Butterfly Community Response to Cattle Management Strategies

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We assessed the influence of four cattle management regimes on the butterfly community and individual species. Our four regimes were season-long grazing without fire, meant to mirror traditional management practices; two forms of patch-burn grazing; and modified twice-over rest-rotation grazing, which are all meant to mimic the natural heterogeneity in vegetation structure in grasslands.

One of our patch-burn grazing treatments has a single season of fire and the other has two seasons of fire. We calculated species richness and total abundance, which were higher in the two patch-burn grazing treatments than the two other treatments.

We also calculated densities for 17 individual species. Six of these species showed differences between treatments: three had the highest densities in patch-burn grazing treatments and three had the highest densities in the modified twice-over rest-rotation treatment. We suggest that managers implement a carefully planned patch-burn grazing system to support the butterfly community as a whole.

Introduction

Pollinators provide valuable ecosystem services worldwide. Native pollinators provide up to $3.07 billion in the U.S. in agricultural pollination (Losey and Vaughn, 2006) in addition to preserving biodiversity through native plant pollination (Allen-Wardell et al., 1998).

However, pollinator populations are in decline worldwide (Potts et al., 2010). The drivers of this decline include climate change (Peterson et al., 2004), pesticide-induced mortality (Rortais et al., 2005) and habitat degradation through mismanagement (Potts et al., 2010).

To combat these declines, creating land management plans that account for native pollinators is important. In the Great Plains, such a plan should reinstitute the natural disturbances of fire and grazing, alongside which native species evolved (Anderson, 2006).

When combined in a patch-burn grazing framework, fire and grazing create a “shifting mosaic” of patches, where grazers utilize the most nutritious forage in the most recently burned patch (Allred et al., 2011; Fuhlendorf and Engle, 2001). This allows for a variety of vegetation structure, including forb diversity, deep litter and bare ground throughout the patches (Fuhlendorf and Engle, 2004).

Different pollinator species have different habitat requirements, so this variety of vegetation could prove beneficial for many native pollinators throughout their life cycles. Previous research into the influence of patch-burn grazing on pollinators has focused on tallgrass prairie in the southern Great Plains (Debinski et al., 2011; Moranz et al., 2012) and not the mixed-grass prairie in the northern Great Plains.

Additionally, past research has included only one season of fire, and our work included dormant and growing-season prescribed burns to determine how this influences the butterfly community. Further, studying the butterfly response to management practices could provide important insight into other native insects because butterflies can be indicator species (Brereton et al., 2010; New, 1997).

As such, our main objectives for this study were to 1) assess the butterfly community response to four treatment types and 2) quantify butterfly species’ densities across the four treatments. Our four treatments are patch-burn grazing with one season of fire, patch-burn grazing with two seasons of fire, season-long grazing and modified twice-over rest-rotation grazing.

Procedures

Our research takes place in the Missouri Coteau ecoregion. The region is primarily mixed-grass prairie with a semiarid climate. Specifically, we are using the Central Grasslands Research Extension Center, which is managed by North Dakota State University in central North Dakota.

Each of our four treatment types has four replicates for a total of 16 pastures, each 160 acres. The patch-burn grazing treatments with one season of fire have a 40-acre prescribed burn applied each spring.

The patch-burn grazing treatments with two seasons of fire have a 20-acre patch burned each spring, and an adjacent 20-acre patch burned in late summer or early fall. The spring prescribed burns were dormant-season burns, and the late summer or early fall burns were growing-season burns.

All pastures were stocked moderately with mixed-breed cow-calf pairs from mid-May to mid-October for 30% forage utilization. Cattle in each treatment, except for the modified rest-rotation, freely roamed within their treatment pasture but do not have access to other treatments or replicates. Cattle in the modified rest-rotation treatment were confined to a 16-ha paddock, with four paddocks in each pasture, each with a different stocking intensity (idle, low, moderate or high).

Each pasture had eight permanent 150-meter transects for conducting butterfly surveys, for a total of 128 transects. We conducted line-transect distance sampling using these transects, wherein we walked each transect and recorded the species and distance perpendicular from the line for each adult butterfly seen.

Observers walked each transect three times throughout the butterfly flight season to capture the most accurate data across the season. The survey period corresponds with the butterfly flight period, and surveys took place between June 1 and Aug. 30.

Statistics
We calculated butterfly abundance and species richness for each treatment, and followed this with an analysis of variance (ANOVA) to quantify the butterfly community. We used the statistical program Distance 7.1, release 1 (Thomas et al., 2010) to calculate densities for all butterfly species with a minimum of 60 detections.

Results

In the 2017-2019 field seasons, we recorded a total of 14,325 butterflies, representing 40 species, across the four cattle management treatments.

Butterfly Community
Our ANOVA showed that the two patch-burn grazing treatments have more abundant and species-rich butterfly communities than the two treatments without fire (Figure 1).

Butterfly Density
We calculated densities for 17 species that met our minimum threshold. Six species showed different densities across the treatments. Three had the highest densities in the treatments that included fire, and three had the highest densities in treatments that did not include fire (Figures 2 and 3). Eleven species did not show statistically different densities across the four treatments (Figures 2 and 3).

Discussion

Grasslands are a disturbance-dependent ecosystem (Anderson, 2006). Not all disturbances are created equally, however, and in grasslands, this means that the use of grazing in the absence of fire is ineffective. For sensitive species including butterflies, which are in decline across most ecosystems, understanding what sort of disturbance regime best suits their needs is imperative (Potts et al., 2010).

Our findings broadly indicate that the butterfly community differs between grazing-only and patch-burn grazing management types. We saw no difference between our two fire regimes, nor between our two types of grazing-only management.

The pastures that included fire and grazing had more individuals of more species than did pastures including only grazing, contradicting previous studies that found that fire can impact butterflies negatively (Swengel 2001; Kral et al. 2017). However, many previous studies applied fire more homogenously than we did, which likely accounts for the dissimilarity (for example, Benson et al. 2007).

While many species likely did experience some mortality during our fires, because our fires were relatively small and always were directly adjacent to unburned grassland, large refuges still were available for butterflies in vulnerable life stages (Vogel et al. 2007).

Our modified twice-over rest-rotation grazing treatment was meant to mimic the effects of patch-burn grazing by rotating grazing intensity yearly such that the heavily grazed paddocks would represent a fire and would be followed by an idle year, representing one year since fire, and so forth (Cid et al. 2008).

This does not appear to be the case at our site. Our butterfly community data, as well as some of the species' densities, show that this treatment was more similar to season-long grazing than it was to patch-burn grazing. When considering individual species' densities, we saw that three species (common ringlet, Aphrodite fritillary and orange sulphur) had the highest density in the modified twice-over rest-rotation grazing treatment.

However, all three of these species were common throughout our entire site, and only common ringlets are grassland obligate species (Glassberg 2001; Royer 2003). Three other species showed differences in density among our treatments, and all three of them were higher in both of the patch-burn grazing treatments than both of the grazing-only treatments.

Two of these species (meadow fritillary and long-dash skipper) are grassland obligates (Glassberg 2001; Royer 2003), and the third is facultative (Melissa blue). Although the remaining two grassland obligate species (regal fritillary and wood nymph [Glassberg 2001; Royer 2003]) at our site did not show statistically significant densities among our treatments, we saw a trend toward higher densities in the patch-burn grazing treatments than the grazing-only treatments.

We evaluated the butterfly community and species' responses to the reintroduction of natural disturbances through the use of patch-burn grazing in a northern Great Plains landscape. Contrary to previous studies of butterflies and fire (for example, Debinski et al. 2011; Moranz et al. 2012), we found that the butterfly community was not only different in patch-burn grazing pastures but also was more species rich and abundant than in pastures treated with grazing alone.

Overall, our findings support the idea that patch-burn grazing is beneficial to pollinators. By leaving large areas of grassland unburned each year, we left refugia for sensitive species and still provided the resources that interacting fire and grazing can create. We recommend that carefully planned patch-burn grazing, with small patch sizes, should be used to support butterfly conservation plans in the northern Great Plains.

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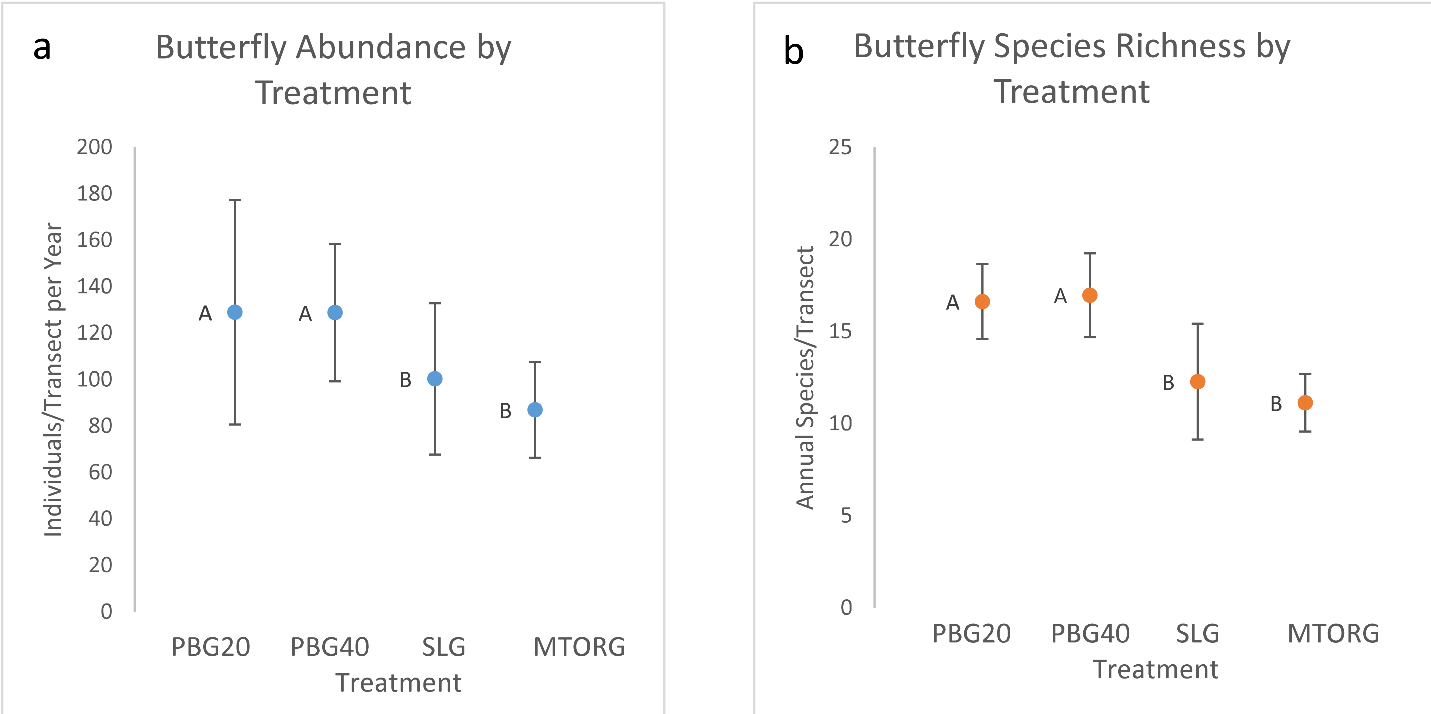

Figure 1a-b. Butterfly total abundance and species richness compared across treatments. Abundance and richness values are based on the mean per transect summed across the season (three surveys summed). Bars indicate standard error. Letters denote results of post-hoc test (p<0.001). PBG20 is patch-burn grazing with two seasons of fire; PBG40 is patch-burn grazing with one season of fire; SLG is season-long grazing; MTORG is modified twice-over rest-rotation grazing.

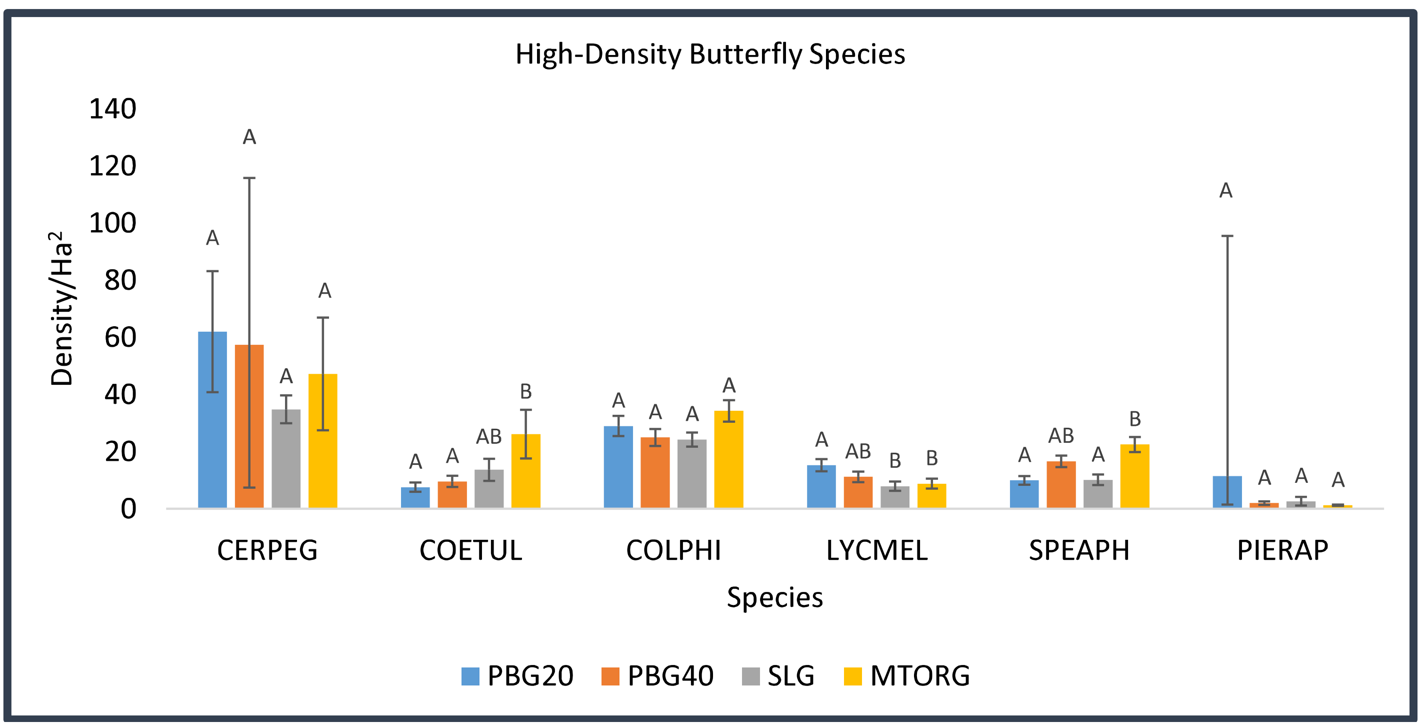

Figure 2. Density estimates for six species meeting a minimum threshold of 60 or more detections and densities of 20 or more individuals per hectare. Bars indicate standard error. PBG20 is patch-burn grazing with two seasons of fire; PBG40 is patch-burn grazing with one season of fire; SLG is season-long grazing; MTORG is modified twice-over rest-rotation grazing. Species codes can be found in Table 1.

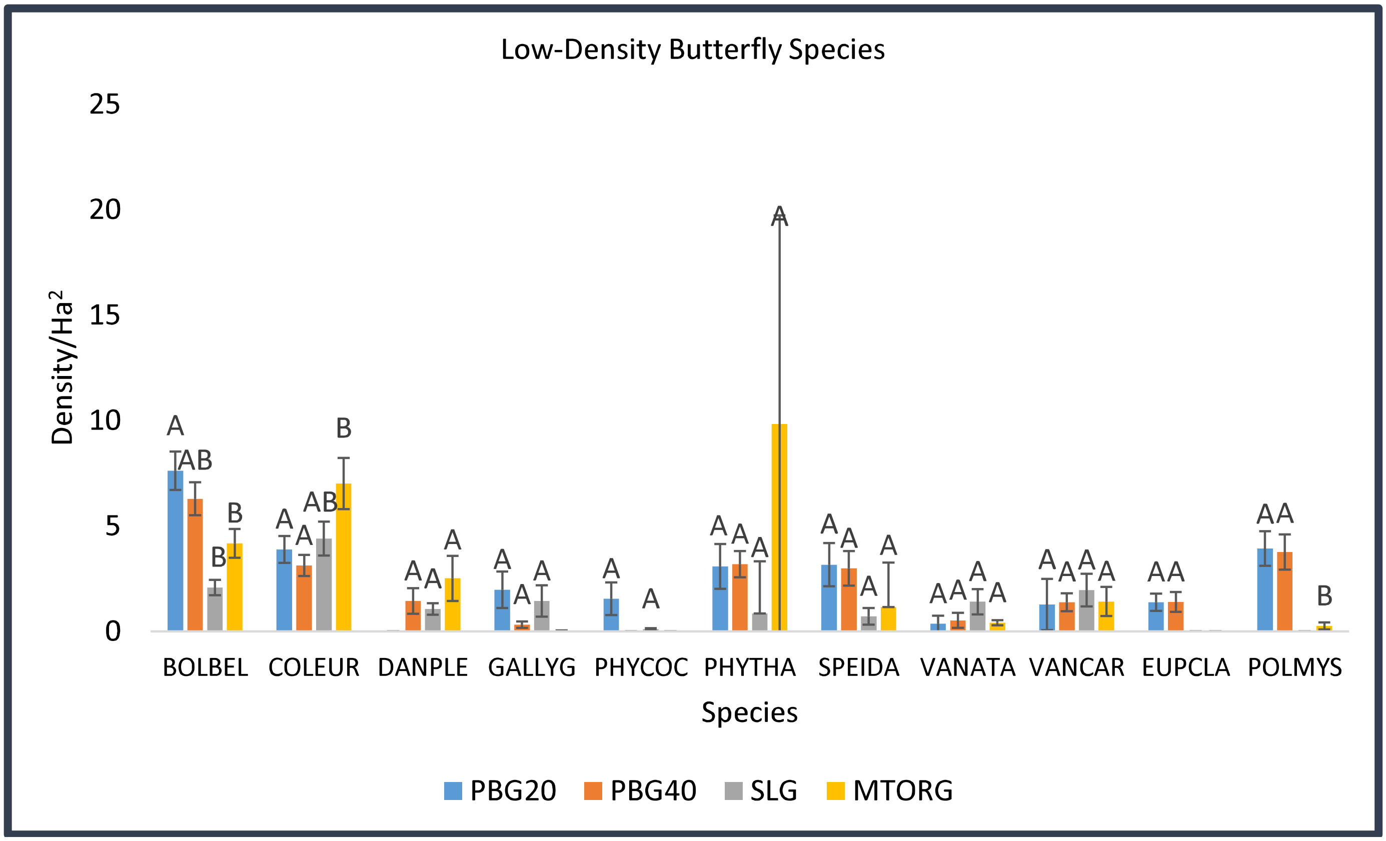

Figure 3. Density estimates for 11 species meeting a minimum threshold of 60 or more detections and densities of 20 or fewer individuals per hectare. Bars indicate standard error. PBG20 is patch-burn grazing with two seasons of fire; PBG40 is patch-burn grazing with one season of fire; SLG is season-long grazing; MTORG is modified twice-over rest-rotation grazing. Species codes can be found in Table 1.

Table 1. List of all butterfly species codes, including common and scientific names.

Species Code	**Common Name**	**Scientific Name**
BOLBEL	Meadow fritillary	*Boloria bellona*
BOLSEL	Silver-bordered fritillary	*Boloria selene*
CELNEG	Summer azure	*Celestrina neglecta*
CERPEG	Common wood nymph	*Cercyonis pegala*
CHLGOR	Gorgone checkerspot	*Chlosyne gorgone*
COETUL	Common ringlet	*Coenonympha tullia*
COLEUR	Orange sulphur	*Colias eurytheme*
COLPHI	Clouded sulphur	*Colias philodice*
DANPLE	Monarch	*Danaus pleixippus*
ENOANT	Northern pearly-eye	*Enodia anthedon*
EPACLA	Silver-spotted skipper	*Epargyreus clarus*
EUPCLA	Variegated fritillary	*Euptoieta claudia*
GLALYG	Silvery blue	*Glaucopsyche lygdamus*
LIMARC	Viceroy	*Limenitis archippus*
LIMART	Red-spotted purple	*Limenitis arthemis*
LYCDIO	Gray copper	*Lycaena dione*
LYCHEL	Purplish copper	*Lycaena helloides*
LYCHYL	Bronze copper	*Lycaena hyllus*
LYCMEL	Melissa blue	*Lycaeides melissa*
LYCPHL	American copper	*Lycaena phlaeas*
NYMANT	Mourning cloak	*Nymphalis antiopa*
PAPGLA	Eastern tiger swallowtail	*Papilio glaucus*
PAPPOL	Black swallowtail	*Papilio polyxenes*
PHYBAT	Tawny crescent	*Phyciodes batesii*
PHYCOC	Northern crescent	*Phyciodes cocyta*
PHYTHA	Pearl crescent	*Phyciodes tharos*
PIERAP	Cabbage white	*Pieris rapae*
POLMYS	Long-dash skipper	*Polites mystic*
POLPEC	Peck’s skipper	*Polites peckius*
POLTHE	Tawny-edged skipper	*Polites themistocles*
PONPRO	Checkered white	*Pontia protodice*
PYRCOM	Common checkered skipper	*Pyrgus communis*
SATEUR	Eyed brown	*Satyrodes eurydice*
SATTIT	Coral hairstreak	*Satyrium titus*
SPEAPH	Aphrodite fritillary	*Speyeria aphrodite*
SPECYB	Great spangled fritillary	*Speyeria cybele*
SPEIDA	Regal fritillary	*Speyeria idalia*
STRMEL	Gray hairstreak	*Strymon melinus*
VANATA	Red admiral	*Vanessa atalanta*
VANCAR	Painted lady	*Vanessa cardui*