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THE EFFECTS OF HABITAT MANIPULATION ON VEGETATION CHARACTERISTICS AND AVIAN COMMUNITIES ON CONSERVATION RESERVE PROGRAM FIELDS IN GRATIOT COUNTY, MICHIGAN

By

Alison Jane Pearks

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ABSTRACT

THE EFFECTS OF HABITAT MANIPULATION ON VEGETATION CHARACTERISTICS AND AVIAN COMMUNITIES ON CONSERVATION RESERVE PROGRAM FIELDS IN GRATIOT COUNTY, MICHIGAN

By

Alison Jane Pearks

Avian populations and vegetation characteristics were examined on 18 Conservation Reserve Program (CRP) fields subjected to varying mowing treatments. Six fields had a 4-year history of complete mowing in late summer; 6 fields had not been previously manipulated and were mowed in late summer in strips totaling 1/3rd of the field acreage; and 6 fields had no history of mowing and served as controls. Manipulated fields were characterized by low live vegetation height and live canopy; strip mowed fields tended towards grass canopy while whole mowed fields had more forb canopy. Control fields were characterized by tall live vegetation and dead canopy. Avian diversity and relative abundance were significantly reduced on manipulated fields compared to control fields. Strip mowed fields showed higher abundances than whole mowed fields, but similar diversity. Overall number of nests was reduced on manipulated fields, but nest success was equivalent to control fields. If mowing is deemed necessary for weed control, strip mowing is recommended over whole field mowing.

Dialogue...

"Morals are your agreement with yourself to abide by your own rules. To thine own self be true or you spoil the game."

"Crazy."

"Then vary the rules and play a different game. You cannot exhaust her infinite variety."

Lazarus Long in Time Enough For Love
by Robert A. Heinlein

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INTRODUCTION

Historical Background of the Conservation Reserve Program

As agricultural production has increased over time, the extensive native grasslands which once covered most of North America have been replaced by croplands and pastures. Monoculture fields now dominate a once heterogeneous landscape. These changes have greatly impacted wildlife communities as their habitats diminished in size and diversity. Loss of nesting sites, feeding areas and cover led to drastic reductions in wildlife populations, both in numbers and in diversity (Berner 1988).

Increasing agricultural development also brought about detrimental environmental effects. Soil erosion and chemical runoff rose dramatically and water quality decreased substantially. At one point, an estimated 3.1 billion tons of soil eroded from croplands on an annual basis. Off-farm damages of $5 - $18 billion were reported annually, as well as $1.84 billion in on-farm damages (U.S. General Accounting Office 1989).

To counter these problems, the federal government implemented several set-aside programs. The first was the Cropland Adjustment Act (CAA) in 1934, which simply removed land from production (Edwards 1984). It was replaced in 1936 with the Agricultural Conservation Program (ACP), an annual set-aside program requiring farmers to plant cover crops such as grasses or legumes to conserve soil (Berner 1988). The Soil Bank Act of 1956 created the Conservation Reserve (CR) - a multiyear, cover crop program - and the Acreage

Reserve (AR) - an annual, non-cover crop program. The AR was discontinued in 1959 (Edwards 1984).

The Emergency Feed Grain Program (FGP), implemented in 1961, and the Wheat Program (WHP), started in 1962, were both annual programs initiated to boost land retirement participation by increasing acreage payments (Berner 1988). Cover crops were not required, and even though participation increased, wildlife population levels remained low (Erickson and Wiebe 1973). In 1966, the Cropland Adjustment Program brought back multiyear retirement plans with cover crops, but the FGP and WHP proved to be more economically attractive to the landowners (Berner 1988). The 1984 Payment-In-Kind (PIK) program combined the time length of an annual cycle with some cover crop requirements, but did not benefit wildlife or landowners, decrease erosion, or improve water quality (Cutler 1984).

In 1985 the Food Security Act (Food Bill) created the current Conservation Reserve Program (CRP). It too is a multiyear set-aside program requiring a cover crop to be planted and targets highly erodible areas, or land that contributes to a water quality problem (U.S. Dept. of Agriculture 1990). The Food Bill was amended in 1990 by the Food, Agriculture, Conservation, and Trade Act (FACTA) to increase opportunities for landowners to retire environmentally sensitive land (U.S. Dept. of Agriculture 1990).

As of the 12th signup period (1993), about 15 million hectares are enrolled in the CRP, with a total acreage goal of 18 million hectares. Presently there are roughly 377,000 contracts, or 8% of all US cropland, in CRP, with 93% of that planted to grass or trees. An estimated 700 million tons of soil are prevented from eroding annually, decreasing the pre-CRP amounts by 22% (Osborn 1993). The CRP has also decreased sedimentation, preserved the long-term productivity of the land, and decreased chemical runoff (U.S. General Accounting Office

1989).

Benefits of the presence of CRP fields to wildlife are well documented (Taylor 1980, Berthelsen et al. 1989, Burger et al. 1990, Stouffer 1990, Campa et al. 1991 Campa et al. 1992, Campa et al. 1993, Campa et al. 1994, Campa et al. 1995). For example, 16 grassland bird species that were in long-term decline are now more abundant on CRP lands than they are elsewhere (Outdoor Life 1994). It is also apparent that the continuing enrollment of lands in the CRP is important to avian diversity, as the "age" of the field - the length of time it has been planted to cover - influences bird use of a field. Younger fields tend to have higher diversity and density, whereas older fields have greater productivity (Millenbah 1993). Age influence can also be seen in small mammal use of the fields, with younger fields having more diversity and older fields having greater abundance (Furrow 1994). The canopy makeup of a field changes by age, with younger fields (1 - 3 years of enrollment) showing relatively large amounts of bare ground, live cover, and forb cover. Older fields (4 - 6 years of enrollment) are characterized by more total canopy coverage, grasses, and litter cover (Campa et. al 1993).

Habitat Manipulation

Key requirements for wildlife are availability and adequate interspersion of cover, food and water. Juxtaposition and interspersion of vegetation types and structures increases potential habitat, particularly in an environment limited for size. The creation of edge tends to increase vegetation and the relative abundance of wildlife (National Research Council, Committee on Impacts of Emerging Agricultural Trends on Fish and Wildlife Habitat 1982).

In a managed system, periodic manipulations to revitalize vegetation and maintain a balance between successional stages may be necessary for long-term maintenance of viable wildlife habitat (Noss 1991, Schenck and Williamson 1991). Periodic disturbance of grasslands in 3 - 5 year intervals has been found to enhance wildlife production by more than 100%, and winter cover/spring nesting vegetation benefits from a 5 - 10 year manipulation cycle (Sousa 1987, Schenck and Williamson 1991). Research has also indicated that interspersion of areas of unmanipulated climax grassland within areas of periodic disturbance tends to perpetuate and increase grassland wildlife populations (Schenck and Williamson 1991).

CRP fields are subject to periodic manipulation as a form of weed control, but the methods used and the amount disturbed vary from one participating area to the next. There have been few data gathered on how these management practices may affect the vegetation structure on the fields or wildlife populations utilizing the fields. One brief, informal study showed that mowing on an annual basis reduces weed content and increases legume mass (Fee 1995), but the impact of this on wildlife was not addressed. Avian species in particular could be the most affected, as vegetation structure variations have a potentially large affect on nesting, feeding, and winter cover habitat.

Information on how habitat manipulation impacts avian communities and vegetation composition could provide insight on which method is the most beneficial to maintaining avian densities and relative abundance. These data could also provide background on how useful habitat manipulations are to avian conservation plans in general.

HYPOTHESIS AND OBJECTIVES

The primary null hypothesis for this study is that manipulated (mowed) CRP fields do not differ significantly from unmanipulated CRP fields with respect to avian productivity, relative abundance, and diversity; and with respect to vegetation characteristics.

Specific objectives are to:

1) quantify vegetation characteristics of manipulated and unmanipulated CRP fields;

2) determine the effects of manipulations (annual whole field mowing, annual strip mowing, and no manipulations) on avian diversity, relative abundance, and productivity; and

3) provide management recommendations for increasing avian habitat and habitat quality for species that utilize CRP fields.

STUDY AREA

Gratiot County is located in central Michigan (T 9, 10, 11, 12N; R 1, 2, 3, 4W) (Figure 1). Precipitation averages 76.1cm annually, 62% of that in the April - September period. Winter snow fall averages 104.9cm annually. Temperatures range from an average low in the winter of - 4.2 C to an average summer high of 20.9 C. Agriculture involves 85% of the land (personal communication from the Farm Service Agency, December 1995), with corn, soybeans, and wheat being the major crops. Soils in the area that are involved with agriculture include Capac, Parkhill, Lenawee, Corunna, Selfridge and Dixboro - all moderate to poor drainers; loamy soil, clay loam, sandy loam, or loamy sand; and mostly level. Soils that have native vegetation on them include Plainfield, Riverdale, and Vestaburg. All are loamy sands, but Plainfield is well drained, whereas Riverdale and Vestaburg are poorly drained (U.S. Dept. of Agriculture 1979).

Among field types, a significant difference was found between sizes of control fields and sizes of whole mowed fields (KW, $P < 0.02$) and strip mowed fields (KW, $P < 0.1$). This may impact avian diversity, relative abundance, and productivity measurements through reduction of species composition (Herkert 1991). Mean sizes of whole mowed fields and strip mowed fields were not significantly different (KW, $P > 0.2$) (Table 1).

Figure 1. Map of the state of Michigan showing the location of Gratiot County.

Table 1. Range and mean field size of whole mowed fields, strip mowed fields, and control fields in Gratiot County, Michigan, 1994 and 1995.

	Field size	
	Range (ha)	Mean size[a] (ha)
whole mowed	2.4 - 13.6	5.325 A
strip mowed	3.2 - 10	6.433 A
control	7.2 - 14.24	10.353 B

[a]among field types, mean field sizes with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

EXPERIMENTAL DESIGN

Eighteen fields were involved in this study, divided into 3 treatments, with 6 replications per treatment. The treatments were:

1) annually completely mowing an entire field (in late July). Two fields used in 1994 were flooded in July 1994 and had to be replaced for the 1995 season.

2) strip mowing one-third of a field (with a different third mowed each year of the study, and taking place at the same time as the annual mowing); and

3) no manipulation (control). These fields were part of a related study that began in 1991, providing vegetation composition and avian use data for 5 years.

METHODS

Vegetation Characteristics

This study took place from March 1993 through August 1995. Two sampling periods were delineated to measure vegetation characteristics. These data were used to determine the vegetation composition and structure that maintained the greatest diversity, relative abundance, and productivity of avian species. The first period was 1 May - 31 May, during peak avian breeding season. The second period occurred 1 July - 31 July, during the maximum vegetative growth season. One sample was taken on each field per period.

Data were collected from sample points on 6 randomly located 100m transects per field. Six sample points were spaced at 20m intervals on each transect. Horizontal cover was measured 4m from the sample point with a Robel pole (Robel et al. 1970). At each point, height of live and standing dead vegetation in dm was also assessed with a Robel pole. Percent of canopy cover made of live, dead, grass, forb, and woody vegetation; percent of bare ground; and percent litter cover were measured with a 50 x 50 cm frame (Daubenmire 1959). Litter depth in cm was recorded with a meter stick. All plant species within the frame were recorded to determine frequencies, and the dominant species on each field was noted.

A post-manipulation vegetation sample was taken on the manipulated fields to determine the amount of canopy cover remaining after mowing. This sample consisted of horizontal cover, live vegetation height, proportion of live canopy cover, and litter depth. Measurements were taken as described above. This post-manipulation sample was timed to occur when the unmanipulated control fields were measured in July. Therefore, manipulated fields were each measured three times and unmanipulated fields were each measured twice. In analysis, values from the July sample taken on control fields were duplicated for a post-manipulation control set.

In addition to 2 flooded fields which had to be replaced in 1995, 1 whole mowed field in 1994 and another whole mowed field in 1995 were mowed ahead of schedule. Therefore, post-manipulation measurements were not taken on the 2 flooded fields, and July vegetation measurements were not taken on the 2 fields that were mowed early.

Avian Diversity and Relative Abundance

Three censuses were conducted per year to determine the relative abundance and diversity of avian species utilizing fields for feeding and breeding purposes. The census periods ran from 15 May - 15 June, 16 June - 15 July, and 16 July - 15 August. Each field was censused once during each period.

The variable-strip survey method was used along randomly located transects. Each field first had a 25m buffer delineated around the perimeter. A corner of each field then was chosen at random, with the first transect starting 25m along the long edge from this corner inside the perimeter. Each transect thereafter was spaced at 50m intervals. The surveys began at dawn and were completed by 3 hours after dawn. This allowed for observations to be made during peak activity times. For each bird seen, researchers noted the perpendicular distance of the bird from the transect line in meters, the distance of the bird to the nearest edge in meters, the species, and the gender. The position of the bird was also recorded on a map. If a flock was seen at a particular location, the center of the flock was used as the location from which to make measurements. Researchers would also then record the number of birds seen and the number of birds of each gender.

Censuses were not taken if there was any precipitation (rain, fog) as this hindered sight and accuracy. Censuses were also not done if the wind speed was greater than 16kph.

Avian Productivity

Researchers looked for nests in 2 censuses to determine productivity and nesting success. The first census ran from 1 May to 31 May and the second from 1 June to 30 June, with 1 census taken on each field in each period. These time frames covered the main nesting season and any repeat nesting that occurred. Researchers walked 1 - 2m abreast across a field until it was completely traversed. Each nest found was revisited every 2 - 3 days until the young fledged or the nest was abandoned or destroyed. Species, number of eggs, number of young, and nest fate were recorded. Any nests found at any other time were also observed.

ANALYSIS

Vegetation characteristics were compared among periods, among treatments and between years using the Kruskal-Wallis 1-way analysis of variance (Siegel 1956). Alpha was set at 0.1. Dominant vegetation characteristics were summarized by treatment. These were then compared to avian relative abundance, diversity, and productivity by treatment.

Avian diversity was analyzed among periods by comparing Shannon-Weaver diversity index values (Shannon-Weaver 1949) using the Kruskal-Wallis 1-way analysis of variance (ANOVA). Comparisons among treatments and between years were also done with Kruskal-Wallis 1-way ANOVA. Alpha was set at 0.1.

Avian relative abundance was compared among periods, among treatments, and between years using the Kruskal-Wallis 1-way ANOVA. Alpha was set at 0.1.

Avian productivity was evaluated as the number of active nests versus the number of successful nests over both periods within each year. Comparisons among treatments and between years were done with Kruskal-Wallis 1-way ANOVA. Alpha was set at 0.1.

Over the 2 year period of the manipulation study, whole mowed fields averaged 4-5 years in age and strip mowed fields averaged 5-6 years in age. As found in previous research (Millenbah 1993), age has been found to influence avian diversity, relative abundance, and productivity by impacting vegetation characteristics. It was necessary to match control fields by age to manipulated fields for analysis. As previously mentioned, the control fields in this study were part of a regional project started in 1991, and historical data for these fields were available. Therefore, data collected in 1991 when control fields were 4 years of age and 1992 when control fields were 5 years in age, were used for comparisons to whole mowed fields. Data collected in 1992 when control fields were 5 years of age and 1993 when control fields were 6 years in age, were used for comparisons to strip mowed fields. As the year the data were collected was not found to be a factor, this eliminated a confounding influence from analysis. Statistical evidence for age influence is presented in Appendix I.

RESULTS

Vegetation Characteristics

In 1994 on whole mowed fields, dead vegetation height, dead canopy cover and forb canopy cover changed significantly between May and July (KW, $P < 0.07$). Horizontal cover, live vegetation height, live canopy cover, and litter depth changed significantly among May, July and post-manipulation (KW, $P < 0.02$). In 1995, dead vegetation height, percent bare ground, and litter cover changed significantly between May and July (KW, $P < 0.06$). Horizontal cover, live vegetation height, live canopy cover, and litter depth changed significantly among May, July, and post-manipulation (KW, $P < 0.08$). Horizontal cover, live vegetation height, and live canopy cover increased between May and July, then decreased post-manipulation. Dead vegetation height, dead canopy cover, and percent bare ground decreased from May to July, while forb canopy cover and litter cover increased. In 1994, litter depth increased from May to July to post-manipulation. In 1995, litter depth decreased from May to July, then increased post-manipulation (Table 2).

Table 2. Mean values of vegetation characteristics on whole mowed fields in May, July, and post-manipulation in 1994 and 1995 in Gratiot County, Michigan.

	1994				1995			
	May	July	Post-manipulation	P[a]	May	July	Post-manipulation	P[a]
HC[b] (dm)	1.83	5.25	2.37	0.01	1.15	5.83	0.79	0.004
LH[b] (dm)	2.36	7.89	4.63	0.003	2.21	7.9	1.51	0.004
DH[b] (dm)	1.67	0.22		0.07	0.97	0		0.004
% TC[b]	95.8	100		0.17	97.3	99.5		0.13
% LC[b]	67.2	94	63.8	0.01	66.2	98.9	49.2	0.01
% DC[b]	2.81	0		0.07	1.85	0		0.17
% GC[b]	37.7	46.6		0.71	32.3	45		0.72
% FC[b]	27.8	47.8		0.07	31	54		0.2
% WC[b]	0	0		1	0	0		1
% BG[b]	4.2	0		0.17	2.75	0.14		0.07
% LtC[b]	95.8	100		0.17	29.5	98.7		0.01
LtD[b] (cm)	3.16	3.55	8.81	0.02	3.92	3.79	9.13	0.05

[a]Kruskal-Wallis one-way ANOVA, May vs July
May vs July vs post - manipulation for HC, LH, % LC, and LtD
[b]HC(horizontal cover), LH(live height), DH(dead height), %TC(total canopy cover), %LC(live canopy cover), %DC(dead canopy cover), %GC(grass canopy cover), %FC(forb canopy cover), %WC(woody canopy cover), %BG(bare ground), %LtC(litter cover), LtD(litter depth)

1994 May values on whole mowed fields were significantly greater than 1995 May values for horizontal cover and litter cover (KW, $P < 0.03$). 1995 July values were significantly greater than 1994 July values for live canopy cover (KW, $P < 0.04$). 1994 post-manipulation values were significantly greater than 1995 post-manipulation values for horizontal cover and live vegetation height (KW, $P < 0.02$) (Table 3).

Table 3. Mean values of vegetation characteristics on whole mowed fields in 1994 and 1995 in Gratiot County, Michigan.

	May			July			Post-manipulation		
	1994	1995	P[a]	1994	1995	P[a]	1994	1995	P[a]
HC[b]	1.83	1.15	0.025	5.25	5.83	0.462	2.37	0.79	0.011
LH[b]	2.36	2.21	0.873	7.89	7.9	0.624	4.63	1.51	0.011
DH[b]	1.67	0.97	0.749	0.22	0	0.18			
%TC[b]	95.8	97.3	0.406	100	99.5	0.264			
%LC[b]	67.2	66.2	0.575	94	98.9	0.032	63.8	49.2	0.394
%DC[b]	2.81	1.85	0.522	0	0	1			
%GC[b]	37.7	32.3	0.522	46.6	45	0.806			
%FC[b]	27.8	31	0.873	47.8	54	0.806			
%WC[b]	0	0	1	0	0	1			
%BG[b]	4.2	2.75	0.406	0	0.14	1			
%LtC[b]	95.8	29.5	0.004	100	98.7	1			
LtD[b]	3.16	3.92	0.337	3.55	3.79	0.712	8.81	9.13	1

[a]Kruskal-Wallis one-way ANOVA, 1994 vs 1995 for May and July
May, July, and post-manipulation for HC, LH, %LC, and LtD
[b]HC(horizontal cover), LH(live height), DH(dead height), %TC(total canopy cover), %LC(live canopy cover), %DC(dead canopy cover), %GC(grass canopy cover), %FC (forb canopy cover), %WC(woody canopy cover), %BG(bare ground), %LtC(litter cover), LtD(litter depth)

In 1994 on strip mowed fields, dead vegetation height, dead canopy cover, and forb canopy cover changed significantly between May and July (KW, $P < 0.02$). Horizontal cover, live vegetation height, live canopy cover, and litter depth changed significantly among May, July, and post-manipulation (KW, $P < 0.06$). In 1995, dead vegetation height, dead canopy cover, forb canopy cover, and litter cover changed significantly between May and July (KW, $P < 0.06$). Horizontal cover, live vegetation height, live canopy cover, and litter depth changed significantly among May, July, and post-manipulation (KW, $P < 0.06$). Horizontal cover, live vegetation height, and live canopy cover increased from May to July, then decreased post-manipulation. Dead vegetation height and dead canopy cover decreased from May to July, while forb canopy cover and litter cover increased. Litter depth decreased from May to July, then increased post manipulation (Table 4).

Table 4. Mean values of vegetation characteristics on strip mowed fields in May, July, and post-manipulation in 1994 and 1995 in Gratiot County, Michigan.

	1994				1995			
	May	July	Post-manipulation	P[a]	May	July	Post-manipulation	P[a]
HC[b] (dm)	2.18	4.75	2.28	0.003	1.07	4.34	1.51	0.002
LH[b] (dm)	2.44	7.16	3.4	0.002	2.11	8.27	2.8	0.003
DH[b] (dm)	2.35	0.72		0.01	2.04	0		0.002
% TC[b]	98.1	96.3		0.52	99.9	100		0.14
% LC[b]	67.2	94	65.8	0.01	56.9	96.8	80.3	0.02
% DC[b]	7.34	1.32		0.06	2.18	0		0.06
% GC[b]	51.7	55.7		0.87	44.7	62.3		0.11
% FC[b]	15.3	36.2		0.06	11.7	34.7		0.06
% WC[b]	0.02	0		0.63	0	0		1
% BG[b]	1.9	0.12		0.63	1.53	0.42		0.9
% LtC[b]	97.7	99.5		0.63	39.6	96.1		0.004
LtD[b] (cm)	4.59	4.35	8.85	0.02	5.08	2.6	4.34	0.06

[a]Kruskal-Wallis one-way ANOVA, May vs July
May vs July vs post - manipulation for HC, LH, % LC, and LtD
[b]HC(horizontal cover), LH(live height), DH(dead height), %TC(total canopy cover), %LC(live canopy cover), %DC(dead canopy cover), %GC(grass canopy cover), %FC(forb canopy cover), %WC(woody canopy cover), %BG(bare ground), %LtC(litter cover), LtD(litter depth)

1994 May values for strip mowed fields were significantly greater than 1995 May values for horizontal cover, dead canopy cover, and litter cover (KW, P < 0.05). 1994 July values were significantly greater than 1995 July values for dead vegetation height, dead canopy cover, litter cover, and litter depth (KW, P < 0.09). 1995 July values were significantly greater for total canopy cover (KW, P < 0.06). Post-manipulation values for horizontal cover and litter depth were significantly greater in 1994 than in 1995 (KW, P < 0.04), while live canopy cover was significantly greater in 1995 post-manipulation (KW, P < 0.06) (Table 5).

Table 5. Mean values of vegetation characteristics on strip mowed fields in 1994 and 1995 in Gratiot County, Michigan.

	May			July			Post-manipulation		
	1994	1995	P[a]	1994	1995	P[a]	1994	1995	P[a]
HC[b]	2.18	1.07	0.004	4.75	4.34	1	2.28	1.51	0.037
LH[b]	2.44	2.11	0.631	7.16	8.27	0.262	3.4	2.8	0.261
DH[b]	2.35	2.04	1	0.72	0	0.007			
%TC[b]	98.1	99.9	0.703	96.3	100	0.059			
%LC[b]	67.2	56.9	0.109	94	96.8	0.872	65.8	80.3	0.053
%DC[b]	7.34	2.18	0.042	1.32	0	0.022			
%GC[b]	51.7	44.7	0.262	55.7	62.3	0.749			
%FC[b]	15.3	11.7	0.423	36.2	34.7	0.873			
%WC[b]	0.02	0	0.317	0	0	1			
%BG[b]	1.9	1.53	0.528	0.12	0.42	0.902			
%LtC[b]	97.7	39.6	0.003	99.5	96.1	0.089			
LtD[b]	4.59	5.08	0.873	4.35	2.6	0.055	8.85	4.34	0.025

[a]Kruskal-Wallis one-way ANOVA, 1994 vs 1995 for May and July May, July, and post-manipulation for HC, LH, %LC, and LtD
[b]HC(horizontal cover), LH(live height), DH(dead height), %TC(total canopy cover), %LC(live canopy cover), %DC(dead canopy cover), %GC(grass canopy cover), %FC (forb canopy cover), %WC(woody canopy cover), %BG(bare ground), %LtC(litter cover), LtD(litter depth)

When differences were significant between whole mowed fields and control fields for horizontal cover, live and dead vegetation heights, dead canopy cover, and percent bare ground, control field values were greater (KW, $P < 0.04$). When differences were significant for total canopy cover, litter cover, and litter depth, whole mowed field values were higher (KW, $P < 0.1$). Live canopy cover was significantly greater on whole mowed fields in July, 1995 (KW, $P = 0.005$), and on control fields in post-manipulation, 1995 (KW, $P = 0.019$) (Table 6).

When differences were significant between control fields and strip mowed fields for horizontal cover, live and dead vegetation heights, dead canopy cover, and percent bare ground, control field values were higher (KW, $P < 0.07$). When differences were significant for total canopy cover, live canopy cover, and litter cover, strip mowed field values were higher (KW, $P < 0.1$). However, in post-manipulation, 1994, control fields had significantly higher levels for live canopy cover (KW, $P = 0.031$). Litter depth was significantly greater on strip mowed fields in post-manipulation, 1994 (KW, $P = 0.011$) and on control fields in July, 1995 (KW, $P = 0.055$) (Table 7).

Significant differences were seen between whole mowed fields and strip mowed fields in dead canopy cover in May and July, 1994 (KW, $P < 0.07$), in total canopy cover in May, 1995 (KW, $P < 0.09$), and in all post-manipulation variables (KW, $P < 0.07$). Strip mowed field values were higher in all instances (Table 8).

A list of the top 5 plant species found on each manipulation type by year is shown in Appendix II.

Table 6. Mean vegetation characteristics values for whole mowed fields (Whl) and control fields (Con) in Gratiot County, Michigan, 1994-5.

	May 1994			July 1994			Post-manipulation 1994			May 1995			July 1995			Post-manipulation 1995		
	Con	Whl	P[a]	Con	Whl	P[a]	Con	Whl	P[a]	Con	Whl	P[a]	Con	Whl	P[a]	Con	Whl	P[a]
HC[b]	6.16	1.8	<0.01	11	5.25	<0.01	11	2.37	0.01	3.7	1.15	<0.01	7.7	5.83	0.2	7.7	0.8	0.01
LH[b]	7.7	2.4	<0.01	10	7.89	0.14	10	4.63	0.01	4.42	2.21	0.01	10.7	7.9	0.03	10.7	1.51	0.01
DH[b]	5.5	1.7	0.02	3	0.22	<0.01				10.3	0.97	<0.01	9.1	0	<0.01			
%TC[b]	90	96	0.52	95	100	0.06				71	97.3	0.02	91	99.5	0.12			
%LC[b]	71	67	0.75	88	94	0.2	88	64	0.15	64	66.2	1	83	98.9	<0.01	83	49.2	0.02
%DC[b]	19	2.8	0.01	7.3	0	<0.01				7.32	1.85	0.02	8.42	0	<0.01			
%GC[b]	50	38	0.2	56	46.6	0.2				48	32.3	0.28	58	45	0.36			
%FC[b]	19	28	0.3	47	47.8	0.72				23	31	0.75	38	54	0.2			
%WC[b]	0.8	0	0.14	0.2	0	0.18				0.1	0	0.32	0.22	0	0.36			
%BG[b]	2.47	4.2	0.1	9.8	0	0.01				2	2.75	0.75	2.1	0.14	0.04			
%LtC[b]	20	96	<0.01	87	100	0.09				51	29.5	0.01	73	98.7	0.02			
LtD[b]		3.2			3.55			8.81		5.58	3.92	0.26	3.63	3.79	0.86	3.63	9.13	0.02

[a]Kruskal-Wallis one-way ANOVA, whole mowed fields vs control fields
[b]HC(horizontal cover), LH(live height), DH(dead height), %TC(total canopy cover), %LC(live canopy cover), %DC(dead canopy cover), %GC(grass canopy cover), %FC(forb canopy cover), %WC(woody canopy cover), %BG(bare ground), %LtC(litter cover), LtD(litter depth)

Table 7. Mean vegetation characteristics values for strip mowed fields (Strp) and control fields (Con) in Gratiot County, Michigan, 1994-5.

	May 1994			July 1994			Post-manipulation 1994			May 1995			July 1995			Post-manipulation 1995		
	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]
HC[b]	3.7	2.18	0.01	7.7	4.75	0.03	7.7	2.28	0.01	2.9	1.07	0.01	8.5	4.34	0.01	8.5	1.5	0.01
LH[b]	4.42	2.44	0.03	10.7	7.16	0.02	10.7	3.4	0.01	3.04	2.11	0.07	12	8.27	0.01	12	2.8	0.01
DH[b]	10.3	2.35	0.01	9.1	0.72	0.01				1.6	2.04	0.01	3.1	0	0.01			
%TC[b]	71	98.1	0.01	91	96.3	0.29				98	99.9	0.03	99.7	100	0.06			
%LC[b]	64	67.2	0.63	83	94	0.08	83	65.8	0.03	57	56.9	1	75	96.8	0.01	75	80.3	0.24
%DC[b]	7.32	7.34	0.52	8.42	1.32	0.01				36	2.18	0.01	12	0	0.01			
%GC[b]	48	51.7	0.34	58	55.7	0.87				51	44.7	0.63	64	62.3	0.87			
%FC[b]	23	15.3	0.2	38	36.2	0.75				14	11.7	0.34	29	34.7	0.52			
%WC[b]	0.1	0.02	0.9	0.22	0	0.32				0.2	0	0.14	0.4	0	0.14			
%BG[b]	1.9	1.9	0.18	2.1	0.12	0.02				1.67	1.53	0.06	0.37	0.42	0.4			
%LtC[b]	51	97.7	0.01	73	99.5	0.01				22	39.6	0.1	17	96.1	0.01			
LtD[b]	5.58	4.59	0.5	3.63	4.35	0.26	3.63	8.85	0.01	3.72	5.08	0.26	3.36	2.6	0.06	3.36	4.34	0.32

[a]Kruskal-Wallis one-way ANOVA, strip mowed fields vs control fields
[b]HC(horizontal cover), LH(live height), DH(dead height), %TC(total canopy cover), %LC(live canopy cover), %DC(dead canopy cover), %GC(grass canopy cover), %FC(forb canopy cover), %WC(woody canopy cover), %BG(bare ground), %LtC(litter cover), LtD(litter depth)

Table 8. Mean vegetation characteristics values for whole mowed fields (Whl) and strip mowed fields (Strp) in Gratiot County, Michigan, 1994-5.

	May 1994			July 1994			Post-manipulation 1994			May 1995			July 1995			Post-manipulation 1995		
	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]	Con	Strp	P[a]
HC[b]	1.8	2.18	0.34	5.25	4.75	0.52	2.37	2.28	0.67	1.15	1.07	0.67	5.83	4.34	0.1	0.79	1.5	0.03
LH[b]	2.4	2.44	0.1	7.89	7.16	0.78	4.63	3.4	0.2	2.21	2.11	0.75	7.9	8.27	0.72	1.51	2.8	0.07
DH[b]	1.7	2.35	0.2	0.22	0.72	0.1				0.97	2.04	0.2	0	0	1			
%TC[b]	96	98.1	0.52	100	96	0.17				97.3	100	0.09	99.5	100	0.1			
%LC[b]	67	67.2	0.63	94	94	0.65	63.8	65.8	1	66.2	56.9	0.58	98.9	96.8	0.19	49.2	80.3	0.05
%DC[b]	2.81	7.34	0.07	0	1.3	0.07				1.85	2.18	0.94	0	0	1			
%GC[b]	38	51.7	0.2	46.6	55.7	0.36				32.3	44.7	0.2	45	62.3	0.27			
%FC[b]	28	15.3	0.11	47.8	36.2	0.2				31	11.7	0.15	54	34.7	0.27			
%WC[b]	0	0.02	0.63	0	0	1				0	0	1	0	0	1			
%BG[b]	4.2	1.9	0.52	0	0.12	0.65				2.75	1.53	0.21	0.14	0.42	1			
%LtC[b]	96	97.7	0.52	100	99.5	0.86				29.5	39.6	0.52	98.7	96.1	0.16			
LtD[b]	3.2	4.59	0.2	3.55	4.35	0.93	8.81	8.85	1	3.92	5.08	0.2	3.79	2.6	0.2	9.13	4.34	0.06

[a]Kruskal-Wallis one-way ANOVA, whole mowed fields vs strip mowed fields
[b]HC(horizontal cover), LH(live height), DH(dead height), %TC(total canopy cover), %LC(live canopy cover), %DC(dead canopy cover), %GC(grass canopy cover), %FC(forb canopy cover), %WC(woody canopy cover), %BG(bare ground), %LtC(litter cover), LtD(litter depth)

Avian Diversity

Comparisons between periods showed that avian diversity on whole mowed fields was significantly greater the second period (16 June - 15 July) than the third period (6 July - 15 August) (KW, $P < 0.06$) in both 1994 and 1995. Comparisons between treatments showed a significant difference between whole mowed fields and control fields in the second period (16 July - 15 August) (KW, $P < 0.06$) and third period (16 July - 15 August) (KW, $P < 0.01$), with greater diversities occurring on control fields in 1994. A significant difference was found between whole mowed fields and control fields in all 3 periods (KW, $P < 0.03$) in 1995, with control fields having more diversity. Comparisons between years found 1994 values to be significantly greater than 1995 in the third period (16 July - 15 August) (KW, $P = 0.06$) (Table 9).

Table 9. Mean avian diversities (Shannon-Weaver Index) on whole mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Whole mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	0.867 (0.3) AB[c] E[d]	1.34 (0.1)	0.15
	16 June - 15 July	1.008 (0.14) A[c] G[d]	1.576 (0.16)	0.055
	16 July - 15 August	0.485 (0.21) B[c] H[d]	1.562 (0.19)	0.01
1995	15 May - 15 June	0.465 (0.28) AC[c] F[d]	1.248 (0.05)	0.025
	16 June - 15 July	0.688 (0.23) A[c] G[d]	1.318 (0.03)	0.01
	16 July - 15 August	0.063 (0.02) C[c] H[d]	1.223 (0.18)	0.003

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs control fields.
[c]within whole mowed fields within years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within whole mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

Avian diversity on strip mowed fields was not significantly different between periods (KW, P > 0.2) in 1994 or 1995. A significant difference was found in 1994 between strip mowed fields and control fields in the first period (15 May - 15 June) (KW, P = 0.025) and second period (16 June - 15 July) (KW, P = 0.025), with control fields showing more diversity. A significant difference was found in 1995 between strip mowed fields and control fields in the second period (16 June - 15 July) (KW, P < 0.06) and third period (16 July - 15 August) (KW, P = 0.004), with control fields showing more diversity. Comparisons between years did not show any significant differences (KW, P > 0.1) (Table 10).

Table 10. Mean avian diversities (Shannon-Weaver Index) on strip mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Strip mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	0.797 (0.08) A[c] B[d]	1.248 (0.05)	0.025
	16 June - 15 July	0.803 (0.15) A[c] C[d]	1.318 (0.03)	0.025
	16 July - 15 August	0.585 (0.4) A[c] E[d]	1.223 (0.18)	0.149
1995	15 May - 15 June	0.74 (0.11) A[c] B[d]	1.213 (0.29)	0.109
	16 June - 15 July	0.46 (0.12) A[c] D[d]	1.137 (0.32)	0.055
	16 July - 15 August	0.595 (0.12) A[c] E[d]	1.528 (0.04)	0.004

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, strip mowed fields vs control fields.
[c]within strip mowed fields within years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within strip mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

No significant difference was found in 1994 in avian diversity between strip mowed fields and whole mowed fields in any period (KW, P > 0.2). In 1995, avian diversity was significantly greater on strip mowed fields than whole mowed fields in the third period (16 July - 15 August) (KW, P = 0.013) (Table 11).

Table 11. Mean avian diversities (Shannon-Weaver Index) on strip mowed fields and whole mowed fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Whole mowed[a]	Strip mowed[a]	Probability[b]
1994	15 May - 15 June	0.867 (0.3)	0.797 (0.08)	0.522
	16 June - 15 July	1.008 (0.15)	0.803 (0.15)	0.298
	16 July - 15 August	0.485 (0.21)	0.585 (0.4)	0.81
1995	15 May - 15 June	0.465 (0.28)	0.74 (0.11)	0.296
	16 June - 15 July	0.688 (0.23)	0.46 (0.12)	0.296
	16 July - 15 August	0.063 (0.02)	0.595 (0.12)	0.013

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs strip mowed fields.

Fifty-three percent of the birds seen were red-winged blackbirds. When this species was removed from the whole mowed field census counts and diversity was recalculated, significantly greater diversity was found in the second period (16 June - 15 July) than the third period (16 July - 15 August) in both 1994 and 1995 (KW, $P < 0.05$). Control fields had significantly more diversity than whole mowed fields in all periods in both years (KW, $P < 0.1$). Comparisons between years found significantly greater diversity in the third period (16 July - 15 August) in 1994 than 1995 (KW, $P < 0.06$) (Table 12).

When the same was done for strip mowed fields, no significant differences were found between periods (KW, $P > 0.1$). Control fields had significantly more diversity than strip mowed fields in 1995 (KW, $P < 0.04$). Comparisons between years found significantly greater diversity in the second period (16 June - 15 July) in 1994 than 1995 (KW, $P < 0.03$) (Table 13).

Table 12. Mean avian diversities (Shannon-Weaver Index) excluding red-winged blackbirds on whole mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Whole mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	0.682 (0.21) A[c] C[d]	1.172 (0.09)	0.092
	16 June - 15 July	0.772 (0.2) B[c] D[d]	1.668 (0.09)	0.005
	16 July - 15 August	0.292 (0.11) A[c] F[d]	1.445 (0.14)	0.004
1995	15 May - 15 June	0.283 (0.21) A[c] C[d]	1.05 (0.16)	0.022
	16 June - 15 July	0.445 (0.14) B[c] E[d]	1.38 (0.03)	0.004
	16 July - 15 August	0 (0) A[c] F[d]	1.222 (0.16)	0.002

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs control fields.
[c]within whole mowed fields, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within whole mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

Table 13. Mean avian diversities (Shannon-Weaver Index) excluding red-winged blackbirds on strip mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Strip mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	0.923 (0.07) A[c] B[d]	1.05 (0.16)	0.574
	16 June - 15 July	1.983 (6.18) A[c] C[d]	1.38 (0.04)	0.199
	16 July - 15 August	0.585 (0.49) A[c] E[d]	1.222 (0.16)	0.147
1995	15 May - 15 June	0.755 (0.19) A[c] B[d]	1.23 (0.14)	0.037
	16 June - 15 July	0.457 (0.13) A[c] D[d]	1.165 (0.11)	0.019
	16 July - 15 August	0.477 (0.1) A[c] E[d]	1.435 (0.04)	0.004

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, strip mowed fields vs control fields.
[c]within strip mowed fields, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within strip mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

Comparisons between strip mowed fields and whole mowed fields showed significantly greater diversity on strip mowed fields in the first (15 May - 15 June) and third (16 July - 15 August) periods in 1995 (KW, $P < 0.1$) (Table 14).

Table 14. Mean avian diversities (Shannon-Weaver Index) excluding red-winged blackbirds on whole mowed fields and strip mowed fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Whole mowed[a]	Strip mowed[a]	Probability[b]
1994	15 May - 15 June	0.682 (0.21)	0.923 (0.07)	0.336
	16 June - 15 July	0.772 (0.2)	1.983 (6.18)	0.2
	16 July - 15 August	0.292 (0.11)	0.585 (0.49)	0.442
1995	15 May - 15 June	0.283 (0.21)	0.755 (0.19)	0.096
	16 June - 15 July	0.445 (0.14)	0.457 (0.13)	0.565
	16 July - 15 August	0 (0)	0.477 (0.1)	0.007

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs strip mowed fields.

Avian Relative Abundance

Comparisons between periods on whole mowed fields in 1994 showed significantly greater avian relative abundance in the second period (16 June - 15 July) than the third period (16 July - 15 August) (KW, $P < 0.03$). In 1995, avian relative abundance on whole mowed fields was significantly different between the second and third periods (16 June - 15 July and 16 July - 15 August) (KW, $P < 0.08$), and the first and third periods (15 May - 15 June and 16 July - 15 August) (KW, $P < 0.03$), with the third period showing the least abundance. Abundances were significantly greater on control fields than whole mowed fields in all periods (KW, $P < 0.04$) in 1994. Control fields had significantly greater abundances than whole mowed fields in the second period (15 May - 15 June) (KW, $P < 0.03$) and third period (16 July - 15 August) (KW, P < 0.04) in 1995. Comparisons between years showed no significant differences (KW, P > 0.1) (Table 15).

Table 15. Mean avian relative abundances (birds/ha) on whole mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Whole mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	1.838 (1.02) AB[c] C[d]	4.135 (2.67)	0.037
	16 June - 15 July	2.565 (1.66) B[c] C[d]	5.701 (3.72)	0.006
	16 July - 15 August	1.055 (0.52) A[c] C[d]	4.471 (3.51)	0.006
1995	15 May - 15 June	2.575 (2.91) A[c] C[d]	2.508 (2.69)	0.873
	16 June - 15 July	1.442 (0.65) A[c] C[d]	3.552 (4.35)	0.025
	16 July - 15 August	0.653 (1.02) B[c] C[d]	3.594 (18.5)	0.036

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs control fields.
[c]within whole mowed fields within years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within whole mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

Comparisons between periods in 1994 on strip mowed fields found significant differences in avian relative abundance between the first and third periods (15 May - 15 June and 16 July - 15 August) and the second and third periods (16 June - 15 July and 16 July - 15 August) (KW, P < 0.04), with the lowest abundance in the third period. Avian relative abundance on strip mowed fields in 1995 was not significantly different between periods (KW, P > 0.3). Control fields had significantly greater abundances than strip mowed fields in the first period (15 May - 15 June) (KW, P < 0.04) in 1994. Strip mowed fields were not significantly different from control fields in any period (KW, P > 0.1) in 1995. Comparisons between years found abundances to be significantly greater in 1994 than 1995 in the first (15 May - 16 June) and second (16 June - 15 July) periods (KW, $P < 0.08$) (Table 16).

Table 16. Mean avian relative abundances (birds/ha) on strip mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Strip mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	4.653 (4.02) A[c] C[d]	2.508 (2.69)	0.037
	16 June - 15 July	5.57 (6.83) A[c] E[d]	3.552 (4.35)	0.150
	16 July - 15 August	1.767 (4.99) B[c] G[d]	3.594 (18.5)	0.200
1995	15 May - 15 June	2.722 (5.16) A[c] D[d]	3.659 (1.38)	0.109
	16 June - 15 July	2.447 (0.3) A[c] F[d]	3.365 (1.62)	0.200
	16 July - 15 August	2.333 (4.4) A[c] G[d]	3.251 (3.88)	0.423

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, strip mowed fields vs control fields.
[c]within strip mowed fields within years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within strip mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

In 1994, strip mowed fields had significantly greater abundances than whole mowed fields in the first period (15 May - 15 June) (KW, $P < 0.01$) and second period (16 June - 15 July) (KW, $P < 0.04$). In 1995, strip mowed fields had significantly greater abundances than whole mowed fields in the second period (16 June - 15 July) (KW, $P < 0.05$) and third period (16 July - 15 August) (KW, $P < 0.09$) (Table 17).

Table 17. Mean avian relative abundances (birds/ha) on strip mowed fields and whole mowed fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Whole mowed[a]	Strip mowed[a]	Probability[b]
1994	15 May - 15 June	1.838 (1.02)	4.653 (4.02)	0.01
	16 June - 15 July	2.565 (1.66)	5.57 (6.83)	0.037
	16 July - 15 August	1.055 (0.52)	1.767 (4.99)	0.749
1995	15 May - 15 June	2.575 (2.91)	2.722 (5.16)	0.873
	16 June - 15 July	1.442 (0.65)	2.447 (0.3)	0.045
	16 July - 15 August	0.653 (1.02)	2.333 (4.4)	0.087

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs strip mowed fields.

When red-winged blackbirds were removed from whole mowed field census counts and avian relative abundance was recalculated, significantly greater abundances were found on whole mowed fields in 1995 in the first period (15 May - 15 June) than the third period (16 July - 15 August) (KW, $P < 0.06$). Control fields had significantly higher relative abundance than whole mowed fields in the second period (16 June - 15 July) and third period (16 July - 15 August) in 1994 and in the third period (16 July - 15 August) in 1995 (KW, $P < 0.02$). Comparisons between years showed no significant differences (KW, $P > 0.1$) (Table 18).

Table 18. Mean avian relative abundance (birds/ha) excluding red-winged blackbirds on whole mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Whole mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	1.07 (0.45) A[c] C[d]	2.383 (1.64)	0.109
	16 June - 15 July	1.208 (0.83) A[c] C[d]	3.183 (1.08)	0.016
	16 July - 15 August	0.637 (0.09) A[c] C[d]	4.038 (2.79)	0.004
1995	15 May - 15 June	1.062 (0.51) A[c] C[d]	1.213 (0.32)	0.575
	16 June - 15 July	1.042 (0.92) A[c] C[d]	1.682 (0.47)	0.127
	16 July - 15 August	0.362 (0.21) B[c] C[d]	2.595 (3.59)	0.006

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs control fields.
[c]within whole mowed fields within years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within whole mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

When the same was done for strip mowed fields, significantly greater abundances were seen in the first (15 May - 15 June) and the second (16 June - 15 July) periods than in the third period (16 July - 15 August) in 1994 (KW, $P < 0.03$). Control fields had significantly higher abundances in the third period (16 July - 15 August) than strip mowed fields in 1994 (KW, $P < 0.01$), and in the first (15 May - 15 June) and second (16 June - 15 July) periods in 1995 (KW, $P < 0.04$). Comparisons between years found significantly higher abundances in the first (15 May - 15 June) and second (16 June - 15 July) periods in 1994 than 1995 (KW, $P < 0.05$) (Table 19).

Table 19. Mean avian relative abundance (birds/ha) excluding red-winged blackbirds on strip mowed fields and control fields in 1994 and 1995 in Gratiot County, Michigan.

		Field type		
Year	Birding period	Strip mowed[a]	Control[a]	Probability[b]
1994	15 May - 15 June	1.115 (0.17) A[c] C[d]	1.213 (0.32)	0.873
	16 June - 15 July	1.225 (0.31) A[c] E[d]	1.682 (0.47)	0.262
	16 July - 15 August	0.438 (0.19) B[c] G[d]	2.595 (3.59)	0.010
1995	15 May - 15 June	0.65 (0.08) A[c] D[d]	1.692 (1.27)	0.037
	16 June - 15 July	0.348 (0.08) A[c] F[d]	2.017 (2.19)	0.016
	16 July - 15 August	1.673 (2.08) A[c] G[d]	2.55 (2.38)	0.262

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, strip mowed fields vs control fields.
[c]within strip mowed fields within years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[d]within strip mowed fields between years, birding periods with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

When comparisons were done between whole mowed fields and strip mowed fields, excluding red-winged blackbirds, significantly greater abundances were found on whole mowed fields in the second period (16 June - 15 July) (KW, P = 0.05), and on strip mowed fields in the third period (16 July - 15 August) (KW, P = 0.05) in 1995 (Table 20).

Table 20. Mean avian relative abundance (birds/ha) excluding red-winged blackbirds on whole mowed fields and strip mowed fields in 1994 and 1995 in Gratiot County, Michigan.

Year	Birding period	Field type		Probability[b]
		Whole mowed[a]	Strip mowed[a]	
1994	15 May - 15 June	1.07 (0.45)	1.115 (0.17)	1
	16 June - 15 July	1.208 (0.83)	1.225 (0.31)	0.522
	16 July - 15 August	0.637 (0.09)	0.438 (0.19)	0.260
1995	15 May - 15 June	1.062 (0.51)	0.65 (0.08)	0.521
	16 June - 15 July	1.042 (0.92)	0.348 (0.08)	0.054
	16 July - 15 August	0.362 (0.21)	1.673 (2.08)	0.053

[a]sample variance in parenthesis.
[b]Kruskal-Wallis one-way ANOVA, whole mowed fields vs strip mowed fields.

A list of the avian species found on CRP fields, with scientific nomenclature, is included in Appendix III. The number of avian species found per treatment per period is in Appendix IV.

Avian Productivity

In 1994, 19 nests were found on whole mowed fields, all active (produced at least 1 egg), and 7 successful (fledged at least 1 young) (36.8%); 43 nests were found on control fields, 40 active, and 24 successful (60%). On strip mowed fields, 129 nests were found, 107 active, and 37 successful (34.6%); control fields had 181 nests, 132 active, and 55 successful (41.7%).

In 1995, 12 nests were found on whole mowed fields, all active, and 5 successful (41.7%); 181 were on control fields, 132 active, and 55 successful (41.7%). Strip mowed fields had 97 nests, 71 active, and 13 successful (18.3%); control fields had 116 nests, 100 active, and 44 successful (44%).

Control fields had significantly greater success than whole mowed fields

(KW, P < 0.03) in 1994, and than strip mowed fields (KW, P < 0.1) in 1995. The most common species found nesting in 1994 were red-winged blackbird, song sparrow, ring-necked pheasant, mallard, and blue winged teal; in 1995 they were red-winged blackbird, song sparrow, mallard, blue winged teal, eastern meadowlark, and vesper sparrow (Table 21).

Table 21. Number of active nests, successful nests, and percent of successful nests found on strip mowed fields, whole mowed fields, and control fields in 1994 and 1995 in Gratiot County, Michigan.

Year	Field type	# of active nests	# of successful nests	% successful[a]
1994	whole mowed	19	7	36.8 AD
	control	40	24	60 B
	strip mowed	107	37	34.6 CD
	control	132	55	41.7 C
1995	whole mowed	12	5	41.7 AD
	control	132	55	41.7 A
	strip mowed	71	13	18.3 BD
	control	100	44	44 C

[a]between field types within a year, % success results with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

When nest success data were combined by year and compared between treatments, control fields had significantly greater success than whole mowed fields (KW, P < 0.02) (Table 22).

Table 22. Mean nest success per field type combined by year on whole mowed fields, strip mowed fields, and control fields in Gratiot County, Michigan.

Field type	Mean nest success[ab]
whole mowed	0.206 (0.08) A
control	0.489 (0.03) B
strip mowed	0.294 (0.09) AC
control	0.419 (0.02) C

[a]between field types, nest success means with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[b]sample variances in parenthesis.

When red-winged blackbird counts were removed from the nesting data, 2 nests were found on whole mowed fields in 1994, both active and neither successful (0%); control fields had 13 nests, 6 active, and 3 successful (50%). Strip mowed fields had 5 nests, all active, and 2 successful (40%); control fields had 18 nests, 16 active, and 6 successful (37.5%).

In 1995, when red-winged blackbird counts were removed from the nesting data, no nests were found on whole mowed fields; control fields had 18 nests, 16 active, and 6 successful (37.5%). Strip mowed fields had 6 nests, 5 active, and 1 successful (20%); control fields had 18 nests, 16 active, and 1 successful (6%).

Control fields had significantly greater success than whole mowed fields in 1995 (KW, $P < 0.01$) without red-winged blackbirds (Table 23).

When nest success data without red-winged blackbirds were combined by year and compared between treatments, control fields had significantly greater success than whole mowed fields (KW, $P < 0.01$) (Table 24).

A list of the number of nests found per species per manipulation type is included in Appendix V.

Table 23. Number of active nests, successful nests, and percent of successful nests, excluding red-winged blackbirds, found on strip mowed fields, whole mowed fields, and control fields in 1994 and 1995 in Gratiot County, Michigan.

Year	Field type	# of active nests	# of successful nests	% successful[a]
1994	whole mowed	2	0	0 AC
	control	6	3	50 A
	strip mowed	5	2	40 AC
	control	16	6	37.5 A
1995	whole mowed	0	0	0 AD
	control	16	6	37.5 B
	strip mowed	5	1	20 AD
	control	16	1	6 A

[a]between field types within a year, % success results with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).

Table 24. Mean nest success excluding red-winged blackbirds per field type combined by year on whole mowed fields, strip mowed fields, and control fields in Gratiot County, Michigan.

Field type	Mean nest success[ab]
whole mowed	0 (0) A
control	0.36 (0.17) B
strip mowed	0.167 (0.15) A
control	0.193 (0.1) A

[a]between field types, nest success means with the same letter are not significantly different (KW multiple comparisons test, Miller 1980).
[b]sample variances in parenthesis.

DISCUSSION

Vegetation results will be discussed first, to establish field composition and structure by manipulation type. Avian diversity will then be tied to vegetation characteristics by manipulation, as will avian relative abundance and productivity.

Vegetation Characteristics

Whole mowed fields and strip mowed fields had more total canopy cover and litter cover than control fields; while control fields had greater proportions of horizontal cover, live and dead vegetation heights, dead canopy cover, and bare ground than whole mowed fields or strip mowed fields (Tables 6 and 7). Manipulated fields can therefore be described as having low, live vegetation, and unmanipulated fields as having tall, dead vegetation.

Whole mowed fields were annually mowed on average for 4 years prior to the initiation of the study, whereas strip mowed fields had no previous manipulation history. Over the 2 years of the study, whole mowed fields showed a decrease in horizontal cover and litter cover, and an increase in live canopy cover (Table 3). In the same time period, strip mowed fields had a decrease in horizontal cover; dead vegetation height, dead canopy cover, litter cover, and litter depth; and an increase in total canopy cover (Table 5).

These results indicate that mowing as a manipulation treatment directly affects the amount of litter and standing dead vegetation that remains on a field from year to year. By cutting down the standing dead vegetation, the horizontal structure of the field is reduced, and the amount of litter accumulating on the ground is decreased. The mowing changes the structure of the field by reducing the amount of leftover standing vegetation present at the beginning of the growing season, decreasing competition for space among the new growth and thereby increasing canopy cover. This supports conclusions made by earlier studies (Holecheck et al. 1982, Cornely et al. 1983, U.S. Dept. of Agriculture 1991).

Vegetation Characteristics and Avian Diversity

Diversity on whole mowed fields followed a consistent pattern in both years, with the greatest diversities in the middle of the field season and the lowest at the end of the year (Table 9). This corresponded with the peak breeding period, which occurred in the middle of the field season; and with young of the year fledging, which took place at the end of the season. Removing red-winged blackbirds from census totals reduced the diversity index on whole mowed fields, but analysis did not reveal different results (Tables 12).

Control fields were significantly more diverse in both years (Table 9). Ring-necked pheasants, savannah sparrows, common yellowthroats, and eastern meadowlarks were consistently found on control fields, but were absent from whole mowed fields (Appendix IV). Vegetation structure on control fields was taller, and composed of more dead vegetation and less litter cover than whole mowed fields (Table 6). These characteristics better fulfilled habitat requirements for these species than did whole mowed fields (Brewer et al. 1991).

Diversity decreased by half on whole mowed fields between 1994 and 1995, while staying constant on control fields. However, this may reflect the changes in fields sampled between 1994 and 1995 and not reflect manipulation effects, because 2 whole mowed fields were replaced between years.

Strip mowed fields had relatively constant levels of diversity (Table 10). When red-winged blackbirds were removed from census counts, diversity indices increased, and strip mowed fields were found to have greater diversity in 1994 than 1995 (Table 13). Total canopy cover was also greater in July 1995 (Table 5), which may have influenced the increase in diversity.

Control fields had higher levels of diversity than strip mowed fields with or without red-winged blackbirds, particularly in 1995 after the strip mowed fields had been manipulated for the first time (Tables 10 and 13). Ring-necked pheasants, common yellowthroats and northern harriers preferred unmanipulated fields, while waterfowl such as mallards, Canada geese, and blue-winged teal were more prevalent on strip mowed fields (Appendix IV). The greater proportion of litter cover on strip mowed fields would deter pheasants, yellowthroats, and harriers from utilizing these fields, while the reduced vegetation height on strip mowed fields would make them more attractive to waterfowl as feeding areas (Table 7) (Brewer et al. 1991).

Strip mowed fields had higher diversity levels than whole mowed fields in 1995, both with and without red-winged blackbirds (Tables 11 and 14). This was mainly due to the presence of waterfowl and ring-necked pheasants on strip mowed fields (Appendix IV). Post-manipulation variables were also higher on strip mowed fields in both 1994 and 1995 (Table 8). The greater availability of ground cover on strip mowed fields left on the field from the summer before would make them more attractive for these ground nesters than whole mowed fields.

Overall, control fields had greater diversity than either manipulation, and there was no consistent difference between the 2 types of mowed fields. Control fields had 5-8 unique species present. Whole mowed fields attracted 1-3 unique species compared to control fields; however strip mowed fields had 3-4 unique species, mostly waterfowl (Appendix IV). Diversity differences between whole mowed fields and strip mowed fields were due to northern cardinals, field sparrows, American woodcocks, and American robins on whole mowed fields, and the presence of mallards, Canada geese, blue-winged teals, tree and barn swallows, and eastern meadowlarks on strip mowed fields (Appendix IV).

Vegetation Characteristics and Avian Relative Abundance

Relative abundances on whole mowed fields were always lowest at the end of the summer (Table 15 and Appendix IV). The dispersing of young during the third birding period would account for the reduction of birds on the fields. Removing red-winged blackbirds shifted the period of greater abundance on whole mowed fields from the second period (16 June - 15 July) to the first period (15 May - 15 June), but significantly lower abundances were only recorded at the end of the field season (Table 18).

Control fields had greater abundance in both years (Table 15 and Appendix IV). Again, this reflects the difference in vegetation structure, as the whole mowed fields were comparatively deficient in horizontal cover and vegetation height (Table 6). When red-winged blackbirds were removed from census totals, the differences between control fields and whole mowed fields were reduced but not eliminated (Table 18).

The lowest abundances on strip mowed fields in 1994 occurred after manipulations took place in late July. The effect of the mowing was seen into the 1995 season, with abundance levels significantly lower in the first 2 periods in 1995 than they were in 1994 (Table 16 and Appendix IV). Horizontal cover, dead vegetation height, dead canopy cover and litter cover were all higher in 1994 (Table 5), and the change in vegetation characteristics reduced avian relative abundance. Results did not change when red-winged blackbirds were removed from census counts (Table 19).

Control fields had higher levels of relative abundance than strip mowed fields in 1994, but not in 1995 (Table 16 and Appendix IV). This could be due to the large number of red-winged blackbirds seen on strip mowed fields in 1994 (Appendix IV), for when this species is eliminated and relative abundance levels recalculated, control fields have significantly higher levels of abundance only in the third period in 1994 (Table 19). Removing red-winged blackbirds from censuses causes control fields to have greater abundances than strip mowed fields in the first and second periods of 1995 (Table 19). As control fields had more horizontal cover and dead canopy cover and taller vegetation height (Table 7), the grassland species prevalent on these fields would have found them more attractive than strip mowed fields.

Strip mowed fields had greater relative abundance than whole mowed fields in both 1994 and 1995 (Table 17 and Appendix IV). This is related to the greater numbers of red-winged blackbirds seen on strip mowed fields in both years (Appendix IV), for when relative abundance is recalculated without this species, strip mowed fields have greater abundance than whole mowed fields only in the third period in 1995, and whole mowed fields have greater abundance than strip mowed fields in the second period in 1995 (Table 20). Analysis of vegetation characteristics showed post-manipulation values to be higher on strip mowed fields in both years (Table 8), which would account for greater abundances on strip mowed fields in this period. The greater abundances seen on whole mowed fields compared to strip mowed fields in this one period may be a factor of the difference in field size (Table 1).

Overall, manipulated fields had less relative abundance than control fields, and strip mowed fields had greater relative abundance than whole mowed fields. Species common to manipulated and unmanipulated fields, such as red-winged blackbirds, sparrows, bobolinks, and sedge wrens, were in greater abundance on control fields, then on strip mowed fields. Whole mowed fields had 6 species represented by only one individual, whereas strip mowed fields had 4.

Previous reports have suggested that while vegetation manipulation may benefit wildlife, it is important to maintain enough cover on fields to sustain avian diversities and relative abundance levels (Schenk and Williamson 1991). These results indicate that whole mowed fields do not have adequate cover, and that strip mowed fields would be likely to support higher relative abundance levels in their place.

Vegetation Characteristics and Avian Productivity

Whole mowed fields had the fewest nests present of all fields types in both years, however nests were more likely to be active on whole mowed fields than on any other type of field. This could be due to nests being built in growing vegetation, and concealed better than nests built in dead vegetation. Only 3 species were observed nesting on whole mowed fields - red-winged blackbirds, vesper sparrows, and song sparrows (Appendix V).

Control fields had greater success than whole mowed fields in 1994 and in both years combined (Tables 21 and 22). Control fields had more standing dead vegetation and horizontal cover (Table 6), and provided more structure for nest building.

Removing red-winged blackbirds from whole mowed field nesting data left 1 vesper sparrow nest and 1 song sparrow nest. Annual removal of standing dead vegetation would greatly reduce nesting cover for ground nesting species found on other fields, such as waterfowl, ring-necked pheasants, northern harriers, bobolinks, and eastern meadowlarks (Appendix V). Control fields had higher nest success in 1995 and in both years combined (Tables 23 and 24).

Strip mowed fields were as successful as control fields in 1994, however after manipulations took place control fields were more successful (Table 21). Horizontal cover and standing dead vegetation on strip mowed fields were also reduced compared to control fields in this time period (Table 8), and these vegetation characteristics changes reduced nesting cover on strip mowed fields. Red-wing blackbirds were most prevalent on strip mowed fields, but song sparrows, field sparrows, mallards, ring-necked pheasants, blue-winged teals, and vesper sparrows used strip mowed fields (Appendix V). Species composition did not change significantly from 1994 to 1995, after manipulations occurred, but nest numbers were reduced (Table 21 and Appendix V).

Red-winged blackbirds made up all but 5 nests in 1994 and 6 nests in 1995 (Appendix V). Nest success without red-winged blackbirds on strip mowed fields was equivalent to control fields and whole mowed fields (Tables 23 and 24).

Comparisons between whole mowed fields and strip mowed fields showed that nest success was not different between manipulations (Tables 21 and 22). Vegetation characteristics were similar on both field types (Table 8), providing similar habitat and similar chance for success. Differences in cover remaining on a field from one year to the next, as shown by the greater post-manipulation values on strip mowed fields (Table 8), would account for the differences in species composition (Appendix V). Ground nesters would prefer the greater ground cover available on strip mowed fields left over from the year before.

Previous studies have shown that standing dead vegetation is an element of preferred nesting habitat, and that fields with high levels of standing dead vegetation have higher avian productivity levels than fields without (Cornely et al. 1983, Millenbah 1993). This study supports these conclusions, and if mowing is necessary for weed control, strip mowed fields may benefit avian populations more than whole mowed fields by providing more standing dead vegetation.

RECOMMENDATIONS

Results of this study indicate that mowing a field affects vegetation characteristics, avian diversity and relative abundance, and avian productivity. Manipulated fields have less horizontal cover and standing dead vegetation, more live vegetation, shorter plant height, reduced avian diversity and relative abundance, and a decline in the total numbers of nests on a field compared to unmanipulated fields.

These results show that unmanipulated fields provide vegetation composition and structure preferred by avian populations utilizing CRP fields in Gratiot County, Michigan. However, previous research has shown that leaving fields unmanipulated eventually results in decreased diversity and relative abundance (Millenbah 1993). To satisfy any requirements for weed control, and to help prevent this decline in avian communities, strip mowing is recommended as a manipulation. Strip mowing provides for more post-manipulation ground cover, greater avian relative abundance, and allows more nests on fields than whole field mowing. Avian diversity does not seem to be impacted more by one or the other manipulation.

While strip mowing may be more beneficial in providing habitat for avian communities initially, the long term impacts of strip mowing are not known, and the effects of strip mowing may change in a continuous annual program. Further research is required to determine if strip mowing provides preferred habitat for avian populations when compared to whole field mowing in the long run.

APPENDICES

Appendix I. Statistical evidence for the effect of field age on avian diversity and relative abundance.

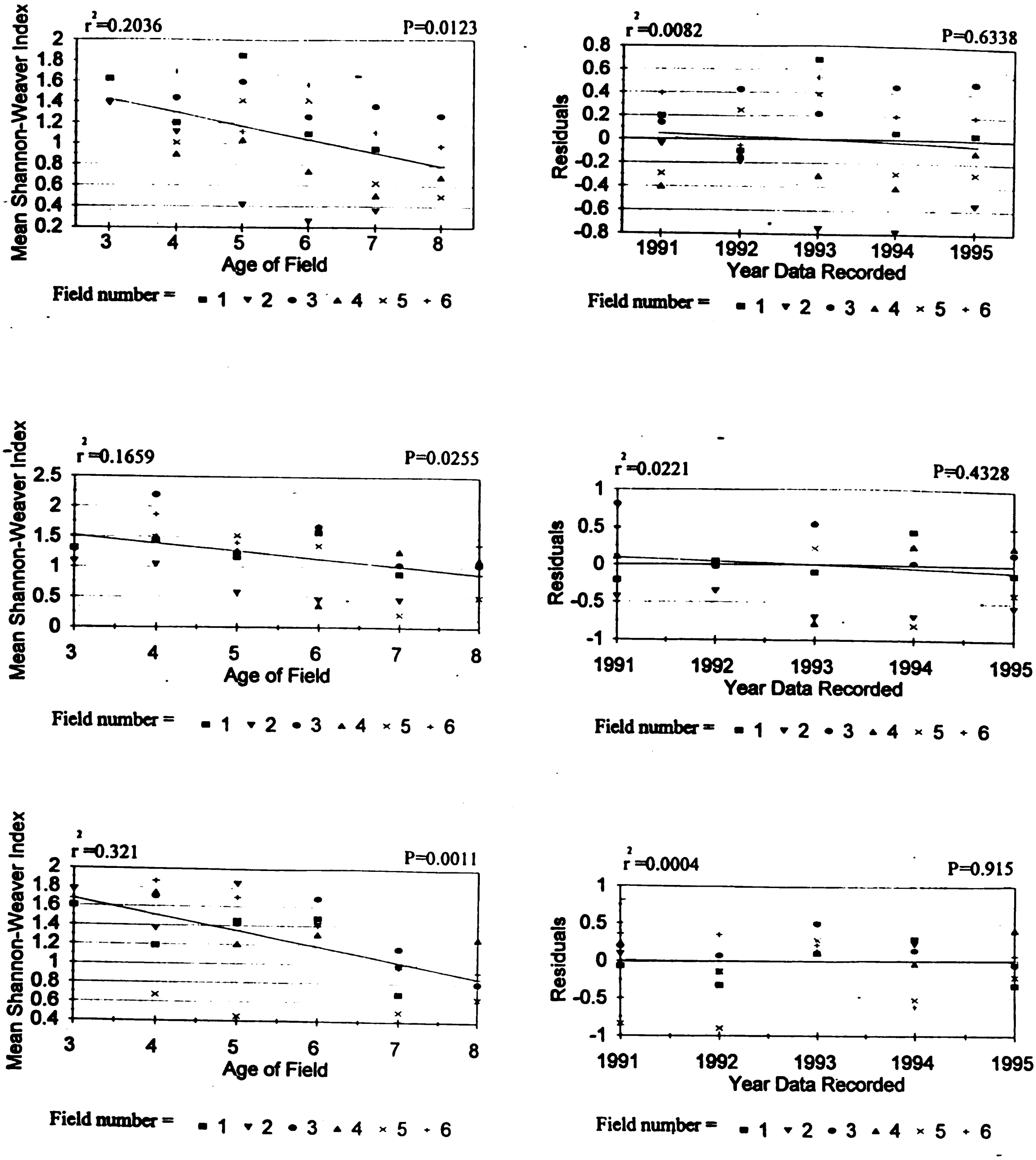

Figure 2. Diversity (Shannon-Weaver Index) regression analysis comparisons by field age and the year the data were recorded for the first, second, and third birding periods respectively.

Appendix I (con't.)

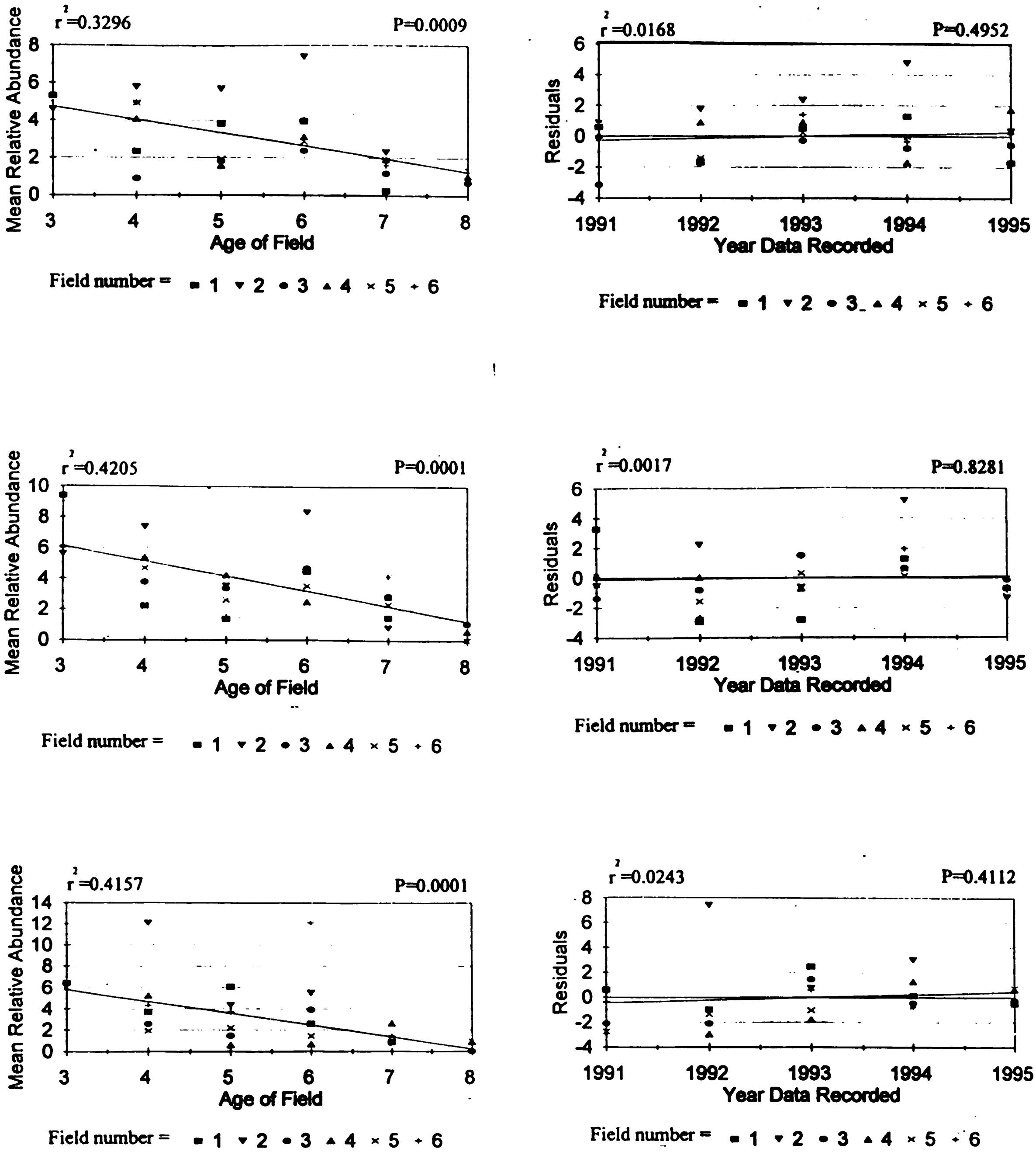

Figure 3. Relative abundance (birds/ha) regression analysis comparisons by field age and the year the data were recorded for the first, second, and third birding periods respectively.

Appendix II. Top 5 vegetation species per treatment in Gratiot County, Michigan, 1994-1995.

	1994	1995
whole mowed	orchard grass (*Dactlyis glomerata*) alfalfa (*Medicago sativa*) dandelion (*Taraxacum officinale*) red clover (*Trifolium pratense*) quack grass (*Agropyron repens*)	orchard grass dandelion alfalfa goldenrod (*Solidago* spp.) red clover
control for whole mowed fields	alafalfa dandelion orchard grass timothy grass (*Phleum pratense*) goldenrod	orchard grass alfalfa dandelion timothy grass Canadian thistle (*Cirsium arvense*)
strip mowed	quack grass alfalfa timothy grass orchard grass dandelion	orchard grass alfalfa dandelion Queen Anne's lace (*Daucus carota*) timothy grass
control for strip mowed fields	alafalfa dandelion orchard grass timothy grass goldenrod	orchard grass alfalfa dandelion timothy grass Canadian thistle

Appendix III. Bird species observed on Conservation Reserve Program fields in Gratiot County, Michigan, 1991-1995.

Species Code	Species	Scientific Name
AMGO	American Goldfinch	*Carduelis tristis*
AMRO	American Robin	*Turdus migratorius*
AMWO	American Woodcock	*Philohela minor*
BARS	Barn Swallow	*Hirundo rustica*
BOBO	Bobolink*	*Dolichonyx oryzivorus*
BWTE	Blue-winged Teal*	*Anas discors*
CAGO	Canada Goose	*Branta canadensis*
COBO	Common Bobwhite	*Colinus virginianus*
COGR	Common Grackle	*Quiscalus quiscula*
COYE	Common Yellowthroat	*Geothlypis trichas*
EAKI	Eastern Kingbird	*Tyrannus tyrannus*
EAME	Eastern Meadowlark	*Sturnella magna*
FISP	Field Sparrow*	*Spizella pusilla*
HOLA	Horned Lark	*Eremophila alpestris*
INBU	Indigo Bunting	*Passerina cyanea*
KILL	Killdeer	*Charadrius vociferus*
MALL	Mallard*	*Anas platyrhynchos*
MODO	Mourning Dove	*Zenaida macroura*
NOCA	Northern Cardinal	*Cardinalis cardinalis*
NOHA	Northern Harrier*	*Circus cyaneus*
RNPH	Ring-necked Pheasant*	*Phasianus colchicus*
RWBL	Red-winged Blackbird*	*Agelaius phoeniceus*
SASP	Savannah Sparrow*	*Passerculus sandwichensis*
SEWR	Sedge Wren*	*Cistothorus platensis*
SOSP	Song Sparrow*	*Melospiza melodia*
TRES	Tree Swallow	*Tachycineta bicolor*
UNID	Unidentified	
UNSP	Unidentified Sparrow*	
VESP	Vesper Sparrow*	*Pooecetes gramineus*

*nesting species

Appendix IV. Number of each avian species seen per treatment per census period in Gratiot County, Michigan, 1994 and 1995[a].

	1994			1995		
Field type	15 May- 15 June	16 June- 15 July	16 July-15 August	15 May- 15 June	16 June- 15 July	16 July-15 August
Whole mowed	27 rwbl* 12 bobo 10 unsp 9 sosp* 1 amro 1 amwo 1 unid	49 rwbl* 19 unsp 10 bobo 8 sosp* 2 sewr 1 rnph 1 noca 1 fisp	15 sewr 11 rwbl 4 vesp 1 unsp	34 rwbl* 12 sosp 9 bobo 2 unsp 1 fisp	17 rwbl* 10 bobo 3 unsp 2 sewr 2 amgo 2 eaki	7 rwbl 7 sewr 1 sosp
Control for whole mowed	135 rwbl* 83 sosp* 31 sewr* 17 sasp 14 bobo 6 rnph 4 unid 2 amgo 2 eame 1 coye	194 rwbl* 46 sosp* 28 unsp 28 sewr* 27 bobo 11 amgo 11 rnph 9 unid 5 eame 2 inbu 1 mall 1 amro 1 noha*	84 bobo 52 sasp 50 rnph 44 sewr 39 sosp 30 unsp 5 unid 3 coye 3 amgo	123 rwbl* 35 bobo 33 sosp 10 unsp* 4 sewr* 2 sasp 2 chsp 2 coye 1 eame 1 unid	178 rwbl* 38 sosp 32 unsp* 16 bobo 14 sewr* 13 sasp* 6 coye 5 rnph 2 vesp 2 eaki 1 amgo 1 eame 1 unid	68 sosp 56 bobo 38 rwbl 22 sasp 16 unsp 13 rnph 11 coye 10 sewr 6 hola 3 amgo 2 vesp 1 noha
Strip mowed	155 rwbl* 14 unsp 12 sosp* 5 mall* 5 bobo 5 sewr 2 rnph*	187 rwbl* 17 sewr* 8 amgo 7 bobo 7 unsp 3 sosp* 3 rnph* 2 bars 1 tres	64 rwbl 6 sewr 5 unsp 3 sosp 2 bobo 2 rnph 2 tres 1 amgo 1 vesp	101 rwbl* 8 fisp 4 bwte 4 bobo 4 sosp* 2 sewr 2 mall* 1 unsp 1 bars	86 rwbl* 4 sosp* 2 sewr 1 rnph 1 fisp 1 amgo 1 eame	29 bobo 22 rwbl 10 bwte 10 mall 6 sewr 3 cago 3 amgo 2 sosp 1 unid 1 fisp 1 rnph

Appendix IV (con't.)

Field type	1994 15 May-15 June	 16 June-15 July	 16 July-15 August	1995 15 May-15 June	 16 June-15 July	 16 July-15 August
Control for strip mowed	123 rwbl* 35 bobo 33 sosp 10 unsp* 4 sewr* 2 sasp 2 chsp 2 coye 1 eame 1 unid	178 rwbl* 38 sosp 32 unsp* 16 bobo 14 sewr* 13 sasp* 6 coye 5 rnph 2 vesp 2 eaki 1 amgo 1 eame 1 unid	68 sosp 56 bobo 38 rwbl 22 sasp 16 unsp 13 rnph 11 coye 10 sewr 6 hola 3 amgo 2 vesp 1 noha	182 rwbl* 42 sosp* 24 bobo* 22 sewr* 5 mall* 5 unsp 2 bwte 1 cobo 1 noha* 1 amgo 1 kill 1 vesp 1 cogr 1 coye 1 rnph	118 rwbl* 24 sewr* 23 rnph* 22 tres 21 bobo 8 unsp 8 sosp 5 coye 2 amgo 1 unid	69 bobo 55 rwbl 38 sosp 31 sewr 16 rnph 14 unsp 10 amgo 3 tres 2 coye 2 eame 1 sasp

[a]see Appendix III for species codes.
*nesting species.

Appendix V. Number of nests by species found per treatment in Gratiot County, Michigan, 1994 and 1995[a].

	number found and species	
Field type	1994	1995
whole mowed	17 rwbl	19 rwbl
	1 vesp	
	1 sosp	
control for whole mowed	30 rwbl	163 rwbl
	9 sosp	6 unsp
	2 sewr	4 mph
	1 noha	3 mall
	1 unid	2 sewr
		2 noha
		1 sasp
strip mowed	124 rwbl	91 rwbl
	2 sosp	2 sosp
	1 fisp	1 vesp
	1 mall	1 unsp
	1 mph	1 bwte
		1 mall
control for strip mowed	163 rwbl	92 rwbl
	6 unsp	8 mall
	4 mph	3 mph
	3 mall	2 sosp
	2 sewr	1 sewr
	2 noha	1 unsp
	1 sasp	1 bobo
		1 noha
		1 bwte

[a]see Appendix III for species codes.

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