Back to the Future: Achieving Resilient, Sustainable Grasslands through Restoration of Ecological Norms

Overview – the Problem, the Opportunity

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Abstract: Grasslands are one of the largest biomes on earth, are the largest agricultural enterprise in the U.S., serve as a major carbon pool, produce high quality dietary proteins, and host a rich biodiversity. However, grasslands, including those of the eastern U.S., have been heavily altered and degraded reducing their resiliency and negatively impacting native fauna. Recent scientific advances in grassland establishment and management, along with the opportunity to monetize the carbon benefits of native grasslands, could provide the needed social and economic support to make such restoration possible on a large scale. Where restored grassland communities align with historical, ecological norms of the region, improved resiliency, sustainability, as well as viability of native biota can all be achieved. Such an approach, based on adapted native grasses and focused on the principles of working lands conservation, can be a template for grasslands restoration globally.

Introduction

Recent focus on the plight of grasslands globally suggests action is needed to conserve existing grasslands and to implement restoration where conversion and/or degradation has occurred (Buisson et al. 2022). Grasslands of North America, including those of the eastern U.S., are not immune to this problem (Samson and Knopf 1994). Finding practical solutions that can facilitate appropriate conservation implementation is critical regardless of geographic context. Approaches likely to be successful must begin with appropriate conformity to historical, ecological norms of the region. In turn, this places an appropriate emphasis on native vegetation, species with strong association with the soils and climate conditions within the restoration area. Given these adaptations, native species can produce resilient grassland communities that are sustainable in the face of weather and climatic extremes (i.e., drought and floods). Furthermore, these native species can provide critical habitat for at-risk grassland fauna including declining bird populations and pollinators. However, any restoration initiatives must be practical to individual farm operators and, therefore, must make sense from a business perspective (Phalan et al. 2011; Keyser et al. 2022). Thus, a working lands approach is most likely to achieve restoration objectives. Herein, we present a case for just such a restoration approach applicable to the eastern U.S. but that could serve as a model more widely.

The Problem

Grasslands are among the most extensive biomes globally accounting for more than 25% of all land on earth, 35% of the tropics and subtropics (Stromberg and Staver 2022) and exclusive of Greenland and Antarctica, 40% of the Earth's land surface, some 52 million km^2 (Bai and Cotrufo 2022). Loss of grasslands is a global phenomenon impacting grasslands in Brazil (with greater losses than the rainforest) and North America (Buisson et al. 2020). It has been estimated that more than 90% of temperate grasslands have been converted to other uses with less than 1% protected from further degradation (Stromberg and Staver 2022). In environments with ample precipitation, such as grasslands of the humid eastern U.S., the losses have been greater. With the loss in grasslands has come a concomitant loss in biodiversity, including soil biota, avifauna, and native pollinators (Keyser et al. 2022). Where native grasslands have

been converted to introduced species, the situation for most of the grasslands in the eastern U.S., vulnerability to increased environmental stress is a concern and with it, sustainability of grasslands agriculture.

The Solution

In the face of the losses in native grasslands and degradation of others, an opportunity exists to restore grasslands based on a working lands approach (Keyser et al. 2019a) and with a focus on adapted native species. Critical to this approach is overcoming obstacles to establishment of these species following elimination of introduced vegetation. Native-based forage systems must also be practical and be economically efficient (Boyer et al. 2020). To achieve social acceptance of conversions to native species, there must be ample evidence of improved resiliency, soil health, biodiversity as well as economic benefit. In recent years, this has included opportunities to monetize the carbon storage capacity of native grassland vegetation (Bai and Cotrufo 2022).

Productive grasslands

To make sense for successful restoration, adapted species must be selected. In the eastern U.S., species such as big bluestem (*Andropogon gerardii*), indiangrass (*Sorghastrum nutans*), switchgrass (*Panicum virgatum*), and eastern gamagrass (*Tripsacum dactyloides*), once dominated native grasslands. Each of these species is well-adapted to the soils, climate, and biota of the region. As such, they can offer improved resiliency and sustainability to agricultural operations across the region. In comparison to their non-native counterparts that now dominate the region, tall fescue (*Schedonorus arundinaceus*) and bermudagrass (*Cynodon dactylon*), the natives have greater tolerance to drought, saturated soils, and extreme heat, and also are productive across a wider range of soils (Gelley et al. 2019).

Making restoration work

However, despite the natural adaptation of these native species to the region's conditions, successful establishment requires careful attention to detail and sound agronomic practices. Native species have been established successfully with conventional (i.e., tillage based) and no-till practices. High quality seedbeds are essential though, regardless of which approach is used. This includes clean, firm, fine textured seedbeds with excellent control of (mostly) non-native competition (Keyser et al. 2019b). Strategies to improve agronomic practices are being explored and should address reliability of establishment and off-setting lost forage production during the establishment year.

Soil health

The role of grasslands in developing and sustaining healthy soils is well known but has often been overlooked. With increased interest in carbon balances, grassland soils are receiving increased attention (Bai and Cotrufo 2022). However, there are other benefits associated with improved soil health including greater resiliency to flood and drought, better plant community stability, and a more diverse and robust soil biota. This, in turn, can allow for reduced inputs of inorganic fertilizers while maintaining productivity (Hu et al. 2022). Because of the large root volumes and deep penetration of their roots within the soil column, the native grasses mentioned above can make a strong contribution to soil organic matter, carbon stores, and, ultimately, soil health outcomes more generally.

The birds and the bees

Biodiversity is essential to any sustainable system including grasslands (Keyser et al. 2022; Stromberg and Staver 2022). Increasing awareness of the impacts of fragmentation, degradation, and conversion of native

grasslands on native biota is a critical first step in moving towards effective conservation of grassland ecosystems (Keyser et al. 2022). Within the eastern U.S., grassland-adapted avifauna have experienced steep population declines, more severe than for any other guild of North American birds (Rosenberg et al. 2019). A particularly compelling example of this decline is the northern bobwhite (*Colinus virginianus*), a gallinaceous species that has experienced a decline of more than 80% over the past 50 years. Fortunately, emerging research indicates this species can show positive population responses in a working lands pasture system based on native grasses (Sinnott et al. 2022).

Dollars and sense

Adoption of grasslands conservation will likely require that the proposed restored systems prove profitable, or at a minimum do not result in reduced farm income. Based on recent research, native grass pastures and hayfields have proven to produce higher rates of gain, more gain per ha, and consequently, provide gain at lower cost with greater net returns than introduced species (Boyer et al.2020). Further, there is evidence that the economic benefits of native grass-based forage programs may be more resilient in response to extreme weather and thus, offer a more effective investment to producers (Brazil et al. 2022). Recent focus on monetizing carbon benefits associated with these grasslands may offer further economic incentive to restore native grasslands for pasture production.

Conclusions

In the face of ongoing loss and degradation of grasslands throughout the world, and within most regions, including the eastern U.S., practical strategies to restore native grasslands should be developed. Such grasslands may play important roles in improving system sustainability through enhanced resiliency, improved soil health, improved biodiversity, and potentially, a pathway to improved carbon balances. However, for such approaches to have an impact, challenges to successful establishment must be addressed and the economic outcomes of conversion need to be clearly documented, including those associated with carbon sequestration.

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