Changes in Floral Resource Availability in Rangelands Managed with Patch-burn Grazing: Implications for Pollinators

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We are evaluating the effect of a patch-burn grazing management strategy on floral phenology. Our treatment structure includes four replicates of the following: (1) season-long grazing, (2) season-long grazing with dormant-season patch burning (one-fourth of the pasture) at a four-year return interval and (3) season-long grazing with dormant-season (one-eighth of the pasture) and growing-season (one-eighth of the pasture) patch burning at a four-year return interval. Here we present preliminary results following two years of study.

Introduction

Grassland pollinators are in decline, and numerous threats include land-use intensification, pesticide use and simplification of floral communities (Hegland and Boeke, 2006; Hladik et al., 2016). Pollinator diversity in grassland systems has been shown to be associated positively with floral community (Fründ et al., 2010), but diversity and abundance are not the only concerns.

Floral availability is essential for a sustained pollinator community throughout the season. For example, if pollen and nectar demand is consistent or increasing throughout the year, it does no good to have abundant floral resources in May and July but limited resources in June. One solution in grasslands lacking a diverse forb assemblage could be to plant a seed mix with floral bloom throughout the season. However, this may be prohibitively expensive (Espeland, 2014).

Another alternative may be to manipulate forb characteristics via management, specifically using patch-burn grazing. Fire has been shown to synchronize the phenology of flowering forbs (Platt et al., 1988). In addition, fire can increase the abundance of flowers on the landscape (Wrobleski and Kauffman, 2003). These studies both show that the availability of flowers can be enhanced via fire, but they treated fire as a binary variable.

By having a diversity of burn ages on the landscape, we hope to stretch the total time that flowers are available on the landscape while also enhancing flower abundance and diversity. Even if flowering times are delayed by fire relative to unburned areas, total availability on the landscape could be increased by a diversity of flower expression.

Procedures

Study Area
The Central Grasslands Research Extension Center (CGREC) is in North Dakota's Kidder and Stutsman counties (46° 42' 56" N, 99° 27' 08" W) in the Missouri Coteau ecoregion of the northern mixed-grass prairie. The herbaceous community is dominated by native cool-season grasses such as green needlegrass (*Nassella viridula*), western wheatgrass (*Pascopyrum smithii*) and needle-and-thread grass (*Heterostipa comata*).

Common invasive grasses on site include Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*) (Patton et al., 2007). Western snowberry (*Symphoricarpos occidentalis*) is the dominant woody species at the CGREC, although silverberry (*Eleagnus commutata*) and wild rose (*Rosa arkansana*) are present.

The forb community is diverse and dominated by western ragweed (*Ambrosia psilostachya*), prairie coneflower (*Ratibida columnifera*), goldenrod (*Solidago* spp.), yarrow (*Achillea millefolium*) and Flodman's thistle (*Cirsium flodmanii*) (Rogers et al. 2005). The climate is characterized as temperate and experiences an average yearly rainfall of 40.28 centimeters (15.9 inches) and an average annual temperature of 4.94 C (40.9 F) (1991-2016, North Dakota Agricultural Weather Network).

Landscape context is important for structuring pollinator communities and seasonal abundances, especially the amount and diversity of surrounding cropland (Rundlof et al., 2008; Persson and Smith, 2013). The surrounding landscape is primarily rangeland, with pastures of corn (*Zea mays*), soybeans (*Glycine max*), canola (*Brassica rapa*) and wheat (*Triticum aestivum*).

The study plots have a history of cattle grazing and limited exploratory agriculture. Additionally, the study plots do not have a recent history of burning. Thus, our treatments may incur a lag effect as we establish the treatment structure.

Treatment Structure

Our treatment structure includes four replicates, each consisting of a 160-acre pasture divided into eight sub-patches. The treatments include: (1) season-long grazing (SLG), (2) season-long grazing with dormant-season patch burning (one-fourth of the pasture) at a four-year return interval (PBG40) and (3) season-long grazing with dormant-season (one-eighth of the pasture) and growing-season (one-eighth of the pasture) patch burning at a four-year return interval (PBG20).

Annual burn plots in treatment 3 will be two adjacent 20-acre sub-patches. Growing-season burns are incorporated to increase forage quality for livestock in the middle of the season (Scasta et al., 2016). Fire return intervals mimic the historical disturbance regime of mixed-grass prairie.

Cow-calf pairs will graze freely within pastures from May 1 to Oct 1 each year at a moderate stocking rate designed to achieve 30% forage utilization. Soil type and vegetation communities are similar among replicates, as defined by Natural Resources Conservation Service ecological site descriptions and equivalent land use histories.

Methods

Assessing Floral Availability

Once per week from May 20 to Sept. 1, we performed floral resource surveys using 300-meter (m) belt transects centered within each one-eighth of a pasture sub-patch (DeBano et al., 2016). Along each transect, we tallied all flowering ramets within 1 m of the transect that are usable by bumblebees (Moranz et al., 2014). We identified ramets to species and estimated the abundance of hyperabundant species such as yellow sweetclover (*Melilotus officinalis*). We randomized the order of surveys each week. In addition, we limited surveys to three consecutive days each week, when possible, to reduce the effects of phenological advancement within the week.

Analysis

The lengths of flowering periods as well as the diversity and abundance of flowers were compared among treatments using generalized linear models using the R package lmer (R Core Development Team).

Prior research demonstrates that fire can prolong the flowering period of rangeland forbs, as well as enhance the flower set of individual plants (Wrobleski and Kauffman, 2003; Mola and Williams, 2018). To assess phenological advancement, we marked the week where each patch had the maximum number of ramets and used this value in models.

Results

Assessing Floral Availability

Our weekly surveys culminated in 15 rounds per year in 2018 and 2019. We documented 156 flowering plant species and 2,483,116 flowering ramets. We found that flowering plant abundance and diversity were higher in both patch-burn grazing treatments, compared with season-long grazing (Figure 1).

Additionally, we found differences in species-specific flowering plant phenology among treatments. For example, rigid goldenrod (*Solidago rigida*) reached its peak abundance more than two weeks later, compared with season-long grazing (Figure 2). Among fire age classes, western snowberry (*Symphoricarpos occidentalis*) reached peak flowering more than three weeks later in new burns, compared with unburned patches and one year-since-fire patches (Figure 2).

Discussion

Our results show that patch-burn grazing increases floral availability and diversity. Even in species that did not extend their phenology under patch-burn grazing, a diversification of phenology within a species increases temporal stability of that resource under patch-burn management (Figure 2). In light of these conclusions, patch-burn grazing appears to be an effective conservation tool for those seeking to increase resource availability for native rangeland pollinators.

Photo credit: C.A. Duquette

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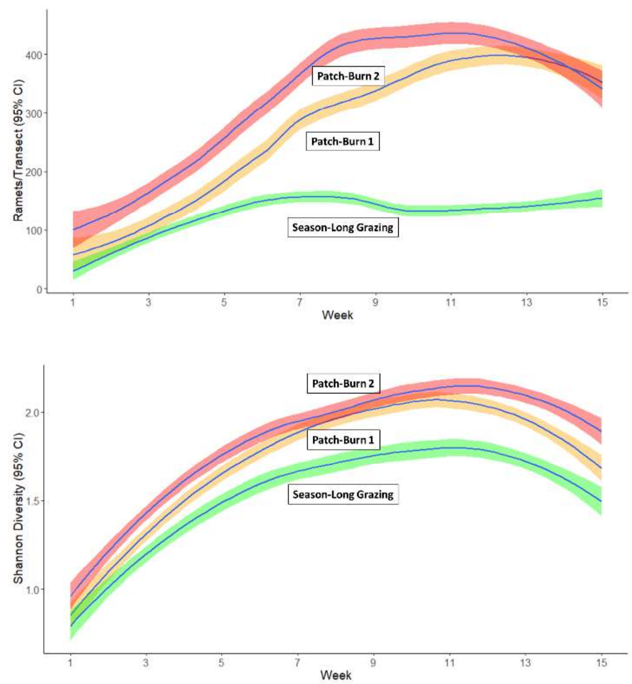

Figure 1. Total flower abundance (top) and Shannon diversity (bottom) of pastures managed with season-long grazing, patch burning with one season of fire and patch burning with two seasons of fire at the Central Grasslands Research Extension Center near Streeter, N.D., in 2018 and 2019.

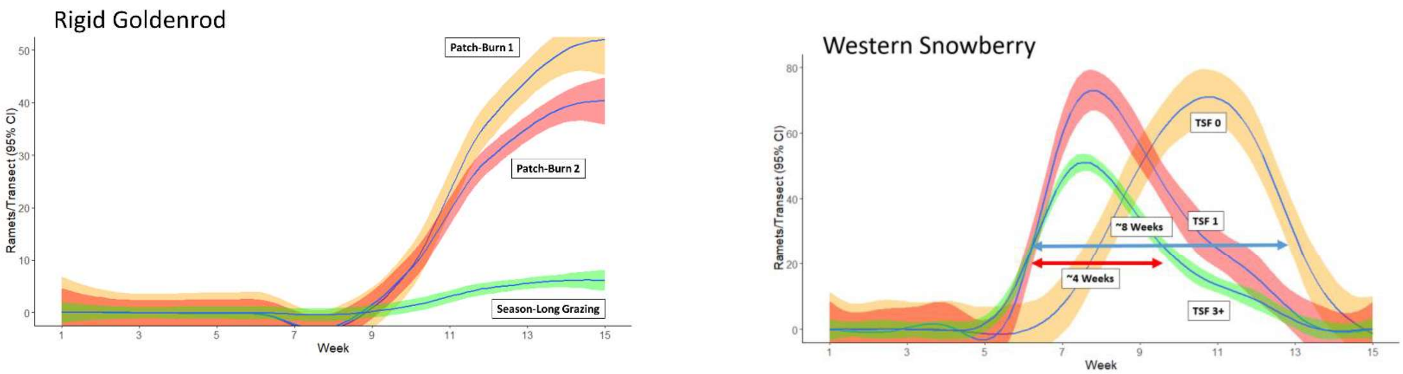

Figure 2. Rigid goldenrod abundance (left) and western snowberry flower expression (right) in pastures with season-long grazing, patch burning with one season of fire and patch burning with two seasons of fire at the Central Grasslands Research Extension Center near Streeter, N.D., in 2018 and 2019, illustrating the resource benefits provided by patch-burn grazing via phenological heterogeneity.