat-sensitive paint (temp. range 93C (200F) – 343 C (650F)) at soil level and 1m above the soil surface. Seed heads were collected from burned and unburned plots for use in germination trials. We conducted three separate germination trials in the lab on an equal number (n = 10) of both large and small seeds. We ran three separate trials of three germination attempts of 20 seeds for all four burned and two of the unburned macroplots.

Results

Fire temperature was on average 300F higher at the soil surface than at 1 m above the ground (ground = 500F ± 50SE; 1m = 200F ± 10SE; $p<0.01$). Exposure to visible flames was only ~1 second; however, goatgrass inflorescences were knocked to the ground by the flaming front and continued to experience the higher temperatures at the soil level for a much longer period. Consequently, the burn decreased germination of barb goatgrass seeds by 99% (unburned germination rate = 73% ± 8SE; unburned <1% ± 0.5SE; $p<0.0001$). Barb goatgrass cover in burned plots was significantly lower than in unburned plots for five consecutive years after treatment (YAT) (Figure 1). By the fifth YAT, burned plots still had half the goatgrass cover of unburned plots. Native plant cover increased one YAT, but did not vary between treatments in later years (Figure 2). Exotic annual grass (EAG) cover, whether including goatgrass or not, did not vary significantly between treatments within any year (data not shown). No clear patterns emerged for total plant cover, although burned plots had lower cover 2 YAT (burned 109% ± 7SE, unburned 132% ± 7SE, p=0.4) and 5 YAT (burned 81% ± 5SE, unburned 100% ± 7SE, p=0.4).

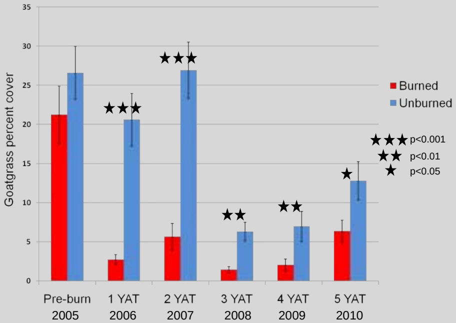


Figure 1: Absolute percent cover (mean ± SE) of barb goatgrass in burned and unburned plots before burning and for five subsequent years.

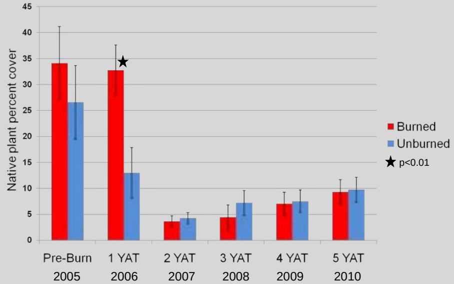


Figure 2: Absolute percent cover (mean ± SE) of native plants in burned and unburned plots before burning and for five subsequent years.

Discussion

Our results show that a single burn at the appropriate time of year can have lasting affects on goatgrass populations. Goatgrass cover was significantly reduced by a single burn for at least five years following the burn. Consistent with other research on fire in California grasslands (Marty 2008), native species cover increased in the burned plots one year after the burn but returned to levels indistinguishable from the unburned plots by the next year.

While goatgrass seed heads in burned plots remained relatively intact after the fire (J. Marty pers. comm.) the fire clearly damaged the seeds. Inferences from previous research suggest that temperatures documented in this burn at 1m would be insufficient to provide adequate kill given the short exposure time (Sweet et al. 2008). We speculate the main damage to the goatgrass seeds occurs after the seed head falls to the ground and experiences the much higher temperatures we recorded there. Once combustion is initiated, the seed head continues to smolder after the flame front passes, leading to seed mortality.

The success of a single burn at this site (Figure 1) differs from results elsewhere (DiTomaso et al. 2001). Many factors potentially affect efficacy of prescribed fire. Thicker thatch present at the time of the burn has been correlated with increased burn efficacy, presumably by slowing down the flame front and/or increasing fire temperature (Kyser et al. 2008). Although the exact factors which led to the success of a single burn are unknown, this success does provide encouraging evidence for the use of fire to control goatgrass as burn regulations become stricter.

Our results show that prescribed fire is an effective tool for reducing cover of problematic annual grasses like barb goatgrass while also promoting native diversity. Prescribed burning is becoming increasingly challenging in the wildland-urban interface as air quality and liability issues become even more prominent. However, it is important to maintain the ability to conduct burns when few other options for large-scale weed reduction remain.

Conclusions

Our research shows that a single late-spring burn:

- reduced goatgrass germination to near zero
- reduced goatgrass cover for up to five years post-burn
- increased native plant cover for one year post-burn

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