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Spring burning: Resulting avian abundance and nesting in Kansas CRP

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Abstract

Spring burning is used to control invasion by woody vegetation of rangelands in eastern Kansas and also of Conservation Reserve Program (CRP) fields planted to native grasses. We measured the effects of spring burning of CRP fields on vegetation structure and avian populations in northeastern Kansas during the summers of 1992 through 1995. Several vegetation characteristics differed between burned and unburned CRP fields in May, but few differed in July. Mean avian abundance on burned CRP fields was 5.6 birds km^{-1} of survey transect, significantly less ($P < 0.01$) than the 8.6 km^{-1} on unburned fields. The avian-assemblages on burned and unburned fields differed more in May/June [Morisita's Index to Similarity (MIS) = 0.86] than in June/July or July/August (MIS = 0.98 and 0.97, respectively). Avian species richness ranged from 12 to 21 on burned fields and from 10 to 19 on unburned fields. A total of 27 nests was found on burned fields, significantly less ($P < 0.01$) than the 372 found on unburned fields. The 22.2% nesting success on burned fields was not significantly different ($P = 0.205$) than the 34.1% success on unburned fields. Spring burning reduced bird-nest numbers in the summer of the same year, but did not reduce significantly ($P = 0.235$) the number of nests found in those fields the following summers nor the abundance of birds or nesting success. Avoidance of annual burning would reduce adverse impacts on bird populations relying on CRP fields for nesting habitat.

Key Words: grassland birds, nest number, species richness, avian assemblages

Resumen

Las quemas en la primavera se usan para controlar la invasion de plantas leñosas en los pastos en el Oriente de Kansas y en campos con pastos nativos bajo el Programa de Reserva de Conservación (CRP). Los efectos de las quemas de campos CRP en la estructura de la vegetación y poblaciones de aves en el Noreste de Kansas fueron medidos durante los veranos de 1992 a 1995. Se registraron varias diferencias en las características vegetacionales de los campos CRP quemados y no quemados en Mayo, pero muy poca diferencia en Julio. El promedio de abundancia de aves en campos CRP quemados fue de 5.6 pájaros/km de trayecto muestreado, significativamente menos ($P < 0.01$) que los 8.6/km en campos no quemados. Los complejos de aves en campos quemados y no quemados variaron mas en Mayo/Junio [Indice de Similitud de Morisita (MIS) = 0.86] que en Junio/Julio o Julio/Agosto (MIS = 0.98 y 0.97, respectivamente). La riqueza de las especies avolas varió de 12 a 21 en campos quemados y de 10 a 19 en los no quemados. Además, se encontró un total de 27 nidos en campos quemados, mucho menos ($P < 0.01$) que los 372 en los no quemados. El 22.2% de anidaje (éxito de anidar) en campos quemados no fue diferente ($P = 0.205$) que el 34.1% en los no quemados. Las quemas redujeron el número de nidos en el mismo verano, pero no redujeron ($P = 0.235$) el número de nidos encontrados en esos campos el siguiente verano, ni tampoco la abundancia de aves o el anidaje. La eliminación de estas quemas reducirían los impactos adversos sobre las poblaciones de aves que dependen de los campos CRP en donde anidar.

Increased mechanization of agriculture and larger farms have resulted in a reduction in the amount of native prairie in the Great Plains. These changes have been associated with declines in populations of several grassland birds (Warner 1994, Herkert et al. 1996).

The Conservation Reserve Program (CRP) was established by the 1985 Food Security Act to curb excess crop production and improve soil and water resources (Blackburn et al. 1991). The program called for the establishment of 18 million ha of permanent vegetative cover on highly erodible cropland by 1995. This program was generally believed to have the potential of benefitting grassland bird populations in the Great Plains, where most CRP fields are planted to grasses (U.S. Department of Agriculture 1992).

Breeding Bird Survey data from North Dakota indicate that CRP has benefitted some grassland species that were declining before the program started (Reynolds et al. 1994). Johnson and Schwartz (1993) and King and Savidge (1995) also provide evidence that CRP fields may benefit grassland bird populations in the northern Great Plains and Nebraska, respectively. These data have generally come from unmanipulated CRP fields. Prescribed spring burning commonly is used to control weeds and invasion by woody vegetation on rangelands in Kansas (Owensby 1994) and also on Kansas CRP fields planted to native grasses (Hull et al. 1996).

Our involvement in a regional study of CRP fields (Best et al. 1997) allowed us to investigate the effects of spring burning on birds in Kansas CRP fields. We did so by comparing avian abun-

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dance, nesting success, species richness, and composition of the avian assemblages in spring-burned versus unburned CRP fields.

Methods

We conducted this research from 1991 to 1995 in Riley County, in the Flint Hills physiographic region of northeastern Kansas. The Flint Hills are part of the tallgrass prairie ecosystem and agriculture is the county's dominant land use. Approximately 65% of the land area is used for agriculture; 45% for cereal grain production, and 55% for livestock grazing and/or forage production (Helyar 1992). Twelve fields were selected for the study from the CRP contract files of the Riley County office of the U.S. Department of Agriculture Farm Services Agency (USDA/FSA). CRP fields were between 9 and 17 ha (mean = 12.9 ha) and planted to native grasses 3–4 years prior to 1991. The native grass planting was the Kansas USDA/FSA-recommended mixture of big bluestem (*Andropogon gerardii* Vitman), Indiangrass (*Sorghastrum nutans* (L.) Nash), little bluestem (*Schizachyrium scoparium* (Michx.) Nash), sideoats grama (*Bouteloua curtipendula* (Michx.)Torrey), switchgrass (*Panicum virgatum* L.), and western wheatgrass (*Agropyron smithii* Rydb.). USDA/FSA recommends that landowners in Riley County burn native grass CRP fields annually or biannually in the spring to control noxious weeds and reduce invasion by woody vegetation. We monitored the burning activity but did not attempt to influence the landowner's decision to burn or not burn.

The vegetation on CRP fields was characterized each year during May and July along 6 parallel transects distributed systematically throughout each field. Vegetation was measured at 6 equally–spaced sample points along each transect. Lengths of transects and the interval between sample points were adjusted to field size; large fields had longer transects and longer intervals between points than small fields. The vertical density of the vegetation was assessed at each sample point by visual obstruction readings at 4 m from a Robel pole at a height of 1 m (Robel et al. 1970). Maximum height of living and standing-dead vegetation was measured at each sample point. Percent vegetation canopy coverage (grass, forb, and woody), bare ground, and litter cover were estimated visually within a Daubenmire (1959) sampling frame. Details of methodology are in Best et al. (1997).

Avian abundances were determined from counts of birds heard or seen while we walked along a second set of transect lines established in each field. The first avian abundance transect line was parallel to 1 field edge and 25 m from it. Successive transect lines across each field were parallel to the first and 50 m apart. Bird counts (1 per field per survey period) were made during the first 3 hours of daylight between 15 May and 15 June, 15 June and 15 July, and 15 July and 15 August of each year. Counts were made by walking slowly along each transect line and pausing frequently to scan and listen for birds. Only birds seen or heard within 50 m of the transect line were recorded, and special care was taken to avoid double counting of individual birds. Birds flying over the fields were not counted unless they landed. Avian abundance data were expressed as the number of birds seen or heard per 1,000 m of transect (No. km^{-1}).

Estimates of bird nesting success were obtained by locating active nests and determining their outcomes. Nests were located by rope dragging (Wiens 1969), intensive searching (Basore et al. 1986) in the CRP fields 2 to 4 times each year between 15 May and 31 July, and incidentally while collecting vegetative and avian abundance data. The number of eggs and/or young was recorded for each nest found. All located nests were visited every 2–4 days to determine their outcomes. A successful nest fledged at least 1 host young, and apparent nesting success was calculated as the percentage of total nests located that were successful. We tried to minimize disturbance at nests during our visits, and markers used to relocate nests were placed > 5 m away. Nest searching effort varied among years, but the proportion of effort was approximately equal for burned and unburned fields.

Total avian abundance was computed for each study field for each time period of each year, and those values were used in statistical analyses. Avian abundance and vegetation characteristics were analyzed using analysis of variance based on a repeated measures split-plot design (Milliken and Johnson 1992) using the GLM and mixed procedures of SAS (SAS Inst., Inc. 1990). Percentage vegetation data were arcsine square root transformed for statistical analysis (Zar 1984). Numbers and species of nests found and apparent nest success in burned and unburned CRP fields were compared using Chi-Square goodness of fit and contingency tests, respectively, with $P = 0.05$ for significance. Numbers and species of birds counted were pooled by time period to create 6 avian assemblages; 3 each for burned and unburned CRP fields. Similarities in the composition of these avian assemblages were determined using Morisita's Index of Similarity (MIS) (Krebs 1989). Species richness was simply the number of avian species observed (Wiens 1989) during each of the 3 time periods for burned and unburned CRP fields.

Results

Controlled burning of our CRP fields generally occurred between 1 April and 15 May. Burning was more common early in our 5-year study than later. Ten of our 12 CRP fields were burned in 1991, 10 in 1992, 6 in 1993, but only 3 each in 1994 and 1995 (Table 1). The frequency of burning varied among the fields, with Field No. 42 being burned only in 1991 and Fields No. 32 and 102 being burned in 4 of the 5 years. Field No. 122 was burned every other year whereas 5 of the fields were burned annually during the first 3 years of our study, and 1 annually dur-

Table 1. Size (ha) and prescribed burn history of the 12 CRP fields used for this 1991–1995 study in Riley County, Kans.

Field No.	Size (ha)	1991	1992	1993	1994	1995
12	11.1	SB[1]	SB	SB	NB	NB
22	12.2	SB	NB	SB	NB	NB
32	10.7	SB	SB	SB	SB	NB
42	13.0	SB	NB	NB	NB	NB
52	11.1	NB	SB	NB	NB	SB
62	13.8	SB	SB	SB	NB	SB
72	16.8	SB	SB	NB	NB	NB
82	9.7	SB	SB	SB	NB	NB
92	13.8	SB	SB	NB	NB	NB
102	13.0	SB	SB	NB	SB	SB
112	15.4	SB	SB	SB	NB	NB
122	14.2	NB	SB	NB	SB	NB

[1]SB = spring burned; NB = not burned

Table 2. Means ± S.E. of vegetation characteristics during May and July of spring-burned and unburned CRP fields in Riley County, Kans., 1992-95.

Variable	May[1] Unburned	May[1] Burned	July Unburned	July Burned
Field years (n)	22[2]	22	22	22
Visual obstruction (dm)	1.3^{b}±0.1	0.6^{a}±0.1	1.7^{c}±0.1	1.9^{c}±0.1
Height of live vegetation (dm)	0.6^{a}±0.1	0.7^{a}±0.1	1.8^{a}±0.1	2.2^{a}±0.1
Head of dead vegetation (dm)	1.3^{b}±0.1	0.2^{a}±0.1	1.1^{b}±0.1	0.1^{a}±0.1
Canopy cover (%)				
Total	59.1^{b}±3.1	23.5^{a}±2.8	67.8^{c}±3.1	57.4^{b}±2.8
Live	24.5^{b}±2.7	21.8^{a}±2.4	55.8^{a}±2.7	57.8^{a}±2.4
Dead	36.0^{c}±2.2	1.4^{a}±1.9	13.4^{b}±2.2	0.2^{a}±1.9
Grass	54.9^{b}±3.1	20.9^{a}±2.8	61.9^{c}±3.1	50.3^{b}±2.8
Forb	4.2^{a}±1.5	2.4^{a}±1.4	5.8^{a}±1.5	6.9^{a}±1.4
Woody	0.0^{a}±0.0	0.0^{a}±0.0	0.0^{a}±0.0	0.0^{a}±0.0
Litter cover (%)	30.2^{b}±4.9	15.3^{a}±4.4	37.4^{c}±4.9	12.3^{a}±4.4
Bare ground (%)	31.9^{a}±5.1	70.7^{c}±4.7	29.8^{a}±5.1	61.4^{b}±4.7
Litter depth (cm)	0.8^{b}±0.1	0.4^{a}±0.1	0.8^{b}±0.1	0.3^{a}±0.1

[1]Means with the same superscript within a row are not significantly different (P<0.05).
[2]Data from Field No. 42 (Table 1) were not included because it was never burned during the 1992–92 period.

ing the first 4 years. On average, the 12 CRP fields were burned 2.5 times each during our study.

Vegetation characteristics varied between burned and unburned CRP fields (Table 2). Visual obstruction measurements (reflecting height and density of vegetation) were significantly higher ($P < 0.05$) on unburned CRP fields during May, but not in July. Height of live vegetation was similar on burned and unburned fields during May and July, but that of dead vegetation was significantly greater ($P < 0.01$) on unburned fields. Total vegetation canopy coverage was significantly greater ($P < 0.05$) on unburned than burned CRP fields. Litter cover and depth each were significantly greater ($P < 0.05$) on unburned CRP fields, whereas bare ground was significantly greater ($P < 0.01$) on burned fields.

Because only 1 avian census count was conducted in 1991 and nest searching did not begin until late summer, that year's avian data were not included in our analysis. Mean annual total avian abundance in 1992–1995 on burned CRP fields ranged from 3.2 to 7.2 birds km^{-1} of transect, whereas that on unburned fields ranged from 8.0 to 8.9 km^{-1} (Table 3). The mean total avian abundance on burned CRP fields was significantly less ($P < 0.01$) than that on unburned fields.

Table 3. Mean annual total abundance of birds (No. km^{-1} of transect) recorded during census counts of burned and unburned CRP fields in Riley County, Kans., 1992-95.

Year	Unburned Fields	Unburned Birds	Unburned S.E.	Burned Fields	Burned Birds	Burned S.E.
	(No.)	- - (No. km^{-1}) - -		(No.)	- - (No. km^{-1}) - -	
1992	2	8.9[1]	2.3	10	7.2	1.0
1993	6	8.0	1.3	6	3.2	1.3
1994	9	8.7	1.1	3	5.6	1.9
1995	9	8.8	1.2	3	5.3	2.1
Overall	26	8.6[2]	0.9	22	5.7	0.8

Twenty-six and 21 bird species were recorded on burned and unburned CRP fields, respectively (Table 4). The dickcissel (for scientific names of birds see Tables 4 and 5) was the most abundant avian species recorded on both burned and unburned CRP fields, constituting 66.4 and 52.4% of the total counts, respectively. Other avian species commonly counted on burned fields were brown-headed cowbirds (11.3%), northern bobwhites (5.0%), meadowlarks (4.1%), and red-winged blackbirds (3.0%). In addition to the dickcissel on the unburned fields, the more abundant avian species counted included the brown-headed cowbird (14.6%), grasshopper sparrow (8.6%), northern bobwhite (4.4%), and meadowlark (3.2%). All of the avian species constituting >1% of the total birds were detected on both burned and unburned fields, except the upland sandpiper, which was recorded only on burned fields.

Bird abundances varied over the summer, with most species showing higher abundances during the June/July and July/August census counts compared to counts made in May/June (Table 4). The avian assemblages on the burned and unburned fields were less similar during the May/June census counts (MIS = 0.86) than during the June/July and July/August counts (MIS = 0.98 and 0.97, respectively). Species richness on burned and unburned CRP fields declined over the summer, but were consistently higher on fields burned in the spring.

The dickcissel was the most abundant avian species throughout the summer on burned and unburned CRP fields, while the brown-headed cowbird and grasshopper sparrow were the 2nd and 3rd most abundant species, respectively (Table 4). Mean counts of brown-headed cowbirds, dickcissels, meadowlarks, mourning doves, northern bobwhites, red-winged blackbirds, and sedge wrens were higher on unburned than burned CRP fields, but only the difference for dickcissels was significantly higher ($P < 0.05$). The probability values for the other species ranged from $P = 0.23$ (sedge wrens) to $P = 0.80$ (brown-headed cowbirds). Counts of eastern kingbirds, grasshopper sparrows, larkspurs, and ring - necked pheasants were higher on burned than unburned CRP fields, but none was significantly different, i.e., ranging from $P = 0.22$ for larkspurs to $P = 0.90$ for grasshopper sparrows. The total abundance of all birds on unburned fields was significantly higher than on spring-burned fields for each sampling period ($P < 0.05$) and the periods combined ($P < 0.01$).

We found 399 nests of 14 avian species in our 12 CRP fields during this study (Table 5). Nests of the dickcissel were found most frequently (247 of 399; 61.9%), followed by nests of the mourning dove (95; 23.8%); common nighthawk (13; 3.3%); and meadowlark (9; 2.3%). None of the 10 other avian species contributed >2% each to the number of nests found. The number of nests found on CRP fields burned in the spring was 27, significantly less than the 372 found on fields not burned in the spring ($x^2 = 245.28$, 1 df, $P < 0.001$).

Nesting success varied among the different avian species (Table 5). The nesting success of dickcissels on spring-burned CRP fields was lower ($P = 0.06$) than for those nesting on unburned fields. The number of nests of other species found on burned and unburned fields was insufficient to provide reliable nesting success comparisons between burned and unburned fields. Success for all nests on spring-burned fields was 22.2%, not significantly different from the 34.1% success of nests on unburned fields ($x^2 = 1.61$, 1 df, $P = 0.205$).

Learning that burning reduced avian nesting on CRP fields and recognizing that periodic burning is necessary to maintain grass-

Table 4. Mean (± S.E.) abundance of avian species (No. km^{-1} of transect) constituting >1% of total counts for either burned or unburned CRP fields in Riley County, Kans., 1992–95.

Species	Burned/ Unburned	Census counts[1] May/Jun	Jun/Jul	Jul/Aug	Mean[2]
		(No. km^{-1})			
Brown-headed cowbird	SB[3]	1.12	1.09	0.19	0.83±0.20
Molothrus ater	NB	1.25	0.83	0.72	0.96±0.18
Dickcissel	SB	1.24	4.02	3.79	2.98±0.34
Spiza americana	NB	3.15	7.37	6.89	5.66±0.44
Eastern kingbird	SB	0.26	0.11	0.00	0.13±0.05
Tyrannus tyrannus	NB	0.02	0.04	0.03	0.03±0.02
Grasshopper sparrow	SB	0.67	0.36	0.43	0.49±0.12
Ammodramus savannarum	NB	0.41	0.18	0.10	0.25±0.09
Lark sparrow	SB	0.15	0.05	0.02	0.08±0.04
Chondestes grammacus	NB	0.00	0.00	0.03	0.01±0.01
Meadowlark	SB	0.21	0.22	0.09	0.18±0.05
Sturnella spp.[4]	NB	0.56	0.33	0.07	0.35±0.06
Mourning dove	SB	0.25	0.03	0.02	0.10±0.04
Zenaida macroura	NB	0.36	0.18	0.09	0.22±0.06
Northern bobwhite	SB	0.13	0.13	0.52	0.25±0.11
Colinus virginianus	NB	0.47	0.22	0.69	0.43±0.13
Ring-necked pheasant	SB	0.02	0.04	0.43	0.15±0.07
Phasianus colchicus	NB	0.11	0.25	0.00	0.14±0.08
Red-winged blackbird	SB	0.16	0.08	0.00	0.08±0.05
Agelaius phoeniceus	NB	0.34	0.26	0.11	0.26±0.08
Sedge wren	SB	0.00	0.00	0.16	0.05±0.04
Cistothorus palustris	NB	0.16	0.05	0.15	0.11±0.05
Upland sandpiper	SB	0.40	0.02	0.00	0.15±0.07
Bartramia longicauda	NB	0.00	0.00	0.00	0.00±0.00
All birds[5]	SB	4.99	6.31	5.76	5.72±0.54
	NB	7.13	9.72	8.88	8.56±1.00
Total species recorded	SB	21	16	42	26
	NB	19	11	10	21

[1]One count annually on each of 22 burned and 26 unburned CRP fields during each sampling period.
[2]Arithmetic means accounting for different number of years for census counts.
[3]SB = spring burned, NB = not burned.
[4]Unable to reliably distinguish between eastern meadowlarks (*Sturnella magna*) and western meadowlarks (*S. neglecta*) during census counts.
[5]All species observed in fields during census counts.

lands (CRP fields and native prairie) in eastern Kansas caused us to examine our data further. We grouped the fields for all years into 4 categories: those not burned for 2 consecutive years (NBNB); those spring burned 1 year but not the next (SBNB); those spring burned in 2 consecutive years (SBSB); and those not burned 1 year but burned the next (NBSB). We used analysis of variance to compare the number of nests found in the fields in the 2nd year of the above sequences. We found significantly ($P < 0.001$) fewer nests in fields that were spring burned the 2nd year (NBSB = 1.00 and SBSB = 1.43 nests) than those not burned the 2nd year (SBNB = 12.92 and NBNB = 17.08 nests). The most nests were found in fields that were not burned for 2 consecutive years (NBNB), but not significantly ($P = 0.24$) more than the number found in the SBNB fields. The number of nests found in fields during the year of burn was significantly less ($P < 0.01$ each) than the number found 1, 2, 3, or 4 years later. Analysis of variance detected no significant difference in the number of nests found in the fields between years 2 and 3 post burn ($P = 0.74$), years 3 and 4 post burn ($P = 0.51$), or years 4 and 5 post burn ($P = 0.85$)

We also used analysis of variance to analyze our data for long-term effects of burning on bird abundance. None of the avian species showed any statistically significant ($P < 0.05$) changes in abundance 1 year, 2 years, 3 years, or 4 years after the CRP fields were burned; except for the meadowlark. Meadowlark abundance showed no significant difference between year of burn and 1 year later ($P = 0.69$), but did increase from year of burn to 2, 3, and 4 years later ($P < 0.01$ each). Meadowlark abundance was 0.05 birds km^{-1} the year of the burn, and increased to 1.23 birds km^{-1} 4 years post burn. When data for all species were pooled, we detected no significant long-term effect of burning on bird abundance over the 5 years ($P = 0.80$). Changes in total bird abundance from the burn year to 1 year later was not significant ($P = 0.26$); nor was it for 2 years later ($P = 0.44$), 3 years later ($P = 0.60$), or 4 years later ($P = 0.55$)

We used a Chi-Square test to determine post-burn effects on avian nesting success. No significant differences ($P < 0.05$) were detected in nesting success of any species during years 1 through 4 after the fields were burned; except for the dickcissel. Nesting success of the dickcissel 1 and 3–4 years post-burn was 32.5 and 30.4%, respectively, significantly higher than the 10.3% success 2 years post-burn ($x^2 = 1.61$, 2 df, $P = 0.03$). When nesting data for all avian species were pooled, nesting success did not differ significantly among years 1 through 4 post burn ($x^2 = 3.06$, 3 df, $P = 0.38$).

Table 5. Number of successful and unsuccessful nests of birds found in spring burned and unburned CRP fields in Kansas, 1992–95.

Species	Unburned Successful	Unburned Unsuccessful	Unburned Successful	Burned Successful	Burned Unsuccessful	Burned Successful
	(No.)	(No.)	(%)	(No.)	(No.)	(%)
Dickcissel	56	175	24.2	1	15	6.3
Mourning dove	51	41	55.4	2	1	66.7
Common nighthawk *Chordeiles minor*	4	6	40.0	2	1	66.7
Grasshopper sparrow	2	1	66.7	1	1	50.0
Red-winged blackbird	2	4	33.3	0	0	—
Ring-necked pheasant	3	4	42.9	0	0	—
Meadowlark	3	6	33.3	0	0	—
Wild turkey *Meleagris gallopavo*	3	3	50.0	0	0	—
Other[1]	3	5	37.5	0	3	0.0
Totals	127	245	34.1	6	21	22.2

[1]Includes the nest(s) of 1 mallard (*Anas platyrhynchos*), 1 common yellowthroat (Geothylpis trichas), 1 killdeer (*Charadrius vociferus*), 2 sedge wrens, 3 northern bobwhites, and 3 lark sparrows.

Discussion

Generally, the value of CRP fields to birds in the Midwest declines with age as the grass monocultures become dense and litter accumulation makes foraging difficult for ground-feeding granivorous birds (Ryan et al. 1995, Millenbah et al. 1997). Spring burning has the potential of reducing the adverse impacts of this aging process by opening up the CRP stands and reducing litter accumulation. In our study, vertical density of vegetation in May was less on burned fields than on unburned fields, but the effect disappeared by July. Burning also reduced total canopy coverage and litter cover, and increased the amount of bare ground on CRP fields at least through July. Therefore, these effects should have increased the value of burned CRP fields as avian habitat, but our bird abundance and nesting data did not reflect that.

We agree that avian abundance alone may not be the best indicator of habitat quality (Van Horne 1983, Vickery et al. 1992), but we did expect some positive response if spring burning improved the habitat value of CRP fields for grassland birds. We certainly did not expect a decline in avian abundance for the majority of the common species in response to "improved habitat conditions". The decrease in avian abundance on spring burned CRP fields reflects what occurs on annually burned tallgrass prairie. Zimmerman (1992) found avian populations to be 50% higher on unburned tallgrass prairie plots than on annually burned plots in Kansas. The differences we found were similar; avian abundance was approximately 50% greater on unburned fields than on spring burned fields. Both of these differences reflected changes in dickcissel populations, the most abundant avian species in each data set.

Zimmerman's (1992) data exemplify how poor CRP fields are as avian habitat compared to native tallgrass prairie. He found mean avian abundances of 50 and 76 birds km^{-1} of transect on burned and unburned native tallgrass prairie sites, respectively, in the same Kansas county in which we recorded abundances of 6 to 9 birds km^{-1} on burned and unburned CRP fields, respectively. While Zimmerman's data were from variable-width transects and ours from fixed-width transects, the vast majority of his counts were of birds within 25 m of his transects making the data sets quite comparable. Zimmerman (1992) attributes the decrease in avian abundance on burned native tallgrass prairie to reduced structural complexity of the vegetation compared to unburned sites, especially during periods of reduced precipitation (Briggs et al. 1989). CRP fields planted to native grasses are far less complex than native tallgrass prairie, and spring burning reduces the complexity even more.

The suite of avian species in the Great Plains grasslands is not extensive (Cody 1966), but the cause of this is not well understood (Ricklefs 1987, Rotenberry and Wiens 1980, Zimmerman 1992). Zimmerman (1992) reported mean avian species richnesses of 12 and 30, respectively, on his burned and unburned Kansas native tallgrass prairie plots. His surveys were conducted in early June, 1981 through 1990. We recorded more species on our burned CRP fields (21) than on our unburned fields (19) during our census counts in May/June 1992 through 1995. A lower avian species richness on our unburned CRP fields than on unburned native tallgrass prairie was expected; however, we did not anticipate finding more species on our burned CRP fields than Zimmerman's (1992) burned native prairie plots. Part of the reason we recorded more species could be the presence of woody borders (shrubs and trees) along some of our CRP fields. Several species recorded by us but not Zimmerman (1992) commonly are associated with woody cover, e.g., the American goldfinch (*Carduelis tristis*), Brewer's blackbird (*Euphagus cyanocephalus*), common flicker (*Colaptes auratus*), eastern bluebird (*Sialia sialis*), house wren (*Troglodytes aedon*), orchard oriole (*Icterus spurius*), scissor-tailed flycatcher (*Tyrannus forficatus*), and wild turkey.

Avian assemblages were not similar on burned and unburned CRP fields in May/June but were similar later in the summer. Vegetation structure plays a key role in determining which avian species use grassland habitats (Wiens 1973). The vegetation structural differences (e.g., vertical density and total canopy cover) that existed between burned and unburned CRP fields in May were less evident in July. The increased similarities in the July vegetation structure on burned and unburned CRP fields most likely accounted for the increased similarities in the avian assemblages in July.

We were surprised by the low number of nests found in spring burned CRP fields compared to unburned fields. Zimmerman (1996) predicted greater productivity of birds nesting in burned native prairie because of the augmentation of primary productivity following fire (Hulbert 1988). Zimmerman (1996:169) further postulated that grassland birds in "burned prairie might function as a source population, providing a pool of surplus individuals to supplement lower productivity in unburned prairie". However, he presented no data to support his hypotheses, and, in fact, concluded that avian productivity was lower in burned than unburned native prairie because of fire-caused changes in vegetation structure. Likewise, data from our CRP fields do not support the hypothesis that avian productivity is higher in burned than unburned grasslands during the burn year.

We acknowledge that we did not find all of the bird nests in our study fields. However, we probably found a greater portion of those nests in the burned than unburned fields because of the more open vegetation structure of spring-burned fields. Retrospectively, we can appreciate why so few birds nested in our spring–burned CRP fields. Dickcissels, the most numerous nesters on our study areas, require tall vegetation for males to establish breeding territories in late May through mid June (Zimmerman 1982). During this period of peak nest initiation, standing dead vegetation provides perches for territorial males and nesting sites for females (Zimmerman 1971), and these 2 habitat characteristics are actively selected for by dickcissels. Standing dead vegetation was virtually absent on spring-burned fields, causing birds to establish nesting territories and build nests in other grassland habitats providing this requirement, e.g., unburned CRP fields and unburned native pasture. The lack of litter cover in burned CRP fields also may have served to discourage nesting by some birds (Zimmerman 1996), e.g., Henslow's sparrows (*Ammodramus henslowii*) and possibly common yellowthroats.

We found no statistically significant difference in nesting success by birds in burned and unburned CRP fields. Our findings were similar to those of Zimmerman (1996) who used daily nest survival probabilities (Mayfield 1961, 1975; Johnson 1979) as his measure of nesting success in burned and unburned native prairie in Kansas. Had the number of nests in burned CRP fields been larger, the 34.1% nesting success in unburned areas (372 nests) might have been statistically different than the 22.2% success in burned fields (27 nests).

We did not detect any significant long–term effects of burning on the number of nests found, bird abundance (except meadowlarks), or nesting success. This contrasts with Johnson and Temple (1990) who reported burning grasslands in Minnesota at frequencies less than once every 3 years reduced nesting success of 5 species of prairie-nesting birds. These differing results could be regional in nature, i.e., long term impacts occur in Minnesota but not in Kansas. The differences also could reflect the type of grassland burned, i.e., natural grasslands in Minnesota and CRP fields seeded to native grass in Kansas. More research needs to be conducted to determine the long–term effects of burning on grassland bird populations across the Great Plains region

The vastly lower number of nests we found in burned than unburned CRP fields combined with no difference in nesting success between burned and unburned fields leads to the obvious conclusion that spring burning of CRP fields is not beneficial to bird populations using those fields for nesting. This creates a dilemma. Burning reduces avian nesting in CRP fields planted to native grasses, but lack of burning of these fields results in invasion by woody species (Owensby 1994) and changes in vegetation composition and structure (Millenbah 1993, Ryan et al. 1995) that are detrimental to grassland bird populations.

The adverse impacts of spring burning of CRP fields on avian populations in Kansas apparently can be reduced by altering regimes from annual burning to burning less frequently. Burning of native prairie on a 2- to 3-year schedule is sufficient to prevent invasion by most woody species (Owensby 1994) and probably applies to CRP fields planted to native grass as well. Given the past differences in burning practices of our cooperating landowners (Table 1), reducing annual burning of CRP fields in the future should not be a monumental task. Such might be accomplished voluntarily by having the USDA/FSA provide pertinent information to those participating in the CRP program or involuntarily by inserting restrictive language into the CRP contracts.

Literature Cited

Basore, N. S., L. B. Best, and J. B. Wooley, Jr. 1986. Bird nesting in Iowa no-tillage and tilled cropland. J. Wildl. Manage. 50:19 –28.

Best, L. B., H. Campa, III, K. E. Kemp, R. J. Robel, M. R. Ryan, J. A. Savidge, H. P. Weeks, Jr., and S. R. Winterstein. 1997. Bird abundance and nesting in CRP fields and cropland in the Midwest: a regional approach. Wildl. Soc. Bull. 25:(in press).

Blackburn, W. H., J. B. Newman, and J. C. Wood. 1991. The Conservation Reserve Program: effects on soil, water and environmental quality, p. 27 –36. *In:* L. A. Joyce, J. E. Mitchell, and M. D. Skold (eds.), The Conservation Reserve—yesterday, today and tomorrow. USDA Forest Serv. Gen. Tech. Rep. RM-203. Washington, D. C

Briggs, J. M., T. R. Seastedt, and D. J. Gibson. 1989. Comparative analysis of temporal and spatial variability in above-ground production in a deciduous forest and prairie. Holarctic Ecol. 12:130–136.

Cody, M. L. 1966. The consistency of intra- and inter-continental grassland bird species counts. Amer.Natur. 100:371–376.

Daubenmire, R. F. 1959. A canopy coverage method of vegetational analysis. Northwest Sci. 35:43 –64.

Helyar, T. (ed.). 1992. Kansas statistical abstract. Inst. Public Policy and Business Research.Univ. Kansas, Lawrence, Kans. 380 pp.

Herkert, J. R., D. W. Sample, and R. E. Warner. 1996. Management of midwestern grassland landscapes for the conservation of migratory birds, p. 86–116. *In:* F. R. Thompson (ed.), Management of midwestern landscapes for the conservation of migratory birds. USDA Forest Serv. Northcentral Exp. Sta. Gen. Tech. Rep., Washington, D. C.

Hulbert, L. C. 1988. Causes of fire effects in tallgrass prairie. Ecol. 69:46–58.

Hull, S. D., R. J. Robel, and K. E. Kemp. 1996. Summer avian abundance, invertebrate biomass, and forbs in Kansas CRP. Prairie Natur. 28:1–12.

Johnson, D. H. 1979. Estimating nest success: the Mayfield method and an alternative. Auk 96:651–661.

Johnson, D. H., and M. D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Conserv. Biol. 7:934–937.

Johnson, R. G., and S. A. Temple. 1990. Nest predation and brood parasitism of tallgrass prairie birds. J. Wildl. Manage. 54:106–111.

King, J. W., and J. A. Savidge. 1995. Effects of the Conservation Reserve Program on wildlife in southeast Nebraska. Wildl. Soc. Bull. 23:377–385.

Krebs, C. J. 1989. Ecological methodology. Harper Collins, New York, N.Y.

Mayfield, H. 1961. Nesting success calculated from exposure. Wilson Bull. 73:255–261.

Mayfield, H. 1975. Suggestions for calculating nest success. Wilson Bull. 87:456–466.

Millenbah, K. F. 1993. The effects of different age classes of fields enrolled in the Conservation Reserve Program in Michigan on avian diversity, density, and productivity. M.S. Thesis, Michigan State Univ., East Lansing, Mich.

Millenbah, K. F., S. R. Winterstein, H. Campa, III, L. T. Furrow, and R. B. Minnis. 1997. Effects of CRP fields age on avian relative abundance, diversity, and productivity. Wilson Bull. 108:760–770

Milliken, G. A. and D. E. Johnson. 1992. Analysis of messy data. Lifetime Learning Publ., Belmont, Calif.

Owensby, C. E. 1994. Introduction to range management. Capco, Oklahoma City, Okla.

Reynolds, R. E., T. L. Shaffer, J. R. Sauer, and B. G. Peterjohn. 1994. Conservation Reserve Program: benefit for grassland birds in the Northern Plains. Trans. North Amer. Wildl. Natur. Resour. Conf. 59:328–336.

Ricklefs, R. E. 1987. Community diversity: relative roles of local and regional processes. Sci. 235:167–171.

Robel, R. J., J. N. Briggs, A. D. Dayton, and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and height of grassland vegetation. J. Range Manage. 23:295–298.

Rotenberry, J. T., and J. A. Wiens. 1980. Habitat structure, patchiness, and avian communities in North American steppe vegetation: a multivariate analysis. Ecol. 61:1228–1250.

Ryan, M. R., L. W. Burger, Jr., E. W. Kurzejeski, and T. D. McCoy. 1995. The relationships of forage quality and land capability class with vegetation on CRP lands in northern Missouri. Final Rep. to Missouri Dep. Natur. Resour., Jefferson City, MO. 47 pp.

SAS Institute, Inc. 1990. SAS user's guide: statistics, 1990 ed. SAS Inst., Inc., Cary, N.C.

U.S. Department of Agriculture. 1992. Kansas CRP contract data. Unpubl. Rep., USDA Agr. Stabilization Conserv. Serv., Manhattan, Kans.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. J. Wildl. Manage. 47:893–901.

Vickery, P. D., M. L. Hunter, Jr., and J. V. Wells. 1992. Is density an indicator of breeding success? Auk 109:706–710.

Warner, R. E. 1994. Agricultural land use and grassland habitat in Illinois: future shock for midwestern birds. Conserv. Biol. 8:147 –156.

Wiens, J. A. 1969. An approach to the study of ecological relationships among grassland birds. Ornithol. Monogr. 8:1–93.

Wiens, J. A. 1973. Pattern and process in grassland bird communities. Ecol. Monogr. 43:237–270.

Wiens, J. A. 1989. The ecology of bird communities (Vol. 1), foundations and patterns. Cambridge Univ. Press, Cambridge, United Kingdom.

Zar, J. H. 1984. Biostatistical analysis, 2nd ed. Prentice –Hall, Englewood Cliffs, N. J.

Zimmerman, J. L. 1971. The territory and its density dependent effect in (*Spiza americana*). Auk 88:591–612.

Zimmerman, J. L. 1982. Nesting success of dickcissels *Spiza americana* in preferred and less preferred habitats. Auk 99:292–298.

Zimmerman, J. L. 1992. Density-independent factors affecting the avian diversity of the tallgrass prairie community. Wilson Bull. 104:85–94.

Zimmerman, J. L. 1996. Avian community responses to fire, grazing, and drought in the tallgrass prairie, p. 167–180. *In:* F. Knopf and F. Samson (eds.), Ecology and conservation of Great Plains vertebrates. Springer-Verlag, New York, N.Y.