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Effects Of Prescribed Burning On Grassland Nesting Birds On Conservation Reserve Program Areas In Gove County, Kansas

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EFFECTS OF PRESCRIBED BURNING ON GRASSLAND NESTING BIRDS ON CONSERVATION RESERVE PROGRAM AREAS IN GOVE COUNTY, KANSAS

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ABSTRACT

Great Plains grasslands were once one of the largest ecosystems in North America. However, farming, ranching, urban development, widespread fire suppression, and numerous other factors have created a great loss of this habitat in central North America. Organisms that depend on that habitat, such as grassland nesting birds, also have declined. The Conservation Reserve Program (CRP), which was established in 1985, paid landowners to remove land with highly erodible soils from production and plant it with perennial vegetation. Increases in CRP acreages brought about increases in numbers of several bird species that were in decline before the program existed.

Prescribed burning is a management tool that has been used extensively in the tallgrass prairie to set back succession. The effects of prescribed burning on grassland nesting birds in the tallgrass prairie are well documented. Research shows some species to be more abundant in areas that have been burned recently, while others are more abundant in less disturbed grasslands. However, limited research has been conducted on the effects of prescribed burning on grassland nesting birds in the mixed grass prairie ecosystem.

The objectives of my research were to assess the effects of prescribed burning on vegetation, nest site selection and nest success, brown-headed cowbird (*Molothrus ater*) brood parasitism of grassland birds, and on insect biomass on CRP stands in the mixed grass prairie region of western Kansas. My research took place during the breeding seasons of 2008 and 2009. In 2008, I monitored 80 nests from 9 avian species in burned

and unburned areas of CRP. In 2009, I monitored 109 nests from 7 avian species on burned, unburned, and one year post burned areas of CRP. The mourning dove (*Zenaida macroura*) was the most abundant species observed in both years of research.

My results showed no significant difference in nest density and daily survival probability of grassland nesting birds on burned and unburned areas in 2008 and burned, unburned, and one year post burned areas in 2009. Brown-headed cowbird brood parasitism was not detected in 2008 and only occurred in 2 nests in 2009. A significant difference was observed in insect biomass between the months of June, July, and August for both 2008 and 2009 with biomass greatest in August. A significant difference in insect biomass also occurred between burned, unburned, and one year post burned areas in 2009 with biomass greatest in unburned areas. However, no significant difference occurred in insect biomass between burned and unburned treatments in 2008. Significant differences in vegetation characteristics also occurred between burned and unburned areas in 2008, and among burned, unburned, and one year post burned areas in 2009. A significant difference in vegetation characteristics between nest sites and random points was also observed in 2008 with percentages of forbs being greater on random sites. This difference was not observed in 2009, however.

My results indicated prescribed burning had no effect on nest density or daily survival probability of grassland nesting birds. However, burning did have a significant difference on vegetation characteristics and might have contributed to differences in insect biomass. Thus, prescribed burning is a management tool that can be used to interrupt succession and create heterogeneity on the landscape. However, more research should be conducted on the effects of prescribed burning on vegetation, insects, and grassland nesting birds in the mixed grass prairie.

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INTRODUCTION

The mixed-grass prairie was once one of the largest ecosystems in North America (Johnson 1997). However, Great Plains grasslands have diminished since the introduction of intensive agriculture in the early 1800's (Samson and Knopf 1994). The overall loss of grassland in North America has been estimated to have exceeded 80% (Brennan and Kuvlesky 2005). Along with diminishing grassland, several bird species that breed in grasslands also have declined (Johnson and Schwartz 1993, Vickery and Herkert 2001). Breeding Bird Survey data indicate North American grassland birds declined significantly from 1966 to 1996 (Peterjohn and Sauer 1999). This makes grassland birds among the most significantly affected of all North American birds (Knopf 1994, Herkert 1995, Peterjohn and Sauer 1999). No other group of living birds has experienced "steeper, more consistent and more geographically widespread declines" (Knopf 1994). Destruction, fragmentation, and degradation of breeding habitat, along with woody encroachment due to fire suppression, all seem to be linked to grassland bird decline (Vickery et al. 2000).

The Conservation Reserve Program (CRP) was introduced on Title XII of the Food Security Act of 1985 (Allen and Vandever 2003). In the program, landowners are paid to plant perennial vegetative cover on eroding or highly erodible fields to prevent soil erosion (Johnson and Schwartz 1993). The program also intended to improve commodity prices by taking substantial amounts of agricultural lands out of crop production (Best et al. 1997). CRP also provided an increase in native grasses; therefore, creating habitat for wildlife (Best et al. 1997). Grassland areas where the CRP program was implemented the most in the late 1980's were the tallgrass and mixed grass prairie regions of the central United States (Koford 1999). Several studies in the 1990's observed grassland bird use of CRP areas in the tallgrass prairie (e.g., Johnson and Igl 1995, Best et al. 1997, Igl and Johnson 1999, Koford 1999). Although wildlife habitat was not one of the original objectives of the CRP, the benefits to wildlife were evident and subsequently were made one of the primary objectives through the 1996 farm bill (Heard et al. 2001). However, most research observing grassland bird use of CRP comes from unmanaged CRP fields (Robel et al. 1998).

Grazing and prescribed burning are management tools used on ranchland, prairie reserves, and wildlife management areas (Griebel et al. 1998). Fields enrolled in CRP early in the program could not be grazed except under special circumstances (Koford 1999). However, prescribed burning is a management practice used on CRP fields in Kansas (Robel et al. 1998). Burning in spring can reduce litter and encourage the growth of warm season grasses (Rohrbaugh et al. 1999). Fire also releases nutrients that are retained in dead vegetation, allows rainfall to reach the soil and allows direct sunlight to the soil warming it and encouraging seed germination (Reinking 2005). Differences in vegetation height and litter can influence greatly densities of grassland nesting birds (Winter et al. 2005). In the tallgrass prairie the effects of fire on grassland nesting birds is well documented (e.g. Tester and Marshall 1961, Eddleman 1974, Halvorsen and Anderson 1983, Westemeier and Buhnerkempe 1983, Zimmerman 1992, and Herkert

1994). However, studies of the effects of fire on grassland nesting birds in the mixed grass prairie are limited (Johnson 1997).

The purpose of my study was to assess the effects of prescribed burning on grassland nesting birds in CRP areas during the 2008 and 2009 breeding seasons. My objectives were to assess the effects of burning: 1) on vegetation characteristics within CRP in the mixed grass prairie, 2) on avian nest site selection and nesting success, 3) on brown-headed cowbird (*Molothrus ater*) brood parasitism, and 4) on insect biomass. Burned areas were defined as those burned in the spring immediately preceding the summer breeding season. Unburned areas were not burned during the study duration. Post-burned areas were defined as areas burned in the spring of the previous year.

I hypothesized that vegetation height, visual obstruction, percent litter, litter depth, and percent grasses and percent forbs would be greatest in unburned areas followed by one year post burned areas and burned areas. I hypothesized that percent bare ground would be greatest in burned areas followed by one year post burned areas and then unburned areas. I also hypothesized that nest success, nest density, and brown-headed cowbird brood parasitism would be greatest in unburned areas followed by one year posted burned areas and burned areas. Insect biomass however, would be greatest in one year post burned areas, followed by burned areas and then unburned areas.

METHODS

Site Description

The study sites were located approximately 16 km southwest of Gove, Kansas, in Gove County in the mixed-grass prairie region. In 2008, the study area consisted of 7 fields (Figure 1) totaling approximately 413 ha (Table 1). In 2009, 2 of the fields that were monitored in 2008 were withdrawn from CRP. Therefore, in 2009 research continued on the 5 remaining fields (Figure 2) totaling approximately 300 ha (Table 1). All of the fields previously had been enrolled in the CRP program. The seed mixes used to establish these CRP fields consisted of various proportions of switchgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), blue grama (*Bouteloua gracilis*), sideoats grama (*Bouteloua curtipendula*), and western wheatgrass (*Pascopyrum smithii*), and had been inter-seeded with yellow sweet clover (*Melilotus officinalis*) (Mathew Palmquist, Natural Resource Conservation Service, personal communication). However, vegetation detected among each of the CRP plots varied, and all vegetation observed in each of the fields was recorded (Table 2). Disked firebreaks were used to divide each field into 3 relatively equal areas (Table 1) in 2008 and in 2009 prior to burning and data collection. In late March of 2008, approximately one third of each of the 7 fields was burned (Figure 1). In 2009, burning occurred in mid-April, on previously unburned areas, on approximately one third of each of the 5 fields (Figure 2).

Field Methods

Nests were located and monitored within each of the CRP fields from mid-May to mid-August of 2008 and 2009. In 2008, nests were detected in burned and unburned areas. In 2009, nests were detected in burned, unburned, and one year post-burned areas. Nests were located by systematically dragging a 25 m rope through each area of each field and flushing birds to locate nests. All nest searching occurred between 0600 and 1100 hours, and searches were conducted approximately every 2 weeks to locate new nests. Each field was sampled 4 times in 2008 and 5 times in 2009. Once nests were located, GPS coordinates were recorded, and flagging tape was placed in a random direction approximately 4 meters from the nest to aid in relocation. Nests were then monitored every 3 to 4 days until the fate of the nests could be determined. Data were collected on species and the number of eggs and/or nestlings per nest, presence of brown-headed cowbird brood parasitism, and the fate of the nest.

Nestling age was estimated by using stages of feather development and nestling appearance (Mirarchi and Baskett 1994, Vickery 1996). The fate of the nests was classified as: fledged, depredated, abandoned, unknown, or disrupted by humans. A nest with one or more fledglings was recorded as a fledged nest. A nest was recorded as depredated if there were fewer eggs than previously recorded from the last visit, or if nestlings were missing at a stage that would be too early in feather development to have fledged. Nests were recorded as abandoned if parents were not on the nest during all the visits to the nest and the eggs did not hatch. Nests damaged accidently were recorded as disrupted by humans. If the nests could not be relocated or if their fate could not be determined, they were recorded as unknown.

Vegetation Sampling

Vegetation data were collected at each nest site after the fate of the nest had been determined, and at a random point for each nest site within the same plot. A Robel pole was used to measure visual obstruction at each nest site and a random point in each of the four cardinal directions (Robel et al. 1970). A 1m^2 Daubenmire frame also was used to estimate the percent of grasses, forbs, woody plants, and bare ground at each nest site and at random points in each field (Daubenmire 1959). Paired random sites were selected by using a random direction table of the four cardinal directions (N, E, S, W) and a random number table to determine the direction and distance from the nest the random point would be located. The distance of the random site was between 8 m and 100 m from the nest site.

Insect Sampling

Net sweeps were conducted in June, July, and August at 3 random points within each area of each field to collect insects. Insect orders detected in 2008 (Table 3) and in 2009 (Table 4) were recorded and insects were then dried in a drying oven at 80º C for 48 hours. After the drying period, samples were weighed to determine the mass of insects for each sample in 2008 (Table 5) and 2009 (Table 6). The samples from each area of each field were used in a repeated measures analysis of variance (ANOVA) to determine differences in insect biomass between burn treatments, months, and a combination of treatment and month.

Statistical Analysis

Apparent nest success was calculated by taking the number of nests that successfully fledged young and dividing that number by the total number of nests. Apparent nest success was calculated for each burning treatment and year (Table 7). These data were used to look for general trends in the data, but were not used for statistical analyses.

I used the Mayfield method (Mayfield 1961) to calculate nest success as a percentage of nests failed per day. Daily survival probability was estimated by taking one minus the number of nests failed divided by the total number of exposure days for each species. Exposure days were estimated by taking the midpoint between the last known active nest day and the first inactive observation day minus the day the nest was first located (Mayfield 1975, Winter et al. 2004, and Zavala 2006). Nest initiation dates were determined on all nests located during incubation by assuming one egg was hatched each day (Mayfield 1975, Johnson 1979, Winter et al. 2004, Zavala 2006). Nest initiation data were used in a repeated measures ANOVA to test for significant difference in nest density among burn treatments over the months of May, June, July, and August. Nest density was calculated by dividing the number of nest in each burn treatment for each month by the number of hectares for each field respectively. The area of each of the fields (Table 1) was determined by loading GPS points into ArcMap and using the area calculator. Nest density data were not distributed normally; therefore a log transformation was used to approach normality. Nests in which the fate could not be determined and those that were impacted by humans were excluded from the analysis. A Mann-Whitney U test for 2008 nest data and a Kruskal Wallis test for 2009 nest data were used to test for a significant difference in the daily survival probability of grassland bird nests based on burn treatment. All statistical tests were conducted by using nest data from all species, nest data from just the mourning dove (*Zenaida macroura*), and nest data with all species without the mourning dove since the mourning dove was the most abundant species for 2008 and 2009. Nests located in firebreaks were removed from analysis for both years.

The number of days used to determine if a nestling had fledged varied among species and was based on the literature. Both the grasshopper sparrow (*Ammodramus savannarum*) and lark sparrow (*Chondestes grammacus*) were estimated to fledge six days post hatch (Vickery 1996, Martin and Parrish 2000). The Cassin's sparrow (*Peucaea cassinii*), meadowlark spp. (*Sturnella spp.*), and dickcissel (*Spiza americana*) were estimated to have fledged at a minimum of eight days post hatch (Dunning et al. 1999, Lanyon 1994, 1995, Temple 2002). The mourning dove, common nighthawk (*Chordeiles minor*), and horned lark (*Eremophila alpestris*) were estimated to fledge at a minimum of ten days post hatch (Mirarchi and Baskett 1994, Poulin et al. 1996, Beason 1995). The northern harrier (*Circus cyaneus*) was estimated to fledge at 14 days post hatch (MacWhirter and Bildstein 1996).

Statistical analysis also was conducted on insect and vegetation data. A repeated measures ANOVA was used for both 2008 and 2009 insect data to determine if there was a significant difference in insect mass based on burn treatment and month. A multiple analysis of variance (MANOVA) was conducted to compare vegetation characteristics both at the nest sites and at random points for both 2008 and 2009. The vegetation data were not distributed normally, so an arcsine-transformation was used for Daubenmire percentage data, and a log-transformation was used for vegetation height, litter depth, and visual obstruction data.

RESULTS

In the breeding seasons of 2008 and 2009 a combined 189 nests were monitored. Eighty nests from 9 avian species were monitored in 2008, and 109 nests from 7 avian species were monitored in 2009 (Table 8). The mourning dove was the most abundant species in both years (Table 8). Species that were monitored in 2008 but not in 2009 include the Northern harrier and Cassin’s sparrow. The lark sparrow was the only species observed in 2009, but not in 2008 (Table 8). In 2008, 19 nests occurred in 7 burned areas, 59 nests occurred on 14 unburned areas and 2 nests occurred in the firebreaks (Table 8). In 2009, 35 nests occurred in burned areas, 30 nests occurred in 1 year post burned areas, 41 nests occurred in unburned areas, and 3 nests occurred in firebreaks (Table 8).

Nest Density

A repeated measures ANOVA for 2008 nest density data showed no significant difference in nest density for all species observed among the months of May, June, July, and August ($F_{3,10}$ = 2.94, P = 0.09, power = 0.52) (Figure 3A) and for the interaction of month and burn treatment ($F_{3,10}$ = 2.14, P = 0.16, power = 0.39). The test was then repeated by using just mourning dove nest density data, and then again by using nest density data from all species without mourning dove. The tests showed no significant difference among the four months ($F_{3, 10}$ = 2.46, P = 0.12, power = 0.45) or among the interaction of month and burn treatment ($F_{3, 10}$ = 1.25, P = 0.34, power = 0.24) for mourning dove, and for all species without mourning dove ($F_{2, 11}$ = 0.66, P = 0.53, power = 0.13, ($F_{2, 11}$ = 0.71, P = 0.52, power = 0.14, respectively). The same question was addressed again in 2009. The ANOVA revealed significant difference in nest densities among the months of May, June, July, and August ($F_{6, 20}$ = 6.73, P = 0.01) with mean density being lowest in August and highest in June (Figure 3B) and no significant difference for the interaction of month and burn treatment ($F_{6, 20}$ = 1.91, P = 0.13, power =0.56). Mourning dove nest density data for 2009 resulted in no significant differences both among the months observed ($F_{6, 20}$ = 2.61, P = 0.11, power = 0.47) and for the interaction of month and burn treatment ($F_{6, 20}$ = 2.51, P = 0.06, power = 0.71). No significant difference also occurred when testing all species without mourning dove both among months ($F_{2, 11}$ = 2.28, P = 0.15, power = 0.37) and the interaction of month and burn treatment ($F_{4, 22}$ = 1.24, P = 0.32, power = 0.32).

Daily Survival Probability

A Mann-Whitney U test for 2008 nest data showed no significant difference in the daily survival probability of all species observed based on burn treatment ($U_{19, 6} = 54.50$, $P = 0.88$). The test was repeated and the results were the same for mourning dove nest data ($U_{9, 4} = 12.50$, $P = 0.41$) and all species observed without mourning dove nest data ($U_{2, 11} = 2.00$, $P = 0.10$). A Kruskal-Wallis test for 2009 nest data also showed no significant difference in the daily survival probability of grassland nesting birds based on burn treatment ($H = 0.86$, $df = 2$, $P = 0.96$). The same results were observed when testing just mourning dove nest data ($H = 2.91$, $df = 2$, $P = 0.23$), and all other species lumped without mourning dove nest data ($H = 1.10$, $df = 2$, $P = 0.58$).

Brood Parasitism

Brood parasitism by the brown-headed cowbird was not observed in 2008. In 2009, however, 2 nests were parasitized by the brown-headed cowbird. The species that were affected in 2009 included a lark sparrow in a burned area and a grasshopper sparrow in a 1 year post burned area. Thus, sample size was too low to observe the effects of prescribed burning on nest parasitism by brown-headed cowbirds.

Insect Biomass

A repeated measures ANOVA for 2008 insect data showed no significant difference in insect biomass between burn and unburned treatments ($F_{2, 60} = 0.15$, $P = 0.861$, power = 0.72) (Figure 4A) and a significant difference in insect biomass among June, July, and August ($F_{2, 60} = 14.14$, $P = 0.001$) with insect biomass greatest in August and the least in June (Figure 5A). In 2009, the repeated measures ANOVA revealed a significant difference in insect biomass both among burn treatments ($F_{2, 41}$ = 66.07, P = 0.001) and months ($F_{4, 82}$ = 3.92, P = 0.006). A post hoc Tukey test revealed the significant difference in insect biomass among treatments occurred between burned and unburned areas (q= 3.89, P = 0.001) with biomass greatest in unburned areas and the least in burned areas (Figure 4B). The significant difference in insect biomass among months revealed the greatest biomass occurring in August and the least amount of biomass occurring in June (Figure 5B).

Vegetation Characteristics

A MANOVA was conducted for both 2008 and 2009 to see if there was a significant difference in vegetation characteristics between burn treatments and at nests sites compared to paired random sites. The MANOVA for 2008 revealed a significant difference in vegetation characteristics between burned and unburned treatments ($F_{7, 144}$ = 48.05, P = 0.001). The differences in vegetation characteristics occurred in litter depth (F_1 = 102.61, P = 0.001), visual obstruction (F_1 = 8.72, P = 0.004), percent forbs (F_1 = 149.82, P = 0.001), percent grasses (F_1 = 6.64, P = 0.011), percent litter (F_1 = 97.56, P = 0.001), and percent bare ground (F_1 = 51.41, P = 0.001). Percent grasses, and percent litter were greater in unburned areas and percent bare ground and percent forbs were greater in burned areas (Figure 6). Visual obstruction (Figure 7A) and litter depth (Figure 7B) were also greater in unburned areas. A significant difference in vegetation characteristics at nest sites compared to paired random sites ($F_{7,144}$ = 18.90, P = 0.001) also occurred. Percent forbs differed significantly between nest sites and paired random sites (F_1 = 118.16, P = 0.001) with forbs being greater at random sites (Figure 8A). The MANOVA for 2008 also revealed a significant difference when observing an interaction of nest site and burn treatment ($F_{7, 144}$ = 23.72, P = 0.001) with percent forbs being significantly different (F_1 = 153.47, P = 0.001) and greater at random sites and in burned areas.

The MANOVA for 2009 showed no significant difference in vegetation characteristics between nest sites and paired random sites ($F_{7, 197}$ = 0.44, P = 0.877, power = 0.19) (Figure 8B) nor when observing an interaction of nest site and burn treatment ($F_{14, 394}$ = 0.60, P = 0.867, power = 0.38). However, a significant difference in vegetation characteristics did occur between burned, unburned, and 1 year post burned treatments ($F_{14,394}$ = 16.44, P = 0.001). A post hoc Tukey test revealed a significance difference in vegetation characteristics between burned and unburned treatments for vegetation height (q = 3.77, P = 0.001), litter depth (q = 8.72, P = 0.001), visual obstruction (q = 3.75, P = 0.001), percent forbs (q = 2.67, P = 0.036), percent grasses (q = 5.27, P = 0.001), percent litter (q = 12.73, P = 0.001), and percent bare ground (q = 11.40, P = 0.001). Percent grasses, and percent litter were greater in unburned areas and percent forbs and percent bare ground were greater in burned areas (Figure 9). Litter depth and vegetation height (Figure 10B) along with visual obstruction (Figure 10A) was also greater in unburned areas than burned and post burned areas. Significant differences in vegetation characteristics between 1 year post burn and unburned areas included vegetation height (q = 3.26, P = 0.004), litter depth (q = 8.25, P = 0.001), visual obstruction (q = 2.92, P = 0.011), percent litter (q = 11.18, P = 0.001), and percent bare ground (q = 7.58, P = 0.001). Vegetation height and litter depth (Figure 10B), visual obstruction (Figure 10A) and percent litter (Figure 9) were greater in unburned areas, and percent bare ground was greater in 1 year post burn areas (Figure 9). A significant difference in percent grasses (q = 5.47, P = 0.001) and bare ground (q = 3.30, P = 0.003) also occurred in comparing burned versus 1 year post burn treatments with percent bare ground greater in burned areas and percent grasses greater in 1 year post burned areas (Figure 9).

DISCUSSION

No significant difference in nest density was detected between burn treatments in 2008, nor among burn treatments in 2009. Since birds are recognized as indicators of habitat condition (Bock and Webb 1984, Szaro and Balda 1982), I concluded that none of the burn treatments was any more favorable for grassland nesting birds in the CRP fields I observed. My results contradict results from Robel et al. (1998) showing a greater number of nests in unburned areas verses burned areas on CRP in northeastern Kansas within the tallgrass prairie ecosystem. A possible explanation for my results has to do with the number of mourning dove nests that were observed in 2008 and 2009. The mourning dove made up 59 of the 80 nests detected in 2008 and 65 of the 109 nests in 2009. The mourning dove is considered to have a broad habitat preference (Hughes et al. 2000). Since a majority of the nests were mourning dove, this might explain why I found no significant difference in nest density for each of the burn treatments. In the tallgrass prairie, grassland bird species respond to prescribed burning differently. Some grassland bird species are more abundant on recently burned or grazed grasslands, whereas other species are more abundant on idle or undisturbed grasslands (Vickery et al. 2000). In my research, the sample size probably was too small to test for the effects of prescribed burning on any single species except for mourning dove.

A significant difference in nest density was detected however, among the months of May, June, July, and August for 2009 (Figure 3B). This difference detected in 2009 might be due to the increase in the number of nests observed along with the decrease in area sampled compared to 2008. Another possible explanation for the detected difference in 2009 might simply be due to the nesting phenology of grassland birds. Nests occur at the time when survival is greatest for young. Therefore, I would expect to see differences in nest density over months with the majority of nest occurring at the time that will ensure the best survival for nestlings.

I also observed no significant difference in the Mayfield daily survival probability of grassland nesting birds in each of the burn treatments for 2008 and 2009 for all species, just the mourning dove, and all species without mourning dove. This seems to suggest that prescribed burning was not having an effect on the daily survival probability of grassland nesting birds. These findings support research conducted by Robel et al. (1998), who reported no significant difference in nesting success on burned fields compared to unburned fields on CRP in northeastern Kansas. Zimmerman (1997) also found no increase in either nest success or in fledging mass of young from successful nests for a number of species in burned versus unburned Kansas prairie. Rohrbaugh et al. (1999) also observed no difference in clutch size or in the number of young fledged per successful nest between burned/grazed plots versus unburned/ungrazed plots. However, Johnson and Temple (1990) found several grassland birds in Minnesota to have higher nest success in areas that were burned recently. Johnson and Temple (1990) attributed their results to the tall dense re-growth following a fire providing better nest concealment from predators. The conflicting results from my study compared to the Johnson and Temple (1990) study might be based on regional differences. The study of Johnson and Temple (1990) took place in native tallgrass prairie in Minnesota whereas my study took place on CRP in the mixed grass prairie region of western Kansas. Differences in native tallgrass prairie compared to CRP, along with differences in soil, precipitation, and temperature can all affect vegetation growth and might account for the differences in my results compared to theirs.

Brood Parasitism

Brood parasitism by the brown-headed cowbird was not observed in 2008 and only occurred in 2 nests in 2009. Therefore, my sample size was too low to address any questions about the effects of prescribed burning on brood parasitism of grassland nesting birds. A possible explanation for low brood parasitism rates might have to do with the high number of mourning dove nests observed. The mourning dove typically is not a host for the brown-headed cowbird (Peer and Bollinger 1998). The way the mourning dove feeds its young is an explanation for low brood parasitism rates. Young of mourning dove initiate feeding by forcing their mouth into the mouth of the adult dove and are fed crop milk (Friedmann 1963). This differs from the typical passerine method in which the adult forces food into the mouth of the nestling. Peer and Bollinger (1998) suggested that it is unlikely that the brown-headed cowbird could adjust to this method of feeding. Rothstein (1975) also observed mourning dove rejecting 31.2% of brown-headed cowbird eggs from experimentally parasitized nests. Of the 124 mourning dove nests observed in my research, none were parasitized by the brown-headed cowbird. A second possible explanation for low brood parasitism rates might have been the lack of woody vegetation. Best (1978), Gates and Gysel (1978), and Johnson and Temple (1990) all show that rates of brood parasitism in tallgrass prairie birds are higher for nests located closer to a wooded edge. Johnson and Temple (1990) suggested that the brown-headed cowbird might be a more effective brood parasite in edge habitat where elevated perches allow birds to more accurately locate and monitor nests to synchronize egg laying. Perch sites are also a major habitat component for displaying and singing brown-headed cowbirds (Friedmann 1929, Norman and Robertson 1975, Elliot 1978, Lowther and Johnston 1977, Kahl et al. 1985). Suitable brown-headed cowbird perches include trees, shrubs, and other structures that exceed the average height of the surrounding vegetation (Kahl et al. 1985, Davis and Sealy 2000, Romig and Crawford 1995, Hauber and Russo 2000). Brown-headed cowbird numbers in tallgrass prairie and CRP fields in Nebraska were shown to be correlated positively to vegetation height (King and Savidge

1995). Finally, Jensen and Finck (2004) and Jensen and Cully (2005) also observed that brown-headed cowbird density estimates were highest near wooded edges where host and perch availability were greatest. My observation of low brood parasitism and the lack of woody vegetation on my study sites also seemed to support past research that suggested that greater brood parasitism near woody vegetation. However, there are several other factors such as density and availability of hosts (Robinson 1999) and distance from grazed areas (Goguen and Mathews 2000) that can affect brood parasitism rates.

Insect Biomass

Fire has been shown to have varied effects on insect diversity and abundance (Swengel 2001). Invertebrate biomass varies with the composition and structure of vegetation (Southwood and Cross 1969, Evans 1988, Baines et al. 1996). Askins (2000) suggests that the succulence and nutrition of new vegetation growth resulting after a fire provides opportunities for grazers such as insects, and also produces better foraging areas for predators such as birds. Research also has shown that grasshoppers hatch earlier on early spring burns than burns that take place later in the spring (Knutson and Campbell 1976), and about 2 weeks earlier on burned compared to unburned grasslands (Evans 1984).

In 2008, I observed no significant difference in insect biomass between burned and unburned treatments (Figure 4A) and a significant difference in insect biomass among the months of June, July, and August (Figure 4B). In 2009, a significant difference in insect biomass was detected for both burn treatment (Figure 4B) and month a (Figure 5B) with the difference in burn treatment being between burned and unburned areas (Figure 4B). Anderson et al. (1989) captured significantly more insects on unburned sites compared to burned sites for the first growing season following a burn, but not in subsequent years. In contrast, Evans (1988) reported that a 4 year burn cycle on Kansas tallgrass prairie did not generate strong patterns of change in local grasshopper communities. However, Anderson et al. (1989) also indicated that when observing individual insect species response to fire, burning is likely to reduce the populations of some insects while increasing others.

The significant difference detected in the second year of my study might be related to the increased precipitation in 2009 (Figure 11). The increased precipitation might have provided habitat more favorable for insects by increasing the amount of new succulent vegetation. A second possible explanation for my differences in insect biomass between years might be related to sweep netting. Evans et al. (1984) suggested that sweeping can yield biased estimates when insect densities are compared between burned and unburned tallgrass prairie sites. Unburned sites contain more dead vegetation, which makes it more difficult to capture insects by sweeping than burned sites, which lack residual vegetation (Evans et al. 1984). Future research is needed to address the response of insects to prescribed burning in all grassland ecosystems of the Great Plains. Methods of capture for future research should combine a variety of techniques such as sweep netting and pit fall traps.

Vegetation Characteristics

Vegetation characteristics differed significantly between burned versus unburned areas in 2008 and 2009. The differences observed were in litter depth and visual obstruction (Figure 7A and 7B), percent forbs, percent grasses, percent litter, and percent bare ground (Figure 6) in burned versus unburned areas for 2008 and 2009 (Figures 9 and 10A and 10B). Similar results also occurred when comparing 1 year post burned areas to unburned areas in 2009 (Figures 9 and 10A and 10B). Differences between burned and 1 year post burned areas in 2009 were evident when observing percent grass and percent bare ground (Figure 9). My results were not surprising since prescribed burning decreases litter and encourages the growth of grasses. However, my results were significant as grassland nesting birds respond to differences in vegetation. Though I was unable to detect differences in nest success and nest density, differences could occur in other years or on other sites as a result of differences in vegetative characteristics.

Vegetation characteristics differed between nest sites and paired random sites in 2008 with the percentage of forbs being greater at random sites (Figure 8A). These results might suggest that birds were nesting at different areas than where they are feeding. Feeding in different areas than where the nest is located would reduce the amount of time spent in the area of the nest and might help keep predators from keying in on nest sites. However, this difference in paired random sites versus nest site was not detected in 2009 (Figure 8B).

Precipitation was greater in the spring of 2009 compared to 2008 (Figure 11). Research in the tallgrass prairie has shown that short term effects of fire depend upon several factors such as precipitation (Reinking 2005). Vegetative productivity increases following a fire except in years of below average rainfall (Hulbert 1988, Briggs et al. 1989). The greater precipitation in 2009 allowed for taller vegetation earlier in the year in 2009 than burned areas in 2008. The combination of increased moisture in 2009 and prescribed burning should have created great potential nesting habitat for grassland nesting birds. Research has shown that grassland nesting birds respond to habitat structure (Wiens 1963, Rotenberry and Wiens 1980, Bock and Webb 1984, Patterson and Best 1996, Zimmerman 1997, Winter et al. 2005) and that vegetation height and structure are dramatically different in areas recently burned versus areas that have not been burned for several years (Reinking 2005). Changes in the vegetation height and density might affect nest success by influencing predator access to nests (Reinking 2005). My results, however, did not indicate a significant difference in the number of nests that occurred in the different burn treatments. However, the first nest that was located in the burned areas in 2008 was a mourning dove nest located in June. In 2009, 4 nests from 3 different species were located in burned areas in May. The earlier nesting in burned areas in 2009 might be a result of the increased moisture and greater re-growth which created taller vegetation earlier in the year resulting in better nesting habitat on burned areas in 2009.

Less area also was sampled in 2009 (320 ha) compared to 2008 (450 ha), however more nests were located and monitored in 2009 (n = 109) than in 2008 (n = 80). One possible explanation for these data could be the management through prescribed burning that was taking place on the CRP fields. In 2008 the areas that were sampled were either unburned or they had been burned in March of 2008. The lack of management on the unburned areas led to vegetation that was dominated by either big bluestem (*Andropogon gerardii*) or Indian grass (*Sorghastrum nutans*) and contained large amounts of litter. Previous research has shown that the value of CRP fields to grassland birds declines with age as grasses become dense monocultures and accumulated litter makes foraging difficult for ground feeding birds (Ryan et al 1995, Millenbah et al. 1996). However, I was unable to detect a significant difference in the number of nests in the different burn treatments.

Decreased suitable habitat at the landscape level is a second possible explanation for locating more nests in 2009. At the end of September in 2008 155,898.59 hectares of CRP expired in Kansas (USDA-FSA 2006). Areas that were in perennial grass cover because they were in the CRP program were disked under when the contracts ended. Areas that once provided suitable habitat for grassland nesting birds no longer provided the habitat needed for nesting. Birds that were nesting in those areas in 2008 had to find a new location to nest. The CRP fields at my study site provided the vegetation necessary for nesting. Birds that were nesting in close proximity to my CRP fields in 2008 might have nested on one of my CRP fields in 2009 due to lack of other options.

Management Implications

Grasslands are dynamic ecosystems whose constituent species evolved with disturbances such as fire, grazing, and drought (Vickery et al. 2000). Studies in the tallgrass prairie have shown that bird species respond differently to the effects of fire with some species increasing in abundance on recently burned or grazed grasslands while others are more prevalent on unburned or idle grasslands. In my project the samples sizes of most species were too small to test for individual species responses to prescribed burning on CRP in the mixed grass prairie. However, I did not detect any effects of prescribed burning on nest success or nest density on grassland nesting birds as a whole or on the mourning dove. Burning significantly altered vegetation characteristics and might have contributed to differences in insect biomass. Thus, prescribed burning is a management tool that can be used to set back succession and create heterogeneity on the landscape.

Managers in the mixed grass prairie should not fear prescribed burning as a management tool. However, several factors such as the timing of the burn and the amount of precipitation following a burn have been shown to have an effect on vegetation and could have an effect on the amount of suitable habitat for grassland nesting birds. These factors should be taken into consideration when planning a prescribed burn. Because of the variability among grassland nesting birds in habitat preference, managers should manage vegetation for heterogeneity. A mosaic of burned and unburned fields of different age classes can provide habitat for a variety of grassland nesting bird species.

However, because of the dynamic nature of grassland ecosystems more research should be conducted on the effects of prescribed burning on vegetation, insects, and grassland nesting birds in the mixed grass prairie.

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Table 1. Conservation Reserve Program fields observed in 2008 and 2009 showing burn treatment and area of each field in hectares.

2008			2009		
Field	**Treatment**	**Hectares**	**Field**	**Treatment**	**Hectares**
1(1)	B	18.04	1(1)	PB	18.04
1(2)	UB	23.11	1(2)	B	23.11
1(3)	UB	19.01	1(3)	UB	19.01
2(1)	B	18.07	2(1)	PB	18.07
2(2)	UB	19.02	2(2)	B	19.02
2(3)	UB	17.85	2(3)	UB	17.85
3(1)	B	22.79	3(1)	PB	22.79
3(2)	UB	24.80	3(2)	B	24.80
3(3)	UB	20.03	3(3)	UB	20.03
4(1)	B	18.75	4(1)	PB	18.75
4(2)	UB	18.34	4(2)	B	18.34
4(3)	UB	19.87	4(3)	UB	19.87
5(1)	B	15.05	7(1)	PB	20.89
5(2)	UB	19.60	7(2)	B	20.42
5(3)	UB	21.51	7(3)	UB	19.74
6(1)	B	17.75	TOTAL		300.71
6(2)	UB	13.93			
6(3)	UB	24.83			
7(1)	B	20.89			
7(2)	UB	20.42			
7(3)	UB	19.74			
TOTAL		413.38			

B = Burned, PB = Post burned, UB = Unburned
(1) = Burned in 2008, (2) = Burned in 2009, (3) = Not burned either year

Table 2. Predominant vegetation occurring in Conservation Reserve Program fields in 2008 and 2009.

Vegetation	Scientific Name	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
Big bluestem	*Andropogon gerardii*	X	X			X	X	X
Bindweed	*Convolvulus arvensis*	X			X		X	X
Common sunflower	*Helianthus annuus*	X	X	X	X		X	X
Goldenrod sp.	*Solidago sp.*	X	X		X			X
Ground cherry	*Physalis angulata*	X	X			X	X	X
Indian grass	Sorghastrum nutans	X	X	X	X	X	X	X
Kochia	Kochia scoparia	X	X	X	X	X		X
Little bluestem	Schizachyrium scoparium	X	X	X	X	X	X	X
Rush skeleton plant	*Lygodesmia juncea*	X	X	X	X	X	X	X
Sand dropseed	*Sporobolus cryptandrus*	X	X	X	X			
Scarlet gaura	*Gaura coccinea*	X	X		X			X
Scarlet Globe mallow	*Sphaeralcea coccinea*	X	X	X	X		X	X
Scurf pea	*Psoralea esculenta*	X	X	X	X		X	X
Side oats grama	*Bouteloua curtipendula*	X	X	X	X	X	X	X
Switchgrass	*Panicum virgatum*	X	X	X	X	X	X	X
Western ragweed	Ambrosia psilostachya		X	X		X	X	X
Western wheatgrass	*Pascopyrum smithii*	X	X	X	X	X	X	X
Witchgrass	Panicum capillare	X	X	X	X			X
Yellow sweet clover	*Melilotus officinalis*	X	X	X	X	X		X
Yucca	*Yucca glauca*		X				X	X

Table 3. Insect orders detected from insect sampling in 2008.

No.	Date	Coleoptera	Diptera	Hemiptera	Homoptera	Hymenoptera	Lepidoptera	Neuroptera	Odonata	Orthoptera	Phasmatodea
1(1)	Jun	X	X	X		X				X	
1(1)	Jul	X	X		X	X		X	X	X	
1(1)	Aug		X		X	X				X	X
1(2)	Jun	X	X	X		X	X		X	X	
1(2)	Jul	X	X	X	X				X	X	
1(2)	Aug	X	X		X	X				X	
1(3)	Jun	X	X	X		X	X			X	
1(3)	Jul	X		X		X				X	X
1(3)	Aug	X	X	X		X				X	
2(1)	Jun	X	X	X		X	X			X	
2(1)	Jul		X	X	X	X				X	
2(1)	Aug			X		X				X	X
2(2)	Jun	X	X	X		X				X	
2(2)	Jul		X	X		X		X	X	X	
2(2)	Aug	X	X	X	X		X			X	
2(3)	Jun	X	X			X	X			X	
2(3)	Jul	X	X		X	X				X	
2(3)	Aug	X	X				X			X	
3(1)	Jun	X	X					X	X	X	
3(1)	Jul	X		X	X	X				X	
3(1)	Aug		X	X	X	X		X		X	
3(2)	Jun	X	X	X	X		X			X	
3(2)	Jul			X	X	X				X	
3(2)	Aug				X	X				X	
3(3)	Jun	X	X	X	X	X	X			X	
3(3)	Jul	X	X	X	X	X	X			X	X
3(3)	Aug		X	X	X	X				X	
4(1)	Jun	X	X	X	X	X	X			X	
4(1)	Jul		X	X	X	X		X	X	X	
4(1)	Aug		X	X	X	X				X	
4(2)	Jun	X	X	X	X	X	X			X	
4(2)	Jul	X	X	X	X	X	X	X		X	
4(2)	Aug	X			X	X	X			X	
4(3)	Jun	X	X	X	X	X				X	X
4(3)	Jul	X	X	X	X	X		X		X	
4(3)	Aug	X	X	X	X					X	
5(1)	Jun		X		X					X	
5(1)	Jul	X	X	X	X	X				X	
5(1)	Aug			X	X	X				X	
5(2)	Jun		X			X					
5(2)	Jul	X	X	X						X	
5(2)	Aug			X	X	X				X	
5(3)	Jun		X	X	X	X				X	
5(3)	Jul	X	X	X	X	X				X	X
5(3)	Aug			X	X					X	
6(1)	Jun	X	X	X	X	X		X	X	X	
6(1)	Jul		X	X		X	X			X	
6(1)	Aug	X	X		X	X				X	
6(2)	Jun	X	X			X	X		X	X	
6(2)	Jul	X	X	X	X	X				X	
6(2)	Aug	X	X		X	X				X	
6(3)	Jun	X	X	X	X	X	X			X	
6(3)	Jul	X	X	X	X	X				X	
6(3)	Aug			X		X				X	

Table 3. Continued

No.	Date	Coleoptera	Diptera	Hemiptera	Homoptera	Hymenoptera	Lepidoptera	Neuroptera	Odonata	Orthoptera	Phasmatodea
7(1)	Jun	X	X	X		X				X	
7(1)	Jul	X	X		X	X				X	
7(1)	Aug		X	X		X				X	
7(2)	Jun	X	X		X	X				X	
7(2)	Jul	X	X		X	X	X			X	
7(2)	Aug	X	X	X						X	
7(3)	Jun	X	X		X					X	
7(3)	Jul	X	X		X	X				X	
7(3)	Aug		X			X				X	

Ephemeroptera- Only occurred in 2(2) in July and was not included in the table.
(1) = Burned in 2008, (2) = Burned in 2009, (3) = Not burned either year

Table 4. Insect orders detected from insect sampling in 2009.

No.	Date	Coleoptera	Diptera	Hemiptera	Homoptera	Hymenoptera	Lepidoptera	Mecoptera	Neuroptera	Odonata	Orthoptera
1(1)	Jun	X	X	X	X		X		X	X	X
1(1)	Jul	X	X	X	X	X			X	X	X
1(1)	Aug	X	X	X	X	X					X
1(2)	Jun	X	X	X	X	X		X	X	X	X
1(2)	Jul	X	X	X	X	X					X
1(2)	Aug	X	X	X	X	X					X
1(3)	Jun	X	X	X	X	X			X		X
1(3)	Jul	X	X	X	X	X					X
1(3)	Aug	X	X	X	X	X					X
2(1)	Jun	X	X	X	X		X				X
2(1)	Jul	X	X	X	X				X	X	X
2(1)	Aug	X	X	X	X						X
2(2)	Jun	X	X	X	X	X					X
2(2)	Jul	X	X	X	X	X					X
2(2)	Aug	X	X	X	X	X					X
2(3)	Jun	X	X	X			X			X	X
2(3)	Jul	X	X	X	X					X	X
2(3)	Aug	X	X	X	X	X					X
3(1)	Jun	X	X	X	X	X	X		X		X
3(1)	Jul	X	X	X	X	X	X	X	X	X	X
3(1)	Aug	X	X	X	X	X					X
3(2)	Jun	X	X	X	X	X	X				X
3(2)	Jul	X	X	X	X	X			X		X
3(2)	Aug	X	X	X	X						X
3(3)	Jun	X	X	X	X				X		X
3(3)	Jul		X	X	X	X	X			X	X
3(3)	Aug	X	X	X	X	X					X
4(1)	Jun	X	X	X	X	X	X				X
4(1)	Jul	X	X	X	X	X				X	X
4(1)	Aug	X	X	X	X	X					X
4(2)	Jun	X	X	X	X	X		X			X
4(2)	Jul	X	X	X	X	X				X	X
4(2)	Aug	X	X	X	X						X
4(3)	Jun	X	X	X	X	X		X	X	X	X
4(3)	Jul	X		X	X	X					X
4(3)	Aug	X	X	X	X	X					X
7(1)	Jun		X	X	X					X	X
7(1)	Jul	X	X	X		X	X			X	X
7(1)	Aug	X	X	X	X	X					X
7(2)	Jun	X	X		X	X				X	
7(2)	Jul	X	X	X							X
7(2)	Aug	X	X	X	X	X					X
7(3)	Jun	X	X		X	X					
7(3)	Jul	X	X	X		X			X	X	X
7(3)	Aug	X	X	X	X						X

Phasmatodea- Only occurred in 2(1) in June and was not included in the table.
Mantodea- Only occurred in 1(2) in June and was not included in the table.
(1) = Burned in 2008, (2) = Burned in 2009, (3) = Not burned either year

Table 5. Mass (in grams) of insect samples collected from Conservation Reserve Program fields in 2008.

Field	Treatment	June	July	August
1(1)	B	0.11	0.05	0.16
	SE	0.04	0.01	0.08
1(2)	UB	0.03	0.15	0.44
	SE	0.01	0.10	0.32
1(3)	UB	0.03	0.27	0.06
	SE	0.01	0.11	0.01
2(1)	B	0.15	0.16	0.49
	SE	0.07	0.06	0.34
2(2)	UB	0.16	0.10	0.05
	SE	0.04	0.04	0.01
2(3)	UB	0.10	0.09	0.62
	SE	0.01	0.02	0.11
3(1)	B	0.09	0.35	0.22
	SE	0.07	0.10	0.06
3(2)	UB	0.04	0.06	0.09
	SE	0.02	0.01	0.06
3(3)	UB	0.06	0.08	0.07
	SE	0.02	0.03	0.02
4(1)	B	0.14	0.35	0.17
	SE	0.03	0.14	0.03
4(2)	UB	0.05	0.11	0.15
	SE	0.03	0.03	0.05
4(3)	UB	0.09	0.53	0.12
	SE	0.04	0.19	0.10
5(1)	B	0.01	0.18	0.22
	SE	0.01	0.05	0.08
5(2)	UB	0.02	0.11	0.07
	SE	0.01	0.08	0.01
5(3)	UB	0.04	0.14	0.10
	SE	0.01	0.06	0.04
6(1)	B	0.05	0.24	0.24
	SE	0.03	0.03	0.03
6(2)	UB	0.04	0.24	0.84
	SE	0.03	0.06	0.34
6(3)	UB	0.07	0.14	0.29
	SE	0.03	0.07	0.16
7(1)	B	0.49	0.36	0.64
	SE	0.27	0.03	0.02
7(2)	UB	0.15	0.24	0.62
	SE	0.07	0.15	0.28
7(3)	UB	0.23	0.38	0.51
	SE	0.18	0.22	0.16

B = Burned, PB = Post burned, UB = Unburned

Table 6. Mass (in grams) of insect samples collected from Conservation Reserve Program fields in 2009.

Field	Treatment	June	July	August
1(1)	PB	0.29	0.80	0.97
	SE	0.08	0.13	0.34
1(2)	B	0.51	0.57	0.79
	SE	0.13	0.11	0.41
1(3)	UB	0.11	0.77	0.77
	SE	0.04	0.16	0.38
2(1)	PB	0.31	0.78	0.82
	SE	0.04	0.17	0.19
2(2)	B	0.05	0.47	0.29
	SE	0.02	0.11	0.15
2(3)	UB	0.16	0.78	0.70
	SE	0.06	0.21	0.22
3(1)	PB	0.17	1.07	0.97
	SE	0.03	0.28	0.18
3(2)	B	0.15	0.73	0.31
	SE	0.08	0.19	0.07
3(3)	UB	0.10	0.61	0.61
	SE	0.04	0.15	0.19
4(1)	PB	0.15	0.85	0.65
	SE	0.04	0.17	0.13
4(2)	B	0.08	0.26	0.35
	SE	0.05	0.08	0.21
4(3)	UB	0.19	0.50	0.53
	SE	0.06	0.21	0.28
7(1)	PB	0.07	0.49	1.15
	SE	0.03	0.12	0.54
7(2)	B	0.26	0.30	0.41
	SE	0.25	0.16	0.03
7(3)	UB	0.01	0.50	0.76
	SE	0.00	0.18	0.44

B = Burned, PB = Post burned, UB = Unburned

Table 7. Apparent reproductive success for each treatment and year.

Year	Treatment	Fledged	Depredated	Abandoned	Direct Human Impact	Unknown	Total
2008	**B**	19% n=4	62% n=13	9.5% n=2	5% n=1	5% n=1	100% n=21
	UB	25% n=15	53% n=31	3% n=2	2% n=1	17% n=10	100% n=59
	Total	24% n=19	55% n=44	5% n=4	2.5% n=2	13.5% n=11	100% n=80
2009	**B**	25% n=9	75% n=27	0% n=0	0% n=0	0% n=0	100% n=36
	PB	27% n=8	63% n=19	10% n=3	0% n=0	0% n=0	100% n=30
	UB	16% n=7	67% n=29	9.3% n=4	2.3% n=1	4.7% n=2	100% n=43
	Total	22% n=24	69% n=75	6.4% n=7	0.9% n=1	1.8% n=2	100% n=109

B= Burned, PB= Post burned, UB= Unburned

Table 8. Number of species observed for each treatment and year.

Species	# of Nests 2008 B	# of Nests 2008 UB	# of Nest 2009 B	# of Nest 2009 PB	# of Nest 2009 UB	Total
Cassin's sparrow	1	0	0	0	0	1
Common nighthawk	1	2	1	1	1	6
Dickcissel	0	2	1	3	3	9
Grasshopper sparrow	0	4	2	7	9	22
Horned lark	0	0	2	0	0	2
Lark sparrow	0	0	3	0	1	4
Meadowlark	0	8	0	3	4	15
Mourning dove	17	41	26	16	23	123
Northern Harrier	0	2	0	0	0	2
Totals	19	59	35	30	41	184

B= Burned, PB= Post burned, UB= Unburned
**Nest located in firebreaks excluded from table

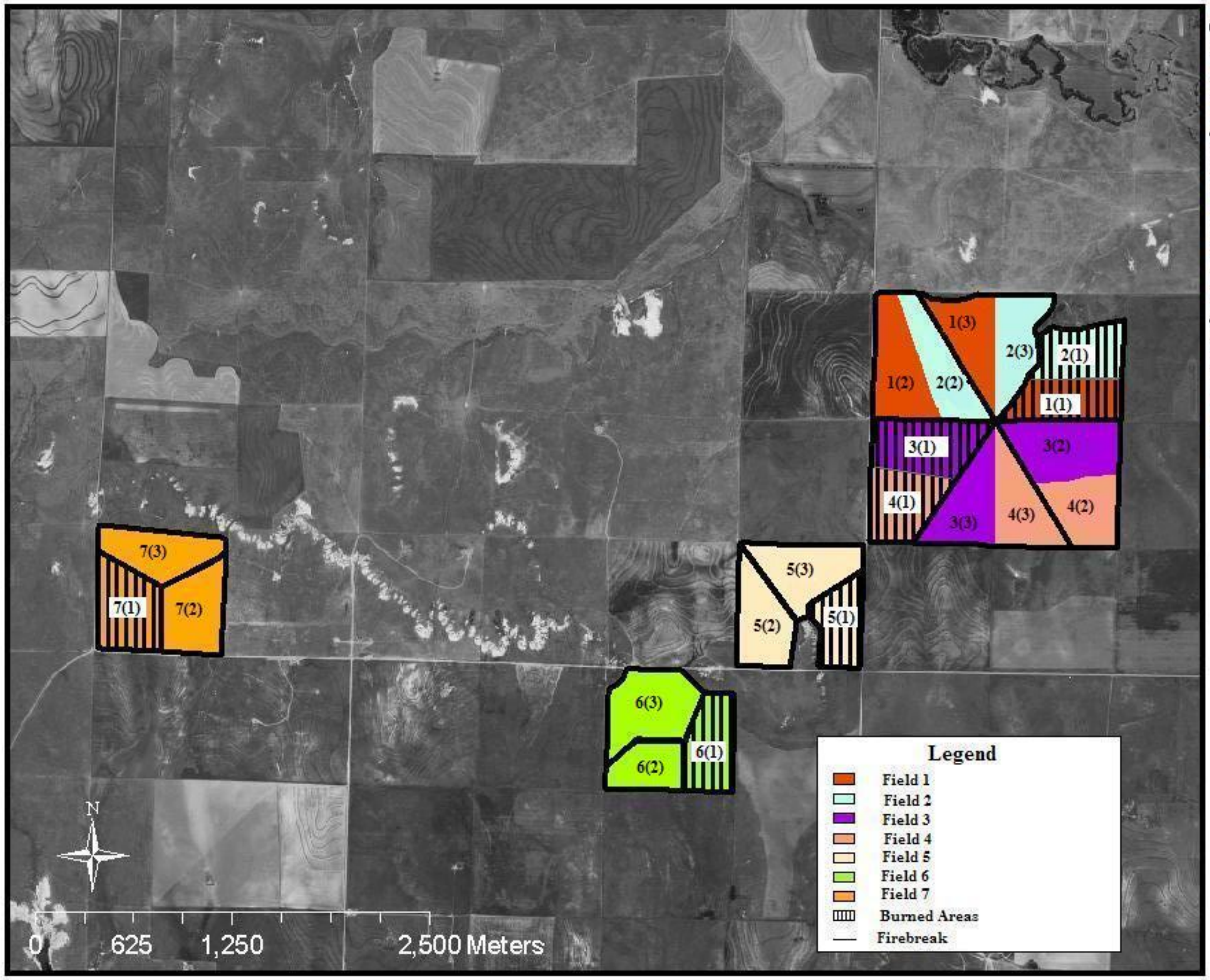
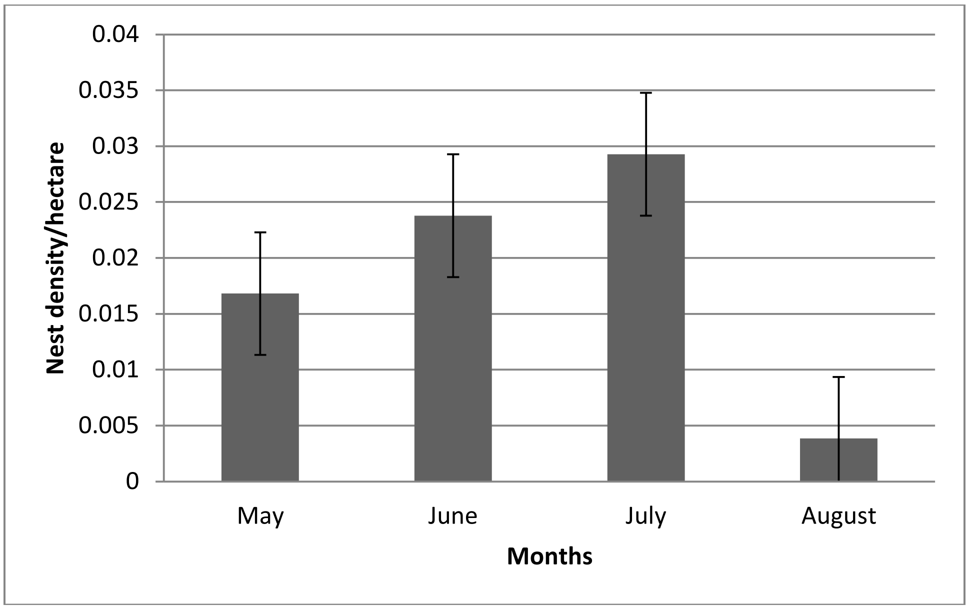


Figure 1. Study site in Gove County Kansas - 2008

Figure 2. Study site in Gove County Kansas - 2009

Figure 3. Comparison of mean (± standard error) nest density per hectare among months observed of grassland nesting birds in Conservation Reserve Program fields in 2008 (A) and 2009 (B).

A.



B.

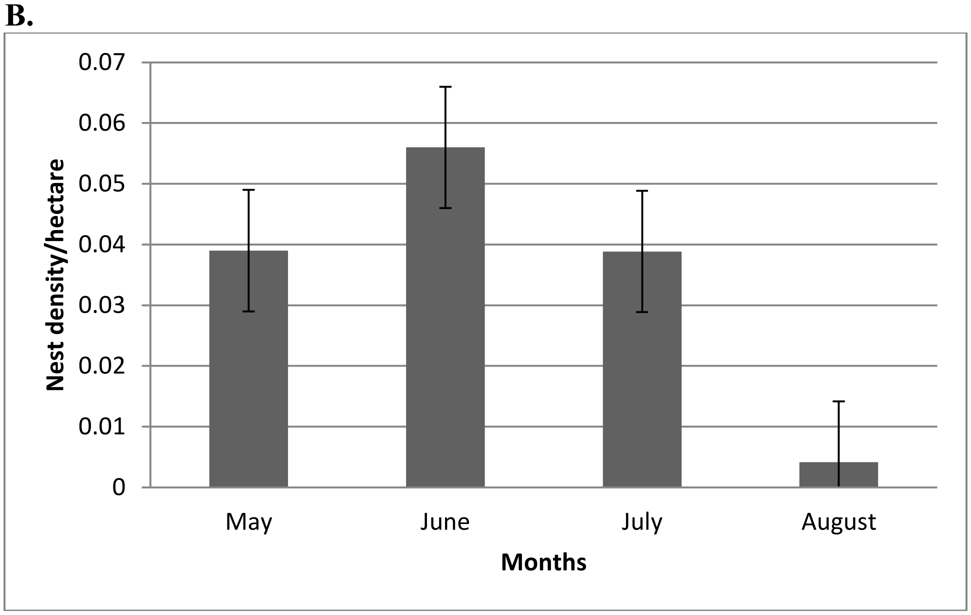
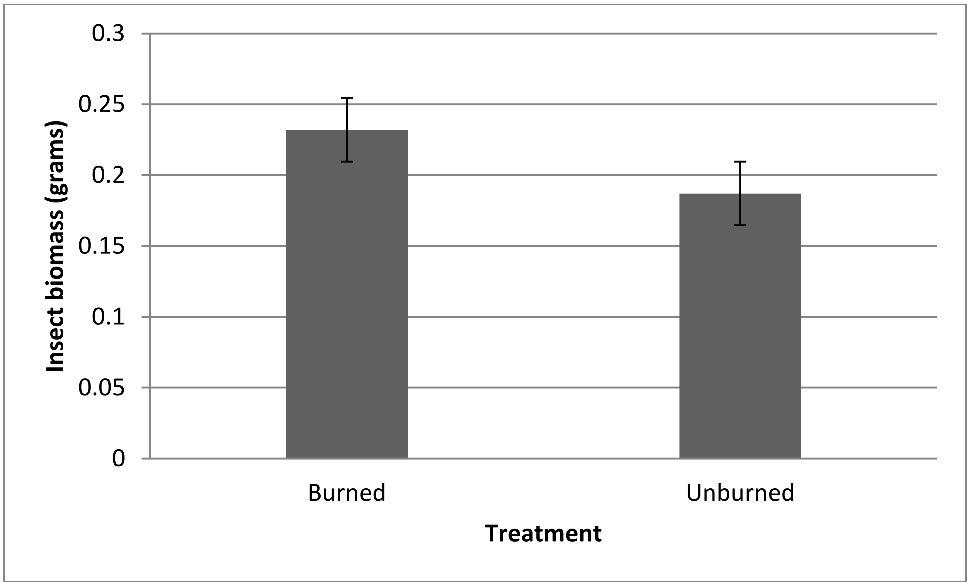


Figure 4. Comparison of mean (± standard error) insect biomass in grams among treatments observed on Conservation Reserve Program fields in 2008 (A) and 2009 (B).

A.



B.

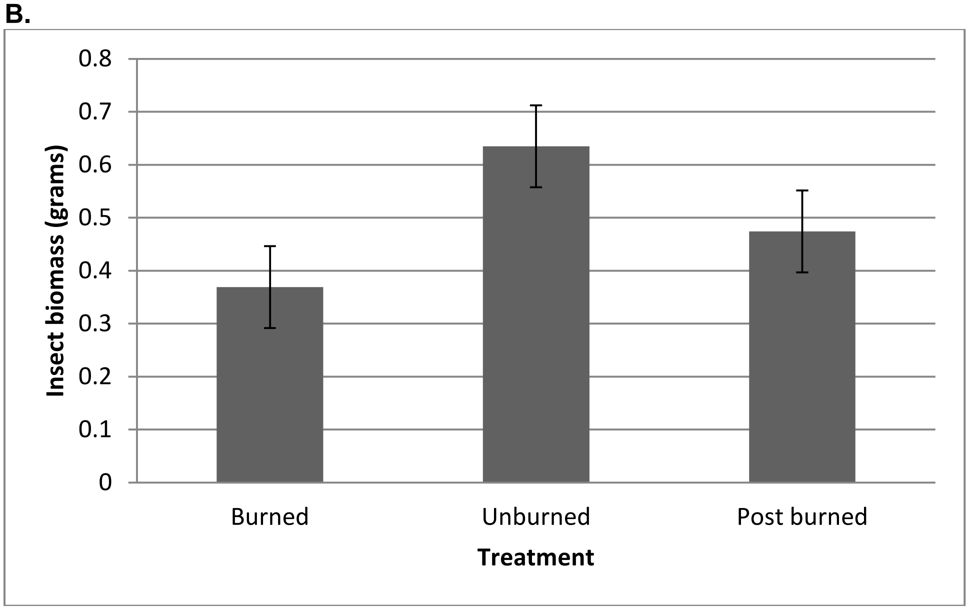
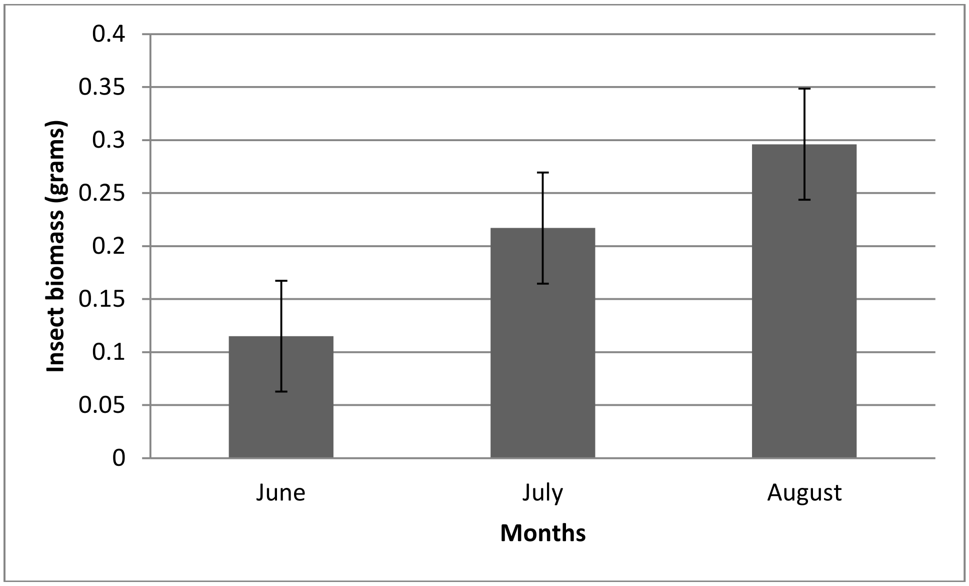


Figure 5. Comparison of mean (± standard error) insect biomass in grams among months observed on Conservation Reserve Program fields in 2008 (A) and 2009 (B).

A.



B.

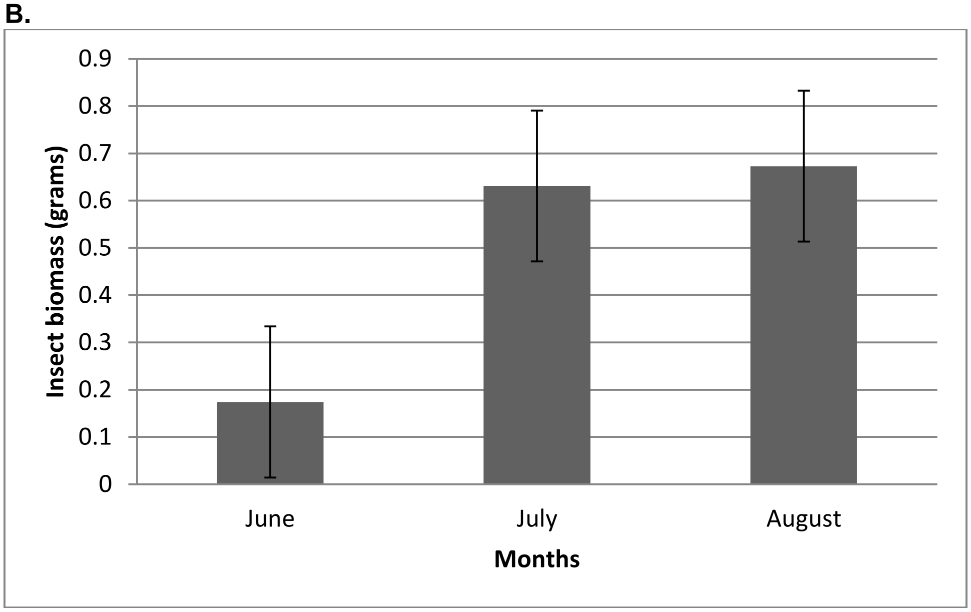


Figure 6. Comparison of means (± standard error) of percent cover of vegetation characteristics between burned and unburned areas on Conservation Reserve Program fields in 2008.

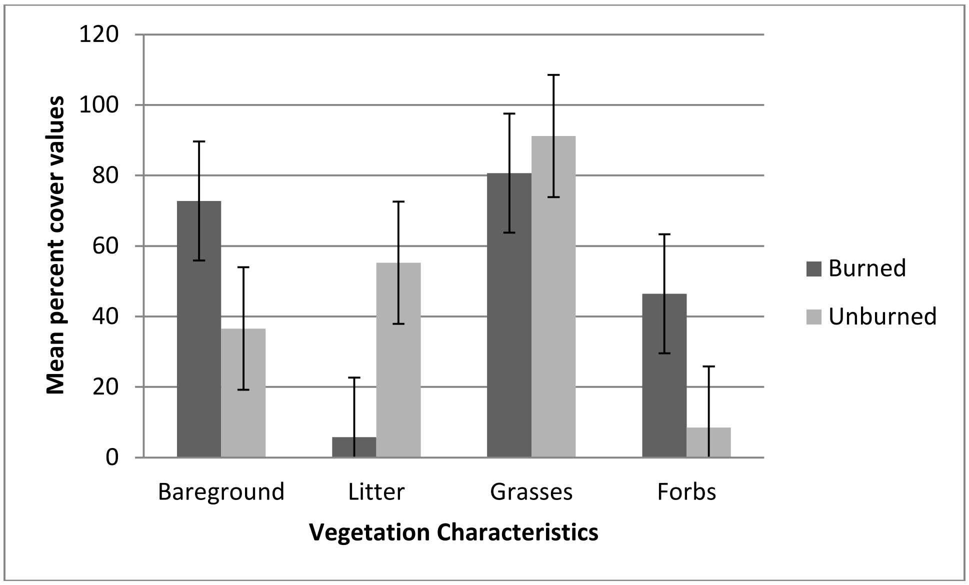
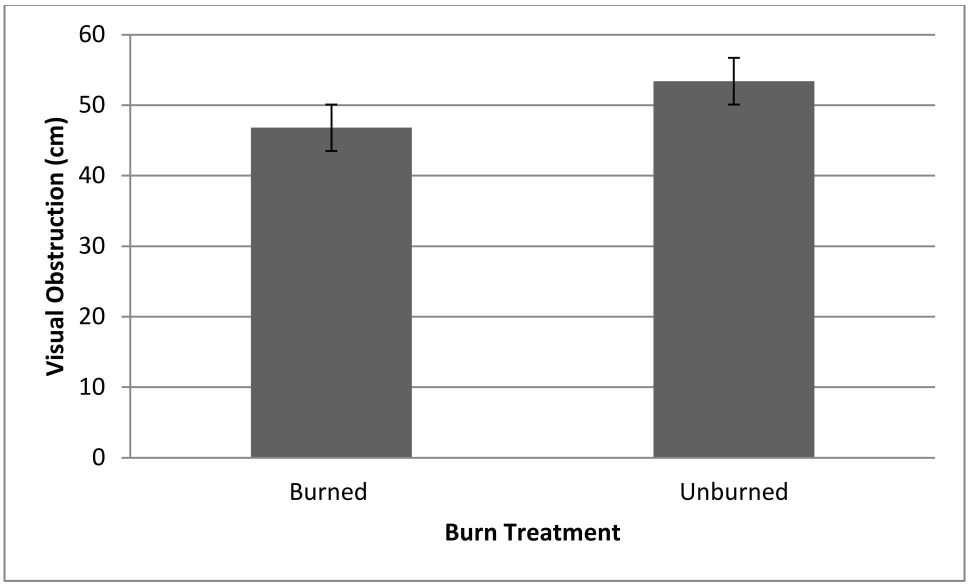


Figure 7. Comparison of means (± standard error) of visual obstruction (A) and litter depth (B) in centimeters between burned and unburned areas on Conservation Reserve Program fields in 2008.

A.



B.

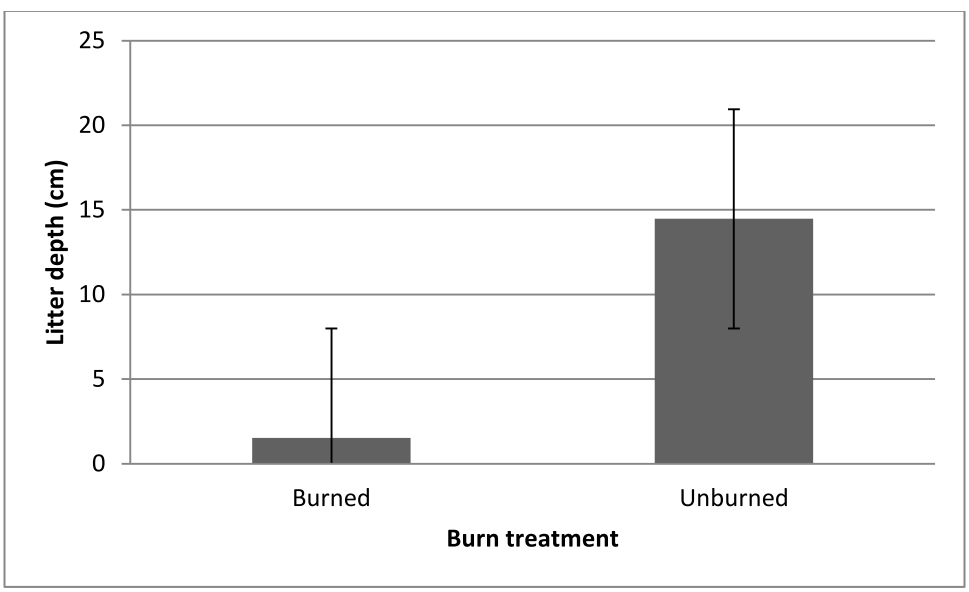
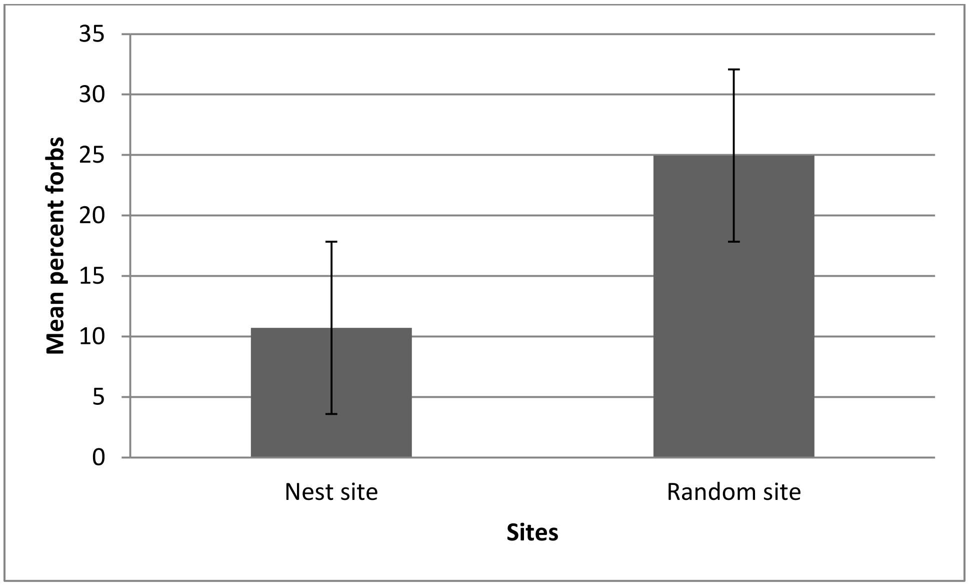


Figure 8. Comparison of means (± standard error) of percent forbs between nest sites and paired random sites on Conservation Reserve Program fields in 2008 (A) and 2009 (B).

A.



B.

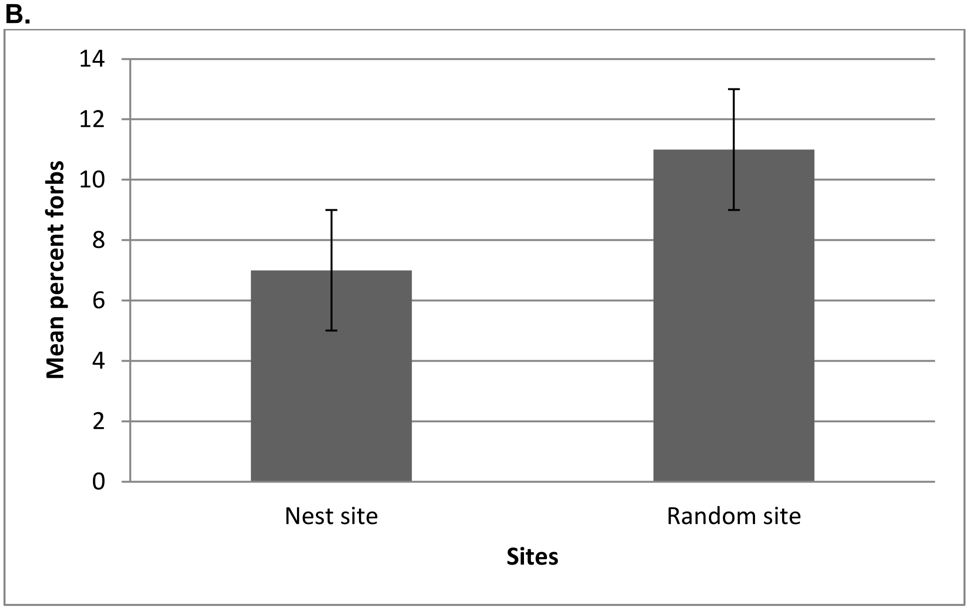


Figure 9. Comparison of means (± standard error) of percent cover of vegetation characteristics between burned, unburned, and one year post burn areas on Conservation Reserve Program fields in 2009.

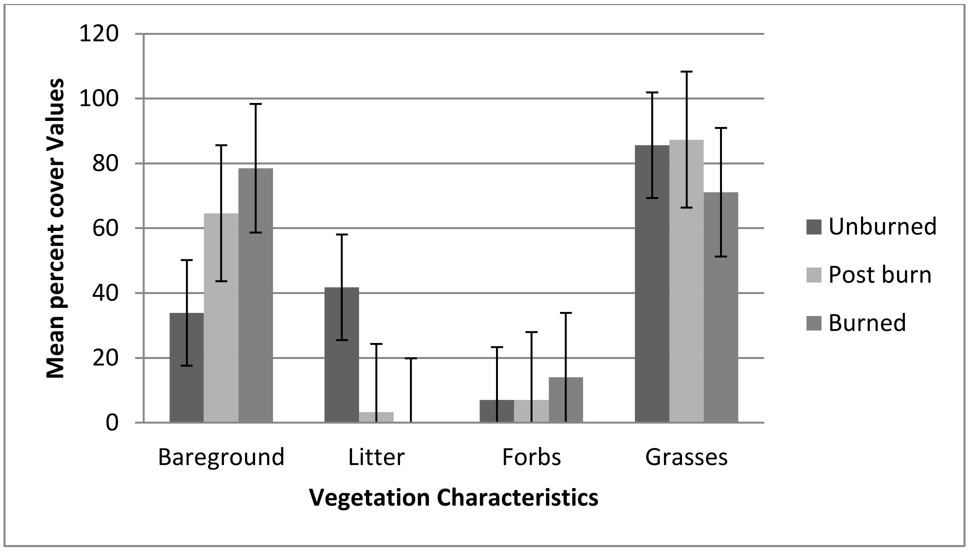
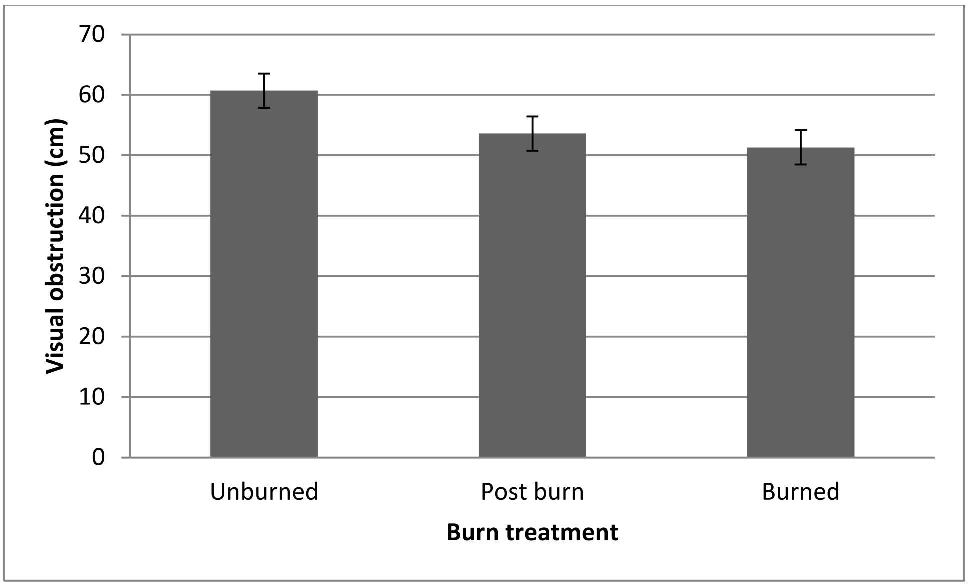


Figure 10. Comparison of means (± standard error) of visual obstruction (A) and litter depth and vegetation height (B) in centimeters between burned, unburned and one year post burn areas on Conservation Reserve Program fields in 2009.

A.



B.

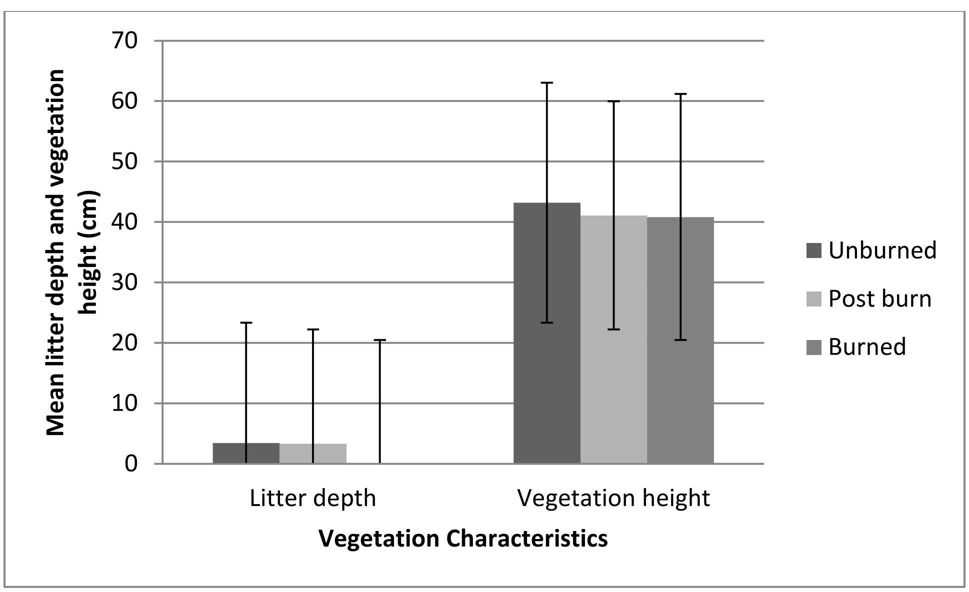


Figure 11. Mean monthly precipitation (± standard error) values in centimeters from a weather station 4 miles west of the center of Gove County, Kansas for 2008 and 2009. (Kansas State University Weather Data Library).