Bird species abundance, composition and vegetation characteristics, and bird productivity in Conservation Reserve Program land in central Iowa

by

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GENERAL INTRODUCTION

European occupation in the mid 1850s caused rapid conversion of the tall-prairie ecosystem to small grain agriculture and pasture, resulting in dramatic changes in the vegetation structure and composition of this region. A brief increase in habitat heterogeneity and wildlife diversity occurred, as additional species of plants and wildlife could exploit the changing landscape (Dambach and Good 1940, Yeatter 1963).

Over the past several decades, there has been a steady shift in the Midwest to larger farms and larger equipment, with a resulting reduction of wildlife habitat associated with smaller fields (fencerows, odd-corners, fallowed fields, etc.) (Vance 1976, Lowther 1984, Warner 1990). Additionally, an increase in row-crop agriculture (corn, soybeans, milo, etc.) and the concomitant reduction of small grains and pasture have combined to cause a precipitous decline in several species of wildlife throughout this region (Robbins et al. 1986, Leedy 1987). Although attractive to some species for nesting, row-crop habitat may reduce bird productivity below levels needed to sustain populations without influx from "source" habitats (Best 1986, Bryan and Best 1991). In addition to nest parasitism and predation, farming activities further reduce nest success (Rodenhouse and Best 1983).

Coupled with the expansion of soil conservation practices in the Midwest, which may benefit wildlife by leaving more food and/or cover on the soil surface for longer periods (Warburton and Klimstra 1984, Basore et al. 1986, but see Best 1986), is the impact of the Conservation Reserve Program (CRP). The CRP is a provision of the 1985 Federal Food Security

Act (Farm Bill) that allows for the removal of highly erodible and environmentally sensitive cropland from production for 10 years (U. S. Dep. Agric. 1991).

Because of the long-term nature of the CRP, the beneficial impacts on agricultural wildlife are projected to be substantial. Without careful evaluations of wildlife populations within these habitats, the impact of the CRP will remain largely speculation. That changes in agricultural practices and policies influence wildlife populations is a matter of history. Our study was designed to determine the value of CRP land for grassland bird use and nesting, and provide some recommendations for the management of future federal set-aside programs to enhance their value to grassland birds.

Explanation of Thesis Format

This thesis contains one paper written for publication in a scientific journal. This paper addresses bird species composition, relative abundance and nesting success in Conservation Reserve Program (CRP) land and agricultural row-crop habitat. The vegetative characteristics of CRP land are also discussed and related to bird composition and abundance. A general introduction precedes the paper; a general summary follows. The literature cited in the general introduction and summary are referenced in the section entitled "Additional Literature Cited." Data acquisition, statistical analysis, and the preparation of the text were the responsibility of the candidate; guidance and editorial advise were given by Dr. Louis B. Best.

PAPER: BIRD ABUNDANCE AND PRODUCTIVITY, AND VEGETATION CHARACTERISTICS OF CONSERVATION RESERVE PROGRAM LAND IN CENTRAL IOWA

ABSTRACT

Bird use of Conservation Reserve Program (CRP) land and row-crop habitat was studied in central Iowa from May through July, 1991-1993. Thirty-three bird species were seen in CRP fields, compared with 34 in row-crop fields. Total bird abundance in CRP fields averaged 315 birds/100 ha, compared to 84 in row-crop fields. Vegetation structure and composition varied among CRP fields, resulting in varying suitability of this habitat for "grassland" bird species. Sixteen species nested in CRP fields, compared with two species in row-crop fields. Mayfield daily survival rates (DSR) were calculated for 4 CRP species and one row-crop species. Nest site vegetation is discussed and related to CRP field suitability for nesting species. Implications of federal guidelines and land-owner management practices to wildlife benefits are discussed.

INTRODUCTION

The tall-grass prairie ecosystem once dominated much of the Midwest; Iowa was in the center of this immense grassland (Transeau 1935, Smith 1981). A diverse avifauna evolved to use the abundant prairie pothole wetlands and upland tall-grass cover (Dinsmore 1981). European occupation in the mid 1850s caused rapid conversion of the prairie ecosystem to small-grain agriculture and pasture, resulting in dramatic changes in the vegetation structure and composition of this region (Dinsmore 1994). A brief increase in habitat heterogeneity and wildlife diversity occurred, as additional species of plants and wildlife could exploit the changing landscape (Dambach and Good 1940, Yeatter 1963).

Over the past several decades, there has been a steady shift in the Midwest to larger farms and larger equipment, with a resulting reduction of wildlife habitat associated with smaller fields (fencerows, odd-corners, fallowed fields, etc.) (Vance 1976, Lowther 1984, Warner 1990). Additionally, an increase in row-crop agriculture (corn, soybeans, milo, etc.) and the concomitant reduction of small grains and pasture have contributed to a precipitous decline in several species of wildlife throughout this region (Robbins et al. 1986, Leedy 1987).

Studies of row-crop habitats have shown them to attract few bird species (Rodenhouse and Best 1983, Best et al. 1990); many of which were less abundant in native tall-grass habitat [e. g., horned lark, red-winged blackbird, and vesper sparrow (see Table 4 for scientific names)] or are exotic introductions (i. e., European starling and ring-necked pheasant). Although attractive to some species for nesting, row-crop habitats may reduce bird productivity below levels needed to sustain populations without influx from "source" habitats (Best 1986, Bryan and Best 1991). In addition to nest parasitism and predation, farming activities further reduce nest success (Rodenhouse and Best 1983).

Coupled with the expansion of soil conservation practices in the Midwest, which may benefit wildlife by leaving more food and/or cover on the soil surface for longer periods (Warburton and Klimstra 1984, Basore et al. 1986, but see Best 1986), is the impact of the Conservation Reserve Program (CRP). The CRP is a provision of the 1985 Federal Food Security Act (Farm Bill) that allows the removal of highly erodible and environmentally sensitive cropland from production for 10 years (U. S. Dep. Agric. 1991). More than 14.2 million ha are enrolled in the CRP nationwide; 32% of this land is in the Midwest states of Illinois, Iowa, Minnesota, Missouri, South Dakota, Nebraska, and Kansas. In Iowa, 850,000 ha are enrolled (U. S. Dep. Agric. 1992).

Studies of the effects of past land retirement and set-aside programs on wildlife have concentrated primarily on game species, particularly ring-necked pheasant (e.g., Erickson and Weibe 1973, Bartmann 1969) and northern bobwhite (Burger et al. 1990). Nongame species have been largely ignored, at least in part, because of the relatively few breeding species in grassland habitats compared with forested ecosystems (Wiens and Dyer 1975). Populations of several native grassland sparrow species [e.g., grasshopper and Henslow's sparrows], as well as dickcissels and meadowlarks have declined dramatically as indicated by results from

Breeding Bird Surveys (Blankespoor and Krause 1982, Zaletel and Dinsmore 1985, Thompson et al. 1993).

Because of the long-term nature of the CRP, the beneficial impacts on agricultural wildlife are projected to be substantial. Without careful evaluations of wildlife populations within these habitats, however, the relative merits of the CRP will remain largely speculation. That changes in agricultural practices and policies influence wildlife populations is a matter of history (Vance 1976, Taylor et al. 1978). The primary goal of our research was to determine the effects of the Conservation Reserve Program on bird populations in central Iowa by (1) documenting bird abundance, species composition, and nesting success in CRP and row-crop fields; and (2) evaluating the influence of differences in the vegetation structure and composition of CRP land on bird use.

STUDY SITE

Our research was conducted in Marshall County, Iowa. The area topography is gently rolling (0-15% slope), and the soils are moderately eroded Tama silty clay loams (Oelmann 1981). About 80% of the county is tillable land; corn and soybeans are the main crops. The average daily maximum temperature from May through July is 26° C. Marshall County's annual precipitation averages 84 cm, of which 40% falls from May through July (Table 1).

Eight 16.2-ha (40-acre) CRP plots paired with 8 16.2-ha row-crop plots were selected for study in 1991. Two additional plot pairs were used in 1992 and 1993. Similarities in topography and edge habitat were considered in the CRP/row-crop pairing process. Only CRP fields planted with exotic, cool-season grasses and legumes were chosen for study plots because such plantings are the predominant CRP cover type in Iowa (>95%) and the only CRP fields large enough for the study. These plots were paired with corn or soybean row-crop plots managed with intermediate conservation tillage (methods leaving more than 30% crop residue coverage on the soil surface; Crosson 1982, Dickey et al. 1985) and in row-crop production for >5 years before 1991. All studied CRP land was enrolled in the program in late 1986 or early 1987. Plot edges were bounded on at least two sides by herbaceous or sparsely wooded fencerows associated with roadsides, farmsteads, or adjacent fields. The other two plot "edges" were positioned within the CRP or row-crop fields such that the plots were 400 m on a side. All plots were at least 1 km apart to reduce the risk of overlapping bird use.

Table 1. Climatological data for Marshall County, Iowa, May-July 1991-93 and departures from normal. [a]

	1991			1992			1993		
	May	June	July	May	June	July	May	June	July
Average daily max. temperature	72.3	82.3	84.3	72.0	79.6	76.6	68.7	76.3	79.1
Departure from normal (1951-1980)	0.3	0.7	-0.5	0.0	-2.0	-8.2	-3.3	-5.3	-5.7
Total precipitation	4.8	6.9	2.3	0.9	1.9	12.8	6.6	9.4	14.0
Departure from normal (1951-1980)	0.3	2.2	-2.0	-3.6	-2.8	8.5	2.3	4.7	9.7

[a] Source of information: National Oceanic and Atmospheric Administration 1991-93.

METHODS

Vegetation Measurements

Vegetation characteristics of the CRP plots were measured twice during the growing season (late May and late June) along six parallel, 350-m long transects placed 50 m apart. Vegetation was sampled every 58 m along the transects (6 equal-spaced sampling points per transect). At each sample point, vertical density of the vegetation was assessed by a visual obstruction reading at 4 m from a Robel pole and at a height of 1 m above the ground (Robel et al. 1970). Maximum height of the living vegetation also was measured. Percent canopy coverage of total vegetation, forbs, grasses, and litter was estimated within a Daubenmire frame positioned 1 m in front of the Robel pole (Daubenmire 1959). Coverage was classified as 0-5, 6-25, 26-50, 51-75, 76-95, and >95%. The midpoints of these classes were recorded for analysis. Vegetation coverages were estimated on an overlapping basis, so the sum of the coverages could exceed 100%. Plant species presence within each frame also were recorded. Coefficients of variation were later calculated from the vertical density and percent grass canopy variables to create indices of vertical and horizontal patchiness (heterogeneity), respectively.

Nest-site vegetation data were collected after nest termination to characterize the vegetative structure used by species breeding in CRP grassland. Vertical density of the vegetation was assessed by placing a Robel pole next to, or on the nest bowl. Readings were taken in the 4 cardinal directions, 4 m from the pole and 1 m above the ground (Robel et al. 1970). A vertical density index was then obtained by generating a mean of the 4 values. The height of the nest substrate also was measured. Percent canopy coverage of total vegetation, forbs and grasses was estimated within a square, 0.5 m^2 frame positioned directly above the nest.

Bird Abundance and Density

Each study plot was laid out in a square grid pattern, with 50-m spacing between colored flag markers. The first grid line in each plot was parallel to one field edge and 25 m from it. Successive grid lines were parallel and 50 m apart, with the final grid line positioned 25 m from the far side of the study plot.

Bird census counts were conducted in all 20 plots twice during the breeding season between 20 May and 10 July by walking the grid lines until the plot had been completely traversed. Stops every 20 m allowed observer to look and listen for birds. All birds seen or heard within 25 m from the line were recorded on grid maps; this minimized the chance of counting the same bird twice. In transit flyovers were not counted, although hawks and swallows were counted when actively hunting above the plot. Relative bird abundances (birds/census count/unit area) were calculated for each plot. All census counts began at sunrise and were completed within 3 hours. Bird counts were not conducted when winds were above 24 km/hr, or when visibility was restricted by fog or rain.

Nest Success and Density

Nesting success estimates were obtained by locating nests and determining their outcome. Teams of individuals walked abreast (less than l-m spacing) across each study plot until it had been completely traversed (Basore et al. 1986). Nest searches were repeated 2 times during

15 May to 15 July to obtain a more complete sample of nesting and renesting. Three entire CRP study plots were searched for nests in 1991, and 5-ha subplots of all ten CRP plots were searched in 1992 and 1993. Because nest densities are low in crop fields, these plots were completely searched to assure adequate sample sizes for statistical analyses. All located nests were marked for relocation and visited every 2-3 days to determine their outcome (Mayfield 1975).

A nest was considered successful if it fledged at least one young. If nest contents (eggs or nestling) were removed, the nest was considered predated. If nests were pulled down or exhibited other major disturbance, predation was assumed to have resulted from large mammals. Predation by small mammals, birds, and snakes was indicated in the absence of nest damage. Failure was attributed to brown-headed cowbird parasitism when only cowbirds were fledged, when nest abandonment occurred after cowbird egg deposit(s), or when only cowbird eggs remained in the nest. Nest failure was attributed to weather when nests were found destroyed after a storm. Nests were recorded as abandoned when nest contents remained unchanged and no attending adults were present for three visits.

Estimates of nest densities were calculated on the basis of all active (contained at least one host egg or young and an adult was present) and inactive nests located each season. The density values represent the total number of nests found during two nest searches conducted about 25 days apart. Single plot nest density values were not compared because vegetation structure in some plots reduced nest detection, yielding low nest density estimates in plots with high bird abundance and extensive evidence of nesting.

Of the 402 nests located in CRP grasslands over the 3-year period, 301 were used in analyzing nest fates, as they were active when found. Other nests were either inactive or destroyed by observers. Of these, only red-winged blackbird, dickcissel, grasshopper sparrow, ring-necked pheasant, and vesper sparrow nests ($\geq$10 active nests/species) were used in calculating species-specific daily nest survival rates using the Mayfield method (Mayfield 1975) and analyzed using MICROMORT (Heisey and Fuller 1985). Survival estimates of other species are reported as apparent success (# of successful nests/ total # of nests).

Nests found over the 3-year study were combined to increase the sample size. Daily survival rates (DSR) were calculated for both the egg (egg laying and incubation) and nestling phases of the nesting cycle, from which overall survival rates were calculated. Ring-necked pheasant incubation, like that of all other species cited, was assumed to start at the laying of the next to last egg (Farris et al. 1977). Successful ring-necked pheasant nests were used to calculate the average clutch size ($\underline{x} = 13$, $\underline{SE} = 0.74$, $\underline{n} = 20$). Pheasants lay one egg about every 1.5 days (Farris et al. 1977). The egg-stage was estimated to be 42 days for the ring-necked pheasant (19 for egg-laying, 23 for incubation). Table 6 references the average clutch size and egg-stage days used in calculating nest success for other species. Because of small sample sizes, rates of individual causes of nest loss were not calculated using MICROMORT. Nest fates were tabulated to show the relative importance of the various causes of nest failure.

Statistical Analysis

Abundance differences between treatments (CRP vs. row-crop) were assessed with an ANOVA test in the General Linear Model (GLM) procedure (Wilkinson 1989) by generating mean abundance values for each plot/year. T-tests were used to compare species diversity between treatments and among years. T-tests were also used to compare individual species abundance over years. Vegetation variables measured within plots did not differ from 1991-1993 (ANOVA, $P > 0.05$), therefore, mean plot vegetation values were combined over years. Principle component analysis (PCA, Wilkinson 1989) was used to illustrate differences in vegetation structure and composition among CRP plots. Pearson product-moment correlation analysis was used to determine relationships between bird abundance and vegetation characteristics on CRP land. One plot was removed from this analysis because the vegetation structure was highly heterogeneous in one half of the plot and homogeneous in the other, consequently mean values would not adequately represent the plot. This plot was included in abundance calculations. Differences among mean nest-site vegetation values were determined by analysis of variance. If significant, Fisher's least significant difference (LSD) tests were used to distinguish between species (Wilkinson 1989). Analysis of variance, correlation, and t-test probabilities were set at $P \leq 0.05$.

RESULTS AND DISCUSSION

Vegetation Characteristics of CRP Plots

CRP plots were initially planted to smooth brome, orchard grass, or alfalfa/grass mixtures. In addition, a few plots contained some timothy (Phleum pratense), red fescue (Festuca rubra), and/or perennial ryegrass (Lolium perenne). The most dominant plant species in CRP plots was smooth brome (Table 2); orchard grass and alfalfa also were common. Single-year forb coverages among CRP plots varied from 0 to >75% of the total vegetation. Although alfalfa was the only forb planted, broadleaf plant coverage was substantial in some plots because of agricultural weed invasion and ineffectual weed management.

The 3-year averages of vegetation measurements taken on the CRP plots are summarized in Table 3. Vegetation variables did not change over the 3-year study period (ANOVA, $P > 0.05$), although there was a declining trend in forb coverage (10%) and a concomitant increase (10%) in grass coverage from 1991 to 1993. Forb growth is inhibited by sod-forming, cool-season grasses, such as smooth brome, which form a thick layer of dead grass litter. Use of broadleaf herbicides and mowing to control weeds also contributed to reduced forb coverage. Orchard grass grows in tussocks, leaving considerable open ground available for the invasion of weedy forb species (Pohl 1966). Among our study plots, those planted to orchard grass had the most diverse vegetation. In Michigan, Millenbah et al. (1993) documented an increase in grass coverage and a reduction in plant species diversity as CRP plots aged.

Table 2. Plant species occurring in >5% of all vegetation samples (n=720) in CRP plots 1992 and 1993. [a]

Species	Frequency of occurrence (%)	
	Overall	Range among plots
Smooth brome (Bromus inermis)	66	7-100
Orchard grass (Dactylis glomerata)	27	0-81
Alfalfa (Medicago sativa)	25	0-82
Canada thistle (Cirsium arvense)	9	0-26
Red fescue (Festuca rubra)	9	0-70
Common dandelion (Taraxacum officinale)	5	0-33
Prickly lettuce (Lactuca serriola)	5	0-22

a Species with frequencies of occurrence <5% but >1% were common morning glory (Ipomoea purpuria), foxtail (Setaria spp.), reed canary grass (Phalaris arundinacea), wild parsnip (Pastinaca sativa), black medic (Medicago lupulina), smart weed (Polygonum spp.), common milkweed (Asclepias syriaca), and pennycress (Thlapsi arvense).

Table 3. Means (SE) and plot ranges of vegetative characteristics in Central Iowa CRP land 1991-1993. [a]

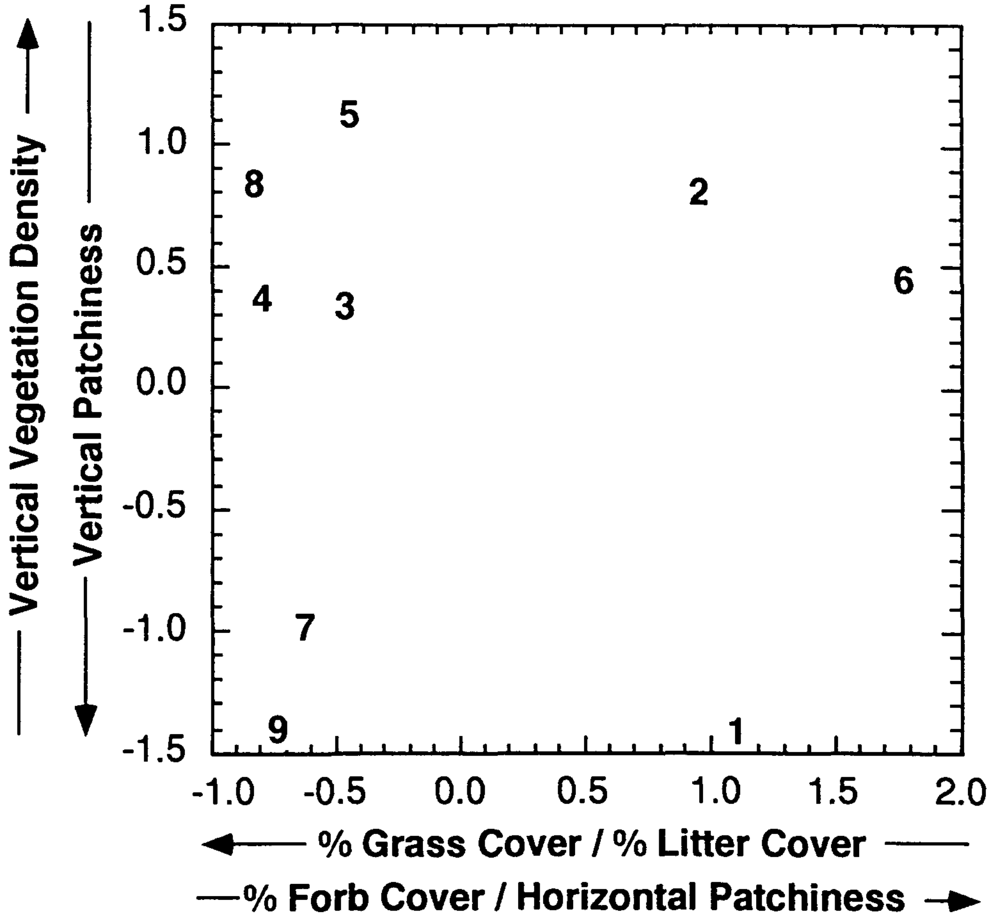
Vegetation character	x	SE	Range
Live vegetation height (cm)	59	2	51-69
Vertical vegetation density (cm)	35	2	24-44
Grass coverage (%)	80	5	47-98
Forb coverage (%)	22	6	3-53
Total coverage (%)	72	2	51-95
Litter coverage (%)	97	1	93-100
Vertical patchiness (%)	36	5	18-56
Horizontal patchiness (%)	35	12	6-65

[a] Mean values were computed for each plot by averaging the six samples collected over the three years (2/year). These were then used to calculate overall means and standard errors (n = 9).

Principle component analysis, including 6 vegetation variables, showed how the CRP plots in our study differed from one another (Fig. 1). Percent forb, grass, and litter coverage and horizontal heterogeneity contributed most to principal component 1. Vertical vegetation density and vertical patchiness were the most important variables in principal component 2. The first two principal components accounted for 93% of the vegetation variance among plots. This descriptive analysis and the ranges of the 6 vegetation variables among plots (Table 3) demonstrate the high degree of variability among CRP fields.

Plots 3, 4, 5, and 8 were planted exclusively to smooth brome and alfalfa (Fig. 1) These plots were the most vegetatively homogenous, because the broadleaf weeds were aggressively mowed and/or sprayed leading to the accelerated loss of alfalfa coverage. Plots 7 and 9 had a low percent forb coverage because alfalfa was not seeded and weeds were well managed. These plots were, however, planted to a diversity of grass species that resulted in greater vertical patchiness. Alfalfa and weedy forbs were the dominant vegetation in plots 2 and 6. Many weed management regimes were attempted in these plots, including spraying, mowing, and disking. Additionally, landowners of these plots mowed the grass sections inundated by weeds, but avoided large alfalfa patches, creating a very different vegetative landscape than other plots. The vegetation in plot 1 was similar to plots 7 and 9, but contained a greater diversity of forb species, including alfalfa. Chemicals were not used for weed management on plot 1, which allowed the alfalfa and some broadleaf weeds to persist.

Fig. 1. Principal component analysis of 9 CRP plots using 6 vegetation variables to show the variation in vegetation among plots.


Vertical Vegetation Density
Vertical Patchiness
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
5
8
2
6
4
3
7
9
1
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
% Grass Cover / % Litter Cover
% Forb Cover / Horizontal Patchiness

Bird Species Diversity

Thirty-three bird species were recorded in CRP plots and 34 in row-crop fields throughout the 3-year study period (Table 4). The 3-year average number of species recorded/plot was 8 (range 3-15) in CRP fields and 6 (range 2-10) in row-crop fields. The total number of species/plot was not different between row-crop and CRP fields in 1991 ($t = 0.94$, 7 df, $P = 0.38$) and 1992 ($t = 2.03$, 7 df, $P = 0.08$), but was different in 1993 ($t = 3.45$, 9 df, $P < 0.01$). The cumulative species count/plot over the 3-year study period did not differ between row-crop and CRP fields ($t = 1.0$, 9 df, $P = 0.34$), but the species composition between treatments was different. Ten species were unique to CRP land (not found or fewer than 1 bird/census count/100 ha in row-crop plots). The horned lark was the only row-crop species absent from CRP plots.

Bird Abundance in CRP vs. Row-crop Fields

The total mean bird abundance between CRP and row-crop plots differed ($F = 94$; 1,9 df; $P < 0.001$) in our study. The most abundant species in both habitats was the red-winged blackbird, accounting for 35% of all birds in CRP and 24% in row-crop fields (Table 4). The dickcissel, grasshopper sparrow, bobolink, common yellowthroat, brown-headed cowbird, savannah sparrow, and ring-necked pheasant were the next most abundant species in CRP plots. These eight species represent 92% of the average bird abundance from 1991 to 1993. Mean total bird abundance in a Nebraska study was slightly lower (290 birds/100 ha; King and Savidge, unpub. ms.). Bird abundance in herbaceous strip-cover habitats (e.g., grassed waterways and roadsides) is much greater (>1,600 birds/census

Table 4. Mean (S. E.) bird abundance (birds/census count/100 ha) in CRP and row-crop fields in Iowa1991-1993.

	CRP		Rowcrop	
Species [a]	x	S. E.	x	S. E.
Ring-necked pheasant (Phasianus colchicus)	6.3 N [b]	2.1	2.4	1.1
Killdeer (Charadrius vociferous)	0.8	0.4	2.4	0.7
Upland sandpiper (Bartramia longicauda)	1.0 N	0.6	0.1	0.1
Mourning dove (Zenaida macroura)	0.6 N	0.4	0.3	0.2
Eastern kingbird (Melanerpes erythrocephalus)	1.0	0.6	0.9	0.4
Horned lark (Eremophila alpestris)	0.0	-	12.0 N	2.5
Barn swallow (Hirundo rustica)	5.5	1.6	4.2	0.9
American crow (Corvus brachyrhynchos)	0.4	0.4	1.9	1.0
Sedge wren (Cistothorus platensis)	2.6 N	0.9	0.0	-
American robin (Turdus migratorius)	0.2	0.2	1.5	0.7
Common yellowthroat (Geothlypis trichas)	10.8 N	4.8	0.8	0.6
Dickcissel (Spiza americana)	58.4 N	15.6	0.3	0.2
Savannah sparrow (Passerculus sandwichensis)	7.8 N	3.8	0.1	0.1
Grasshopper sparrow (Ammodramus savannarum)	48.5 N	13.3	1.0	0.5
Vesper sparrow (Pooecetes gramineus)	0.6 N	0.4	12.0 N	1.6
Song sparrow (Melospiza melodia)	3.4 N	1.2	0.9	0.6
Bobolink (Dolichonyx oryzivorus)	37.7 N	10.0	0.0	-
Western meadowlark (Sturnella magna)	5.6 N	1.3	0.6	0.4
Red-winged blackbird (Agelaius phoeniceus)	109.0 N	21.0	20.0	7.1

Table 4. cont.

Species[a]	CRP x	CRP S. E.	Rowcrop x	Rowcrop S. E.
Common grackle (Quiscalus quiscula)	0.5	0.4	5.9	4.4
Brown-headed cowbird (Molothrus ater)	10.1 N	2.7	11.0	1.9
American goldfinch (Carduelis tristis)	1.9 N	0.8	0.6	0.6
Total abundance	315.0	22.8	84.0	9.6
Total # of species	33		34	

a Only species with mean abundance values > 1 bird/census count/100 ha are listed. Species with abundance values <1were mallard (Anas platyrhynchos), gray partridge (Perdix perdix), northern harrier (Circus cyaneus), rock dove (Columba livia), chimney swift (Chaetura pelagica), cliff swallow (Hirundo pyrrhonota), tree swallow (Tachycineta bicolor), blue jay (Cyanocitta cristata), house wren (Troglodytes aedon), brown thrasher (Toxostoma rufum), cedar waxwing (Bombycilla cedrorum), European starling (Sturnus vulgaris), northern cardinal (Cardinalis cardinalis), indigo bunting (Passerina cyanea), Henslow's sparrow (Ammodramus henslowii), chipping sparrow (Spizella passerina), and house sparrow (Passer domesticus).

b N=species nesting in CRP or row-crop plots.

count/100 ha) than in block habitats such as CRP fields (Bryan and Best 1991, Camp and Best 1993). All of the above species, except the ring-necked pheasant and brown-headed cowbird were more abundant in CRP than in row-crop fields (ANOVA, $P < 0.05$).

The red-winged blackbird, horned lark, vesper sparrow, brown-headed cowbird, common grackle, and barn swallow represented 79% of the average bird abundance in row-crop fields (Table 4). Total bird abundance values in row-crop reported by Camp and Best (1993) were about two-thirds of our values.

Relationships between CRP Characteristics and Species Abundances

Many studies have related vegetation structure and composition to the abundance and diversity of grassland bird species (e.g., Wiens 1973, Skinner 1975, Herkert 1991). Vegetation factors believed to affect grassland bird abundance include vertical density, the percent canopy coverage of grasses and forbs, and vertical and horizontal heterogeneity (Wiens 1974). Bird abundance varied among CRP plots (Fig. 2), and this variation probably resulted from differences in the vegetation characteristics of the plots. Individual bird species abundances were correlated with various vegetation characteristics (Table 5). Dickcissel abundance was positively correlated with vertical vegetation density and % forb coverage (Fig. 2, Table 5). The relationship with vertical vegetation density reflects the dickcissel's need for structurally sound nesting substrates. Additionally, alfalfa, a dominant forb species in CRP land and a preferred nesting cover, is very dense. Dickcissel preference for habitats with abundant forb

Fig. 2. Mean abundance of the dickcissel and grasshopper sparrow (histograms) and mean % forb coverage (lines) in 10 CRP plots.

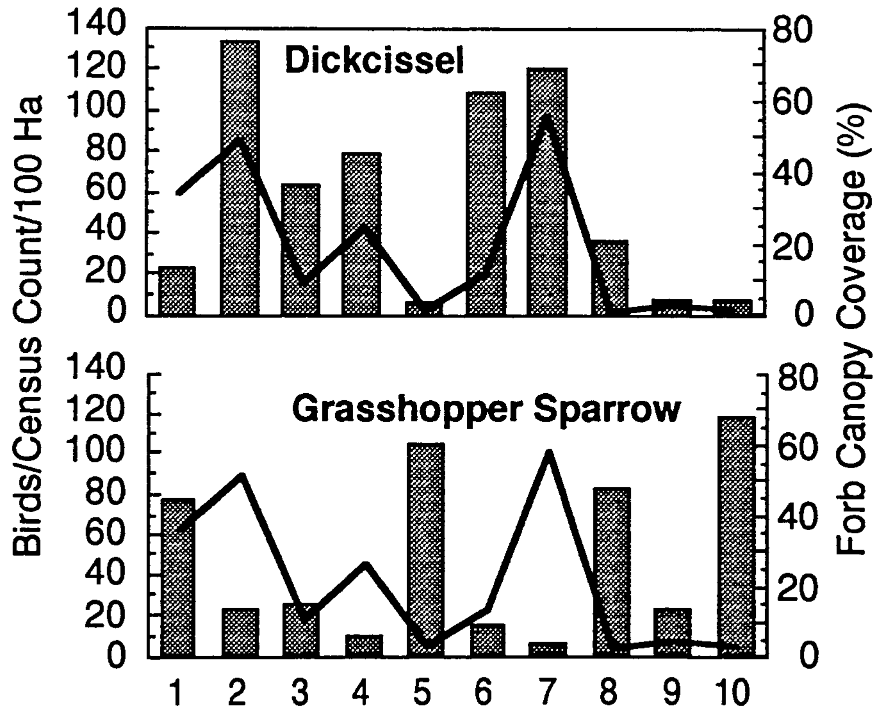

Dickcissel
Grasshopper Sparrow
Birds/Census Count/100 Ha
Forb Canopy Coverage (%)
0
20
40
60
80
100
120
140
1
2
3
4
5
6
7
8
9
10

Table 5. Significant (P < 0.05) relationships between bird numbers (birds/census count/100 ha) and vegetation characteristics in CRP plots in central Iowa 1991-1993 (n=9 plots).[a]

	Vertical vegetation density	Percent canopy coverage: Grasses	Percent canopy coverage: Forbs	Percent canopy coverage: Litter	Vertical patchiness	Horizontal patchiness
Common yellowthroat		-0.93 *[b]	0.94 *			0.91 *
Bobolink		0.81 *	-0.85 *	0.78		-0.83 *
Western meadowlark	-0.68				0.69	
Dickcissel	0.70		0.72			
Grasshopper sparrow	-0.75					

[a] Values given are Pearson's product-moment correlation coefficients.

[b] * = P<0.01

coverage is well documented (e.g., Zimmerman 1982, Frawley and Best 1991).

Grasshopper sparrow abundance was negatively correlated with the vertical density of the vegetation (Table 5). This was consistent with this species preference for relatively short and clumped grasses (e.g., orchard grass) for nesting (Smith 1963). Grasshopper sparrows were most abundant in areas within plots with moderate grass height (<0.5 m) and vertical density (<0.3 m). A similar response was noted in Wisconsin by Wiens (1969). Kantrud and Kologiski (1982) found the greatest grasshopper sparrow abundance in lightly grazed plots that favorably reduced grass height and density. In our study, thick stands of brome, even when short (<50 cm), did not appeal to grasshopper sparrows. When sections of this CRP cover type were mowed for weed control, grasshopper sparrows quickly colonized the areas with shorter vegetation.

Bobolink abundance was positively correlated with percent canopy coverage of grass and litter and negatively correlated with percent canopy coverage of forbs and horizontal patchiness (Table 5). Bollinger and Gavin (1992) also found positive correlations between bobolink abundance and a high grass-to-legume ratio and high litter coverage. Skinner (1975) noted a negative relationship between bobolink abundance and percent forb coverage.

Common yellowthroats were most abundant in CRP plots with a high forb coverage (Table 5). This species was rarely seen in plots with a homogenous grass stand but was very abundant in plots with patches of weedy forbs, as reflected in the positive correlation with horizontal patchiness. The common yellowthroat is not considered a "grassland" species but is commonly found in grassland habitats that contain sufficient forb, woody, or dense grass cover (Ehrlich et al. 1988, Herkert 1991). Reed canary grass, a dense species commonly planted in Iowa agricultural waterways (Bryan and Best 1991), is also attractive cover for common yellowthroats. In CRP plots without forb and woody species, common yellowthroats were most abundant within grassed waterways left intact when the agricultural land was enrolled in the CRP.

Western meadowlark abundance was negatively correlated with vertical vegetation density and positively correlated with vertical patchiness (Table 5). Western meadowlarks in Wisconsin preferred the least vertically dense vegetation of all grassland bird species (Sample 1989). Meadowlarks also appear to be responding to plots with a wide range vertical vegetation densities (vertical patchiness), because it is within these plots that they can find patches of shorter vegetation. Western meadowlarks commonly nest in mowed roadside edges (Camp 1991). Spot mowing in CRP may be important for meadowlarks in opening up this otherwise dense vegetation, and could increase their use of CRP fields.

No relationships were found between 3-year mean red-winged blackbird abundances and the vegetation variables measured ($\underline{P} > 0.05$). Redwings were abundant in nearly all of our CRP plots, regardless of vegetation structure. The redwing is a habitat generalist (Clark et al. 1986, Stauffer and Best 1980), capable of nesting in a variety of substrates. Vegetation structure and composition required by redwings was available in all of our CRP plots.

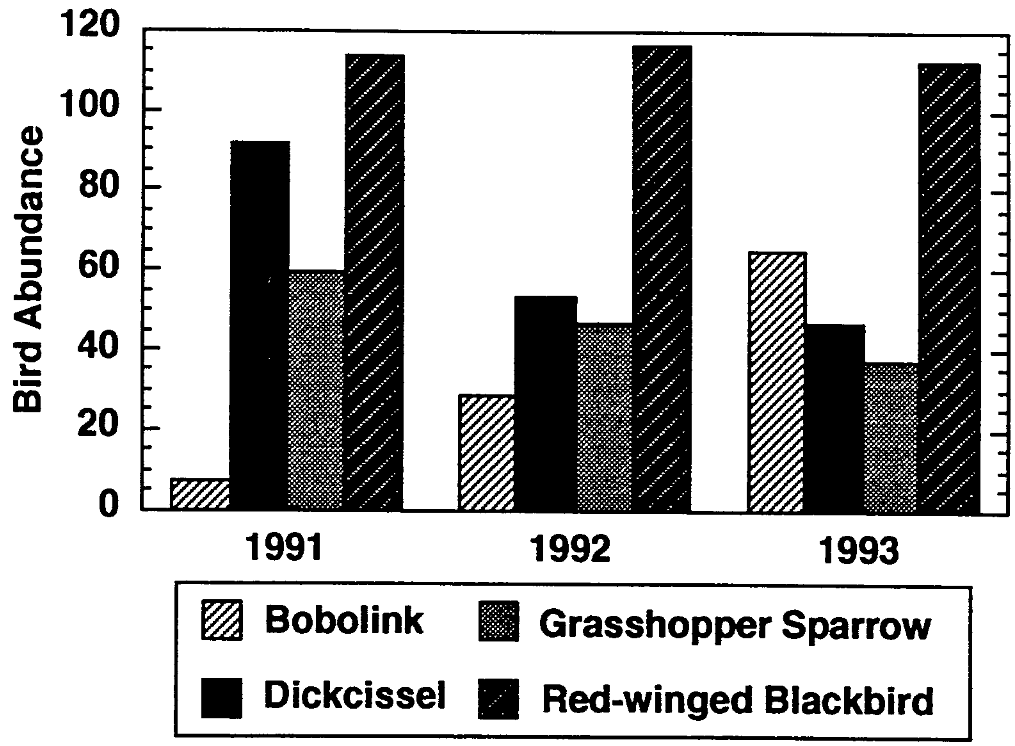
Weather Effects and Yearly Variations in Bird Abundance

Temperature and moisture patterns varied greatly over the 3-year study period (Table 1). The 1991 breeding season began (May and June) with above normal temperatures and rainfall, but was followed in July with rainfall 50% below normal. In 1992, central Iowa experienced a short-term drought from early spring through June, but a very cool and wet July followed. This late 1992 precipitation marked the beginning of a wet cycle in Iowa of historic proportion. Total precipitation in the spring and summer of 1993 exceeded the 100-year record, and temperatures were well below normal throughout the breeding season.

Habitat selection by grassland birds is strongly influenced by fluctuations in temperature and precipitation (Cody 1985). Site tenacity may be weakly developed in birds that have evolved under such conditions (Wiens 1974) and are capable of relocation to areas with less harsh conditions (more food and cooler temperatures) after evaluating the availability of resources within their normal ranges (Droege and Sauer 1989). Igl (1991) looked specifically at dickcissel response to drought conditions by using historical Breeding Bird Survey and weather data, and found that dickcissels extend north and east of their traditional range when drought conditions plague the Midwest.

Yearly changes in dickcissel abundance in our study could be attributed to weather phenomena, as dickcissels were most abundant in 1991 (Fig. 3), when moisture and temperature levels were near normal during the census period (Table 1). Dickcissel abundance decreased in 1992 ($\underline{t} = 2.35$, 7 df, $\underline{P} = 0.05$), when moisture was well below normal and breeding

Fig. 3. Mean yearly abundances (birds/census count/100 ha) of selected species in CRP land 1991-1993.


120
100
80
60
40
20
0
Bird Abundance
1991
1992
1993
Bobolink
Grasshopper Sparrow
Dickcissel
Red-winged Blackbird

conditions were presumably less ideal. Dickcissel abundance in 1993 was similar to that of 1992 ($t = 0.73$, 9 df, $P = 0.48$), but also less than that of 1991 ($t = 2.36$, 7 df, $P < 0.05$). Low 1993 abundances were associated with climatic conditions much different from those in 1991. It is likely that excess moisture and much cooler than normal temperatures could also decrease bird abundance. Insect abundance in Iowa oat and alfalfa fields in 1993 were well below average (J. Obrycki, Iowa State University, pers. commun.). Although we did not collect data on food availability in CRP, our CRP plots were uncharacteristically "quiet" during the first half of the 1993 breeding season, with few territories of any grassland species being established before 15 June.

The bobolink was the only species showing an increase in abundance over the 3-year study period ($F = 4.6$; 2, 30 df; $P = 0.02$; Fig. 3). This change in abundance could be attributed to a variety of factors. Bobolinks require high grass coverage and thick grass litter for nesting (Bollinger and Gavin 1992). Grass coverage has increased over time among CRP fields, providing more favorable habitat. Once conditions became favorable for bobolinks, their numbers probably increased each year in response to breeding success the previous year and the subsequent return of site tenacious individuals over the past 3 years (Gavin and Bollinger 1988). Few bobolink nests were found during our study (Table 6), but we know that some CRP plots contained high bobolink nest densities because of the many pre-flight fledglings on these plots.

Nesting Species Composition and Nest Density

Sixteen species nested in CRP fields over the 3-year study period (Table 4). Red-winged blackbirds were the most abundant nesting species in CRP fields, representing 48% of all nests found (Table 6). The vesper sparrow and horned lark were the only species found nesting in row-crop fields. Vesper sparrow nests represented 87% of all nests found in row-crop fields. The 3-year mean nest density (nest/100 ha, 2 searches/year) of all species was greater in CRP fields than row-crop fields (Table 6). This CRP estimate was much lower than those of linear grass habitats such as waterways and roadsides [(>1100 nests/100 ha, Bryan and Best (in press), Camp and Best (1994)]. Our row-crop nest density was less than those reported for no-till row-crop fields (20 nests/100 ha) and greater than those for tilled fields (5 nests/100 ha) (Basore et al. 1986). Nest densities increase in row-crop habitats with an increase in crop residue (Basore et al. 1986). Crop residue in our fields was intermediate (55%) between that in Basore et al.'s tilled (13%) and no-till (80%) fields.

Causes of Nest Failure and Nesting Success

The major cause of nest loss for all species was predation, accounting for more than 50% of all nest loss in CRP fields and row-crop fields (Table 6). Predation rates varied considerably among plots. We believe predation in our study to be as much a function of off-site landscape phenomena as of on-site habitat characteristics (Warner 1994). Plots near farmsteads with many outbuildings seemed more vulnerable to nest predation than others. Although we were not always able to identify the predator species of individual nests, red fox (Vulpes vulpes), raccoon (Procyon lotor), striped

Table 6. Nest densities/ 100 ha (SE) and nesting outcomes (%) in CRP and row-crop fields for species with >2 nests/100 ha 1991-1993.

				Causes of nest failure				
Species [a]	Active nests (n)	Nest densities [b]	Successful	Abandoned	Predation	Weather	Farming Activities [c]	Cowbird parasitism
				CRP				
Ring-necked pheasant	34	54 (22)	65	0	32	0	3	0
Upland sandpiper	3	2 (1)	33	0	67	0	0	0
Bobolink	3	3 (0)	67	0	33	0	0	0
Western meadowlark	5	3 (1)	60	0	40	0	0	0
Red-winged blackbird	143	129 (34)	26	4	57	6	3	4
Dickcissel	39	24 (3)	23	0	67	5	0	5
Grasshopper sparrow	62	43 (17)	50	0	45	2	2	2
Total	301	263 (63)	38	2	52	4	2	3
				Row-crop				
Horned lark	4	3 (1)	25	0	75	0	0	0
Vesper sparrow	27	10 (3)	33	0	63	0	0	4
Total	31	15 (4)	32	0	65	0	0	3

[a] Species with < 2 nests/100 ha were American woodcock, sedge wren, common yellowthroat, mourning dove, savannah sparrow, song sparrow, vesper sparrow, and American goldfinch.

[b] Nest densities were based on 2 searches each year. The standard error was generated by averaging over years (n=3). All nests found were included in density estimates, but only the active nests (297 in CRP and 31 in row-crop) were used in calculating apparent nest success and outcome.

[c] Farm activities included mowing or spraying weeds in CRP fields and planting and cultivation in row-crop fields.

skunk (Mephitis mephitis), and farm cats were commonly seen within or near the study plots. Small mammals (i.e., rodents), birds, and snakes were believed to be responsible for the remaining predation losses. Large mammals accounted for 89, 88, and 85% of the predation on grasshopper sparrow, red-winged blackbird, and dickcissel nests, respectively. All predation on ring-necked pheasant nests was attributed to large mammals. Nest loss from cowbird parasitism did not exceed 5% for any species (Table 6), although the incidence of parasitism was 25, 33, and 9% for red-winged blackbirds, dickcissels, and grasshopper sparrows, respectively. Farming activities (mowing or chemical application) in CRP fields also resulted in some nest desertion or destruction. Overall nest success of ground nesting species (ring-necked pheasant and grasshopper sparrow) was twice that of above-ground nesting species (dickcissel and red-winged blackbird) in CRP plots (Table 7). Weather and predation accounted for nearly all the additional above-ground nest losses (Table 6).

It is important to compare nest success and the causes of nest failure in CRP fields to that of other agriculturally associated habitats to determine the relative benefits of CRP to nesting bird species. Mayfield nest success values are used for comparison when available; otherwise, apparent success is discussed. The Mayfield success rate for red-wing blackbirds in CRP habitat was intermediate between that in Iowa grassed waterways (8%, Bryan and Best In press) and roadsides (26%, Camp and Best 1994), the dominant, linear, grassland habitats within Iowa agricultural regions (Table 7). Alfalfa fields, a common block habitat in much of Iowa, are also frequently used by redwings for nesting before the first hay cutting

(Frawley 1989). Redwing nest success was low (5%) in alfalfa fields, primarily because of nest losses due to mowing (41%) and predation (29%) (Frawley 1989). Thirty percent of the redwing nests in grassed waterways were lost to mowing (Bryan and Best In press). Mowing accounted for less than 3% of total redwing nest loss in our CRP fields.

Dickcissel nest success (Mayfield) in CRP habitat was nearly 3 times greater than that in Iowa alfalfa fields (5%, Frawley 1989, Table 7), a habitat preferred by dickcissels because of the high forb content. Apparent dickcissel nest success in our study (23%, Table 6) was similar to that in grassed waterways (26%, Bryan and Best in press) and much higher than that in roadsides (0%, Camp and Best 1994). Dickcissel abundance and nesting activity increases in CRP fields after the first alfalfa mowing within a localized area. CRP habitat appears to be important for sustaining localized dickcissel populations, as the threat of nest destruction from mowing is greatly reduced.

Grasshopper sparrow nest success in CRP habitat was twice that in alfalfa fields (15%, Frawley 1989). Grasshopper sparrows were infrequent nesters in grassed waterways (Bryan and Best, in press) and not found in roadside habitats (Camp and Best 1994). The grasshopper sparrow is an area-sensitive species (Herkert 1994) and would not be expected to benefit much from narrow, linear habitats. Currently, CRP land is the predominant habitat available to grasshopper sparrows in central Iowa. Although grasshopper sparrows presumably nest in pastures and fallow fields throughout the state, nesting data do not exist for these habitats.

Table 7. Daily survival rates and percent nest success (SE) for species with >10 nests in 1991-1993. [a]

Species	Daily survival rate		Overall nest success (%)
	Egg	Nestling	
Ring-necked pheasant (42) [b]	0.9734 (0.0001)	-	32
Dickcissel (15, 9)	0.9507 (0.0002)	0.8741 (0.0008)	14
Red-winged blackbird (14, 11)	0.9341 (0.0001)	0.9161 (0.0001)	15
Grasshopper sparrow (14, 9)	0.9567 (0.0002)	0.9365 (0.0002)	30
Vesper sparrow (15, 9) [c]	0.9179 (0.0006)	0.9431 (0.0004)	16

[a] Values are Mayfield (1975) estimates using MICROMORT (Heisey and Fuller 1985)

[b] Interval lengths used in calculating overall nest success. Ring-necked pheasant: see text, dickcissel: Zimmerman (1982), red-winged blackbird: Besser et al. (1987), grasshopper sparrow: Smith (1963) and present study, vesper sparrow: Ehrlich (1988). The egg interval includes egg-laying and incubation. Mean clutch sizes were calculated from our data.

[c] Values are daily survival rates for nests found in row-crop plots. Only 2 vesper sparrow nests were found in CRP fields.

Apparent ring-necked pheasant nest success in CRP fields (Table 6) was much greater than that in Iowa linear agricultural habitats [roadsides, 25% (Camp and Best 1994); waterways, terraces, roadsides, and fencerows combined, 22% (Basore et al. 1986)]. Higher predator densities and frequent human disturbances are believed to account for the reduced success in these linear habitats, although this is not always the case (see Warner 1994). Pheasant nest loss has historically been high in alfalfa fields because of frequent mowing. The long egg stage for pheasant nests increases the chance of destruction before young are fledged (Warner and Etter 1989). CRP land seems to be ideal nesting habitat for pheasants, as it is a block habitat and subject to less frequent disturbance than alfalfa or small grain fields.

Past nesting studies in row-crop habitats have been unable to calculate Mayfield survival estimates because few nests were found. Basore et al. (1986) reported apparent nest success of vesper sparrows in row-crop fields to be 21%, considerably lower than in our study (Table 6). Previous studies of tilled crop fields have shown extensive nest loss due to farming activities (e.g. disking, planting, cultivation), indicating that bird productivity in these habitats may not be adequate to sustain populations (Rodenhouse and Best 1983). Our study fields were all managed with reduced-tillage techniques, requiring fewer passes of machinery over the field. No row-crop nests were destroyed by farming activities during our 3-year study, however, very wet conditions did restrict machinery access to fields to levels below that normally required under minimum tillage practices. A trend towards further reduced and no-tillage agriculture is occurring in Iowa, and this may increase nesting success of row-crop nesting birds.

Nest-site Vegetation

Nest-site vegetation characteristics differed most between ground and above-ground nesting species (Table 8). Plots dominated by tall, thick vegetation were likely to contain more above-ground than ground nests because this vegetation provided for the structural needs of dickcissels and red-winged blackbirds. Dickcissel and redwing nest sites had similar structural characteristics, and differ only in nest height (Table 8). Red-winged blackbird nests, however, were found in a wider variety of plant species, including smooth brome, wild parsnip, thistles, orchard grass, and reed canary grass. Dickcissel nests found in May and early June were sometimes placed in thick patches of smooth brome before weedy forb species were above the grass canopy. Nearly all late season nests were in alfalfa or bull thistle (Cirsium vulgare). Dickcissels nest density was positively correlated with both vertical vegetation density ($r = 0.74$, $n = 9$, $P = 0.02$) and total percent canopy coverage ($r = 0.81$, $P < 0.01$) on the entire study plots. Redwing nest density was not correlated ($P > 0.05$) with any of the vegetation variables.

As red-wing blackbirds are more successful generalists than dickcissels, a vegetation management regime to favor use by dickcissels would only be marginally successful. Although dickcissel numbers may increase in fields with high vertical vegetation density, as well as a higher forb and total canopy coverage, redwings, a species we might rather manage against, would better exploit this vegetation structure. Plots that

Table 8. Mean (SE) nest-site vegetation values for the most abundant bird species in CRP fields 1991-1993.

Species	Vertical vegetation density (cm)	Height of live vegetation (cm)	Nest height (cm)	Percent canopy coverage		
				Grass	Forbs	Total
Ring-necked pheasant (33) [a]	42 (4) B [b]	74 (5) B	–	80 (6) A	25 (6) B	73 (3) B
Dickcissel (37)	67 (3) A	98 (4) A	38 (3) B	48 (6) B	54 (6) A	94 (3) A
Western meadowlark (5)	31 (9) BC	53 (12) BC	–	67 (15) AB	39 (16) ABC	58 (7) BC
Red-winged blackbird (128)	67 (2) A	96 (2) A	44 (1) A	57 (3) B	49 (3) A	91 (1) A
Grasshopper sparrow (56)	24 (3) C	45 (4) C	–	95 (5) A	7 (5) C	57 (2) C

[a] Number of nests used for calculating means.

[b] Column values with the same letter are not significantly different ($P > 0.05$, Fisher's least significant difference test).

were sprayed for weeds lost their forb component and became undesirable nesting habitat for dickcissels. Land-owners that controlled weeds by mowing, however, generally avoided the alfalfa, and hence maintained good dickcissel habitat, while reducing much of the taller forb structure used by red-wing blackbirds for nesting.

Grasshopper sparrow nests were found exclusively in smooth brome or orchard grass litter and were associated with less vertical vegetation density than ring-necked pheasant, dickcissel, and red-winged blackbird nests (Table 8). Grasshopper sparrow nest sites had a much higher grass coverage, yet lower total canopy than pheasant, dickcissel, and redwing nest sites. Grasshopper sparrow nest density was negatively correlated with vertical vegetation density on the study plots ($\underline{r} = 0.69$, $\underline{n} = 9$, $\underline{P} = 0.04$).

Managing CRP land for grasshopper sparrows, savannah sparrows, and upland sandpipers should be achievable, as all species prefer relatively short and diverse grass structure. Redwing numbers would remain low within this vegetation regime. Late season mowing (July and August) could be used to open up tall vegetation to grasshopper sparrow nesting.

MANAGEMENT IMPLICATIONS

The Conservation Reserve Program has contributed to an increase in abundance of many bird species in central Iowa, as the row-crop habitat it replaced has lower bird abundance and supports fewer nesting species. We have also shown CRP fields to be better nesting habitat than roadsides (Camp and Best 1994), grassed waterways (Basore et al. 1986), and other agriculturally associated habitats in Iowa. The diverse vegetation structure and composition, the large blocked nature of much of this habitat, as well as the reduced agricultural activity on this land are believed to account for these differences.

Factors Affecting the Variation in CRP Vegetation Structure and Composition

Many factors affect CRP vegetation structure and composition, and hence the wildlife species that benefit from the program. Some factors are environmental (climate, weather, topography, and soil type), whereas others involve the administration of the CRP program. Federal enforcement of this policy, as well as landowner interpretation, must both be considered. An examination of these practices, and their influence on wildlife can further our efforts to optimize CRP habitat for bird species of concern in the Midwest.

Current federal policy requires the planting of specific grass and forb species to satisfy the local Soil Conservation Service's (SCS) "conservation plan" (U. S. Dep. Agric. 1991). The species used varies from state to state and is determined by the forage species traditionally used within a region. This suggests that CRP structure and composition is not the same in other regions of the country. Species planted on CRP land should be based, at least, in part, on structural and compositional attributes to which birds respond.

Weed control policies requiring farmers to mow or spray noxious weeds will, in time, decrease plant species diversity and manage against bird species that rely on heterogeneous habitats. Weed control enforcement varies widely among Iowa counties (Matthew Patterson, pers. obs.), as does farmer tolerance of weeds. This likely results in a disparity in the program's benefits to wildlife from one CRP field to another and across the state. Grassland birds may benefit from a lack of unity between federal policy, county implementation, and the landowner, as a greater diversity of CRP vegetation structure and composition is certain to result. Such benefits to wildlife are fortuitous and should not be relied upon as an effective wildlife management policy.

Future Management Considerations

Many of the wildlife concerns related to land management practices are beyond the control of the wildlife manager, whereas others can be addressed through reconsideration of future federal land set-aside policies and an increased communication between farmers and wildlife ecologists. A wide variety of management practices from one farm to another will create a mosaic of habitat structures that benefit the greatest number of grassland bird species. Allowing the planting of a greater diversity of vegetation species, as well as increasing the weed management options to landowners, will further enhance the bird use of CRP land. Many grassland birds, however, require large tracts of similar habitat (Samson

1980, Herkert 1994). In our study, upland sandpipers and bobolinks were most abundant on plots that were part of larger CRP tracts (>50 ha). Ecologists and county ASCS offices could work together in developing a plan to increase the diversity of CRP management regimes within a county, while maintaining large tracts of similar structure for area sensitive species.

Currently, there are no federal restrictions on when CRP fields are mowed or sprayed for weeds. Optimal weed reduction is obtained before weed seeds mature (May and June) (Marshall Co. ASCS, pers. commun.), the peak of the nesting season of most grassland birds. Some studies have suggested mowing grasslands later in the season (15 July-15 August) to avert catastrophic nest losses (Bryan and Best 1991, Camp and Best 1993), however, some species nest beyond this period. Later mowing may be detrimental to the American goldfinch, which begins nesting in mid-summer (Middleton 1978), and other species, which may successfully fledge young only later in the season when the threat of cowbird parasitism is reduced (Payne 1973).

Further research is needed to understand the long-term impact of the CRP on grassland bird abundance and productivity. The benefits to wildlife may decline over time because of increasing vegetation homogeneity and the accumulation of litter. Nest predators may also increase as the grass community becomes more established (Schwartz and Whitson 1987). Mid-contract disturbances (e.g., disking, burning, grazing, and inter-seeding) need to be studied, as they could affect the long-term benefits to wildlife.

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GENERAL SUMMARY

The Conservation Reserve Program has contributed to an increase in abundance of many bird species in central Iowa, as the row-crop habitat it replaced has lower bird abundance and supports fewer nesting species. Additionally, the vegetation structure and composition among CRP fields can be diverse, resulting in a variety of bird species communities among CRP fields.

Thirty-three bird species were recorded in CRP plots and 34 in row-crop fields over the 3-year study period. The most abundant species in both habitats was the red-winged blackbird (Agelaius phoeniceus), accounting for 35% of all birds in CRP and 24% in row-crop fields. The dickcissel (Spiza americana), grasshopper sparrow (Ammodramus savannarum), bobolink (Dolichonyx oryzivorus), common yellowthroat (Geothypis trichas), brown-headed cowbird (Molothrus ater), savannah sparrow (Passerculus sandwichensis), and ring-necked pheasant (Phasianus colchicus) were the next most abundant species in CRP plots.

Sixteen species nested in CRP fields over the 3-year study period. Red-winged blackbirds were the most abundant nesting species in CRP fields, representing 48% of all nests found. The vesper sparrow and horned lark were the only species found nesting in row-crop fields. The major cause of nest loss for all species was predation, accounting for 52% of all nest loss in CRP fields and 65% in row-crop fields. Mammals accounted for 89, 88, and 85% of the predation on grasshopper sparrow, red-winged blackbird, and dickcissel nests, respectively.

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