Butterfly Species in Native Prairie and Restored Prairie

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ABSTRACT – The objective of our study was to compare butterfly species composition in native versus restored prairie. The study took place at the Rockefeller Experimental Tract of Kansas Ecological Reserves, Jefferson County, Kansas. The five tracts chosen for the study included a native prairie and an area reseeded to prairie undergoing four different management treatments (untreated, mowed, grazed, and burned). Three 50 x 50 m plots were placed within each tract and butterfly species richness was assessed five times in each plot during May through October, 1992. Native prairie had by far the highest frequency of occurrence of butterflies; the burned prairie had lowest. Grazed, mowed, and untreated tracts had intermediate frequency of occurrence of butterflies. Species richness was not significantly different among tracts. Two species, the monarch (*Danaus plexippus*) and the clouded sulphur (*Colias philodice*) showed statistically different frequencies of occurrence among tracts, highest in the native prairie. Vascular plant species richness was not a good predictor of butterfly species richness in our study, despite a twofold difference in species richness of vascular plants in the native prairie relative to the restored prairies.

Key words: prairie, butterflies, species richness, management, restoration.

Restoration ecology, with a particular focus on prairie restoration, has become an emerging science in the past few decades (Jordan et al. 1987, Thompson 1992, Shirley 1994, Falk et al. 1996, Packard and Mutel 1997). Many of the "recipes" for prairie restoration remain anecdotal, and rigorously designed experimental approaches are often limited by logistical constraints. In addition, the restoration of communities has been biased towards restoring the plant community, which makes sense given that the plant community dictates potential habitat for most of the animal community. Yet there are many unanswered questions about the types of management that are best,

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particularly for the insect community. Taron (1997) describes the "flames of controversy" surrounding the debates about the benefits of burning for prairie restoration relative to the insect community: critics proclaim that burning can damage or even eliminate populations of rare insects, but the literature is scant for examples supporting this claim.

In our study we compared the butterfly communities in a native prairie with those of four adjacent "restored" prairie habitats. Each of these restored habitats varied with respect to its management prescription, and because this experimental landscape has been maintained with the same management prescription since 1962, it was an ideal landscape in which to compare the butterfly communities.

The objective of our study was to examine the relationships between prairie management and butterfly species richness and frequency of occurrence. Butterflies rank among the most prairie remnant-dependent of all insects (Panzer et al. 1995), and given their popularity and tractability are an excellent indicator group for monitoring effects of management on the insect community.

STUDY SITES

Our research was conducted on five prairie habitat tracts, encompassing the Rockefeller Experimental Tract (T11S, R20E, Sec. 33 SW1/4, Jefferson County, Kansas) of the University of Kansas (Fig. 1): native prairie and four tracts of reseeded prairie --untreated, mowed, grazed, and burned. Because the management regimes in each of the tracts has been maintained for over 30 years, the five tracks provided an ideal setting in which to study the relationship between butterfly species richness and prairie restoration techniques. Each of the tracts has had a different history, resulting in five very different vegetation assemblages (Fitch and Hall 1978).

Before 1957, the untreated, mowed, grazed, and burned tracts were used for agriculture. In 1957, they were plowed and then reseeded with four perennial tall grasses, big bluestem (*Andropogon gerardii)*, little bluestem (*Andropogon scoparius)*, Indian grass (*Sorghastrum nutans)*, and switchgrass (*Panicum virgatum*), and, since 1962, they have been used by the University of Kansas for experimental purposes. The native prairie was never plowed. Below is a description of the five tracts (Fig. 1). The numbers in parentheses refer to the tract numbers in Table 1. No published accounts describing these tracts were available post-1978. Therefore, we have added personal observations where they were deemed appropriate.

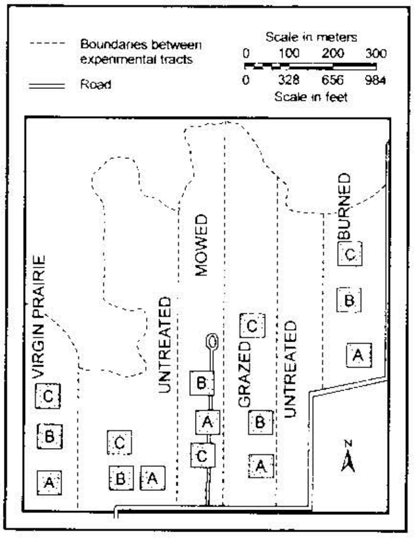

Figure 1. Rockefeller Experimental Tract, Jefferson County, Kansas, showing placement of 50 x 50 m plots for butterfly sampling (adapted from Fitch and Hall 1978).

Native Prairie (3001)

The native tallgrass prairie was a 4.0 ha tract that was maintained by annual burning from 1870 to 1957. The management regimen was changed to burning every three years from 1957 through the late 1960's. Thereafter, it was burned annually or biannually, except in some years when it was mowed or both mowed and burned (Fitch and Hall 1978). Prior to our research, the most recent burn occurred on April 13, 1992. No woody species had invaded except for smooth sumac (*Rhus glabra*). There was a high species diversity of vegetation, which included tall grasses, forbs, and the endangered Mead's milkweed (*Asclepias meadii*) (K. Kindscher unpub. data, Kansas Biological Survey).

Untreated (3002)

After reseeding in 1957 the untreated 7.06 ha tract was left unmanaged. Patches of invasive woody vegetation include rough-leaved dogwood (*Cornus drummondii*), red cedar (*Juniperus virginiana*), high-bush blackberry (*Rubus ostryifolius*), and smooth sumac. Grass was sparse (Fitch and Hall 1978) and the herbaceous vegetation was primarily short (less than 1 m) including some prairie species (Debinski, pers. observ.).

Mowed (3008)

The 0.75 ha mowed tract has been annually mowed during July or early August since 1962. Mowing, like fire proved to be highly effective in maintaining prairie vegetation, although this plot had a higher diversity of prairie vegetation than the restored burned plot (Fitch and Hall 1978). Woody species had not invaded. The site was predominantly covered with grasses, but the grass was much more sparse than that of the restored burned site (Debinski, pers. observ.).

Grazed (3011)

Since 1962, cattle have grazed tract 3011 from early June to sometime in August at about 1 animal per 0.4 ha grazing pressure. This 7.8 ha area was subject to rapid invasion of woody plants and had open areas of bare ground between clumps of individual plants (Fitch and Hall 1978). The microhabitats within the grazed tract ranged from patches of short grass and bare ground to tall grass as well as patches of tall, woody species such as oaks (*Quercus* spp.), slippery elm (*Ulmus rubra*), and rough-leaved dogwood (Debinski, pers. observ.). There was also a farm pond within the tract.

Restored Burned (3013)

From 1962 to 1976, the 5.6 ha restored burned tract was annually burned. Thereafter it was usually burned every second year, but in some cases it was burned every third or fourth year (D. Kettle, pers. comm.). Relative to our research, the most recent burn was in 1991. Little bluestem and switchgrass dominated the area and the grassland was virtually free from woody vegetation. In some areas the switchgrass was 1 m in height (Fitch and Hall 1978).

METHODS

Three 50 x 50 m plots (labeled A, B, and C) were located in each tract, and flags were placed at the corners to facilitate relocation (Fig. 1). Plots were located to avoid tract boundaries, thus providing the most homogenous habitat available. As noted, some of the tracts contained patches of woody vegetation, but efforts were made to avoid placing plots in woody areas. The plots within a tract were placed as far apart as possible; however, the distribution of the woody vegetation limited the options in some tracts.

Presence/absence data were collected for butterflies in each plot by netting and releasing. Butterflies were recorded as present within the plot only if they landed or foraged in the plot. Individuals that only flew over the plot were not counted. Each of the plots were sampled for at least 20 min. per visit unless no butterflies were seen within the first 10 min. The amount of time spent in each plot was determined by calculating a species-effort curve (Debinski and Brussard 1992). A species effort curve allowed us to discern that after 20 min. in any of our 50 x 50 m plots, the number of new species observed had reached an asymptote and we had observed most of the butterfly species that occurred in the plot. Each plot within each treatment was sampled five times between 28 May through 4 October, 1992, between 1100 and 1600 hrs CDT. Therefore, each tract was sampled fifteen times during the summer. No single tract type was sampled more than once per day.

At the beginning of each census, a summary of the approximate weather conditions was recorded. This included wind speed and direction, temperature, and cloud cover. Any changes in the weather were noted during the census. Censuses were curtailed if wind speed was high (above approximately 15 kph) or cloud cover blocked the sun. Butterflies observed immediately outside of the plot were also noted, but these were not used in the analysis. The resulting data were presence/absence records of butterflies for each of the plots. Differences in frequency of occurrence within species across tracts and over all species across tracts were tested by using a Chi-Square goodness of fit test. Comparisons of plant species richness versus butterfly species richness and frequency of occurrence were analyzed by using a regression analysis.

RESULTS

Twenty-four butterfly species were observed during the censuses (Table 1). Both the native prairie and the untreated plot contained the greatest species richness (18 species each) and the least species richness (14) occurred in the restored burned plot (Table 1), but there were no statistically significant differences among tracts in species richness. Frequency of occurrence across all species was significantly different among tracts, with the native prairie having the highest frequency of butterfly occurrences and the restored burned plot having the lowest ($X^2 = 26.59$, df = 4, $P<0.001$).

Seven species were more frequently observed in the native prairie over other habitats: monarch (*Danaus plexippus*), Eastern tailed-blue (*Everes comyntas*), tiger swallowtail (*Papilio glaucus*), clouded sulphur (*Colias philodice*), cloudless sulphur (*Phoebis sennae*), painted lady, (*Vanessa cardui*), and great spangled fritillary (*Speyeria cybele*). Only two of these species, however, showed statistically significant differences across tracts: the monarch ($X^2 = 12.55$, df = 4, $P<0.05$) and the clouded sulphur ($X^2 = 26.59$, df = 4, $P<0.001$). The giant swallowtail (*Papilio cresphontes*), and the hackberry butterfly (*Asterocampa celtis*) were present most frequently in the untreated tract. The gray copper (*Lycaena xanthoides*) and the snout butterfly

(*Libytheana carinenta)* were more numerous in the mowed tract. The red admiral (*Vanessa atalanta*) and the little wood-satyr (*Megisto cymela*) were more numerous in the grazed tract. No species showed their highest frequency of occurrence in the restored burned tract. One species, the common wood-nymph (*Cercyonis pegala*), was evenly distributed among all five tracts.

The butterfly species with the highest frequency of occurrence overall was the alfalfa butterfly (*Colias eurytheme*). Its highest frequency of occurrence was in the mowed plots, whereas its lowest was in the restored burned tract. Species found only once or twice were zebra swallowtail (*Eurytides marcellus*), question-mark (*Polygonia interrogationis*), silvery checkerspot (*Chlosyne nycteis*), and snout butterfly.

The native prairie had 167 species of vascular plants, the highest species richness of vascular plant of all tracts, whereas the untreated plot had the lowest species richness of vascular plants (72 species) (K. Kindscher, unpub. data). Table 1 notes the number of vascular plant species, number of butterfly species, and the frequency of butterfly occurrence in each of the tracts. The vascular plant species richness listed is for the entire tract, but it gives a general range of the host plant diversity available in the plots. There was a trend towards increased butterfly frequencies of occurrence and species richness with increasing plant species richness, but the regression was statistically significant for neither plant species richness versus butterfly frequency of occurrence (R^2=0.626, P=0.11) nor plant species richness versus butterfly species richness (R^2=0.139, P=0.535).

DISCUSSION

Overall, the results of our research show some indications of differences among prairie habitat types with respect to butterfly species richness and particular species frequencies. There was a tendency for the restored burned tract to have the lowest butterfly species richness and lowest frequency of occurrence, perhaps because it was dominated by grasses rather than forbs. Botanists often encourage burning to promote prairie restoration because it eliminates woody competitors and accumulated dead plant material and stimulates the flowering and productivity of many prairie species (Thompson 1992). However, the trend here suggests that frequent burning may not benefit the butterfly community. Swengel (1996) observed negative effects of fire on the lepidopteran community, and Schlict and Orwig (1992) noted that no "management window" for potential burning existed between late April and early October in the Loess Hills of Iowa. At least one skipper population was in flight during those times.

Table 1. Numbers of butterfly occurrences within each of five habitats of the Rockefeller Experimental Tract, Jefferson Co., Kansas.

Scientific name	Common name	Tract: Native prairie 3001	Untreated 3002	Mowed 3005/8	Grazed 3011	Burned 3013	TOTAL
		NUMBER PRESENT					
Danaus plexippus *	Monarch	11	3	2	3	3	22
Papilio cresphontes	Giant swallowtail	1	3	0	2	0	6
Eurytides marcellus	Zebra swallowtail	0	0	0	0	1	1
Papilio glaucus	Tiger swallowtail	5	2	1	3	2	13
Colias eurytheme	Alfalfa butterfly	9	7	10	6	5	37
Colias philodice *	Clouded sulphur	5	1	1	0	1	8
Phoebis sennae	Cloudless sulphur	3	1	1	1	0	6
Eurema lisa	Little sulphur	2	1	1	1	1	6
Everes comyntas	Eastern tailed-blue	9	6	5	6	1	27
Vanessa atalanta	Red admiral	3	1	3	4	0	11
Vanessa cardui	Painted lady	5	3	2	1	1	12
Vanessa virginiensis	American painted lady	2	2	0	1	1	6
Polygonia interrogationis	Question mark	0	0	1	0	1	2
Phyciodes tharas	Pearl crescent	6	6	3	4	3	22
Speyeria idalia	Regal fritillary	2	1	0	0	0	3
Speyeria cybele	Great spangled fritillary	4	3	1	2	1	11
Chlosyne nycteis	Silvery checkerspot	0	1	0	0	0	1
Megisto cymela	Little wood-satyr	0	1	0	3	0	4
Asterocampa celtis	Hackberry butterfly	5	6	4	3	2	20
Euptoieta claudia	Variegated fritillary	1	0	3	1	0	5
Cercyonis pegala	Common wood-nymph	5	6	5	5	5	26
Libytheana carinenta	Snout butterfly	0	0	2	0	0	2
Lycaena xanthoides	Gray copper	1	0	3	0	0	4
Total Number of species		18	18	17	16	14	
Total occurrences of all species *		79	54	48	46	28	
Vascular plant Species Richness **		167	72	82	80	85	

* significant difference in frequency of occurrence among tracts as tested with a Chi Square Analysis, $P<0.05$.

** K. Kindscher, Kansas Biological Survey, provided these data

Plant species richness showed a positive but non-significant regression with butterfly species richness and frequency of occurrence, but it is potentially worthy of additional consideration. The lack of a significant relationship between butterfly richness and plant richness in our study may be because some of the plant species present were not important nectar or host plants. Effects of host plants on the distribution of butterflies have been examined in other studies (e.g., Courtney and Chew 1987, Thomas and Singer 1987, Turchin 1991). Thomas and Singer (1987) examined the movement of butterflies in areas that contained host plants versus areas without host plants and found that "females were more likely to leave areas without the preferred host and stay where preferred hosts were present." Courtney and Chew (1987) found that "host plant affiliations are... strongly influenced by habitat characteristics."

Several factors determine the presence of a butterfly species within a habitat. The life histories of the different species are often very diverse, so the butterflies may be attracted to the habitats for various reasons. For example, *C. eurytheme*, the most frequently occurring species in our study is a generalist species living in open areas where it oviposits on legumes (Scott 1986). It is not surprising that it was found most often on the mowed tract. *Danaus plexippus* is a migratory species that may be stopping in the area for nectar and to lay its eggs, and may prefer the prairie because of its diversity of nectar plants.

In summary, our research suggests that the native prairie was distinct both in the overall frequency of butterflies observed and in abundance of two butterfly species. Among the restored prairie tracts, there were no significant differences in the butterfly community. Our results indicate that additional research designed to quantitatively test the effects of fire on the lepidopteran community may be a fruitful area of future research.

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