



This is to certify that the

thesis entitled

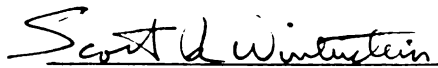
The Effects of Different Age Classes of Fields
Enrolled in the Conservation Reserve Program in
Michigan on Avian Diversity, Density and Productivity

presented by

Kelly F. Millenbah

has been accepted towards fulfillment
of the requirements for

Master of Science degree in Fisheries and Wildlife


Major professor

Date 11-6-93

**PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.**

DATE DUE	DATE DUE	DATE DUE
MAR 28 1996 IL 4400551		
MAY 19 1996		
JUN 09 1998 0812158 12		
MAY 19 1998		
MAY 19 1998		
081202 DEC 09 2001		
JUN 17 2009 010610		

MSU is An Affirmative Action/Equal Opportunity Institution

c:\circ\datedue.pm3-p.1

**THE EFFECTS OF DIFFERENT AGE CLASSES OF FIELDS
ENROLLED IN THE CONSERVATION RESERVE PROGRAM IN
MICHIGAN ON AVIAN DIVERSITY, DENSITY,
AND PRODUCTIVITY**

By

Kelly F. Millenbah

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

1993

ABSTRACT

THE EFFECTS OF DIFFERENT AGE CLASSES OF FIELDS ENROLLED IN THE CONSERVATION RESERVE PROGRAM IN MICHIGAN ON AVIAN DIVERSITY, DENSITY, AND PRODUCTIVITY

By

Kelly F. Millenbah

Agricultural landowners have enrolled lands in the Conservation Reserve Program (CRP) for wildlife and economic benefits. Avian communities and vegetative characteristics were examined on 6 age classes (1 - 6 growing seasons) of CRP fields in Gratiot County, Michigan in 1991 and 1992 to determine the relationships between field age and characteristics of avian communities. Younger CRP fields (1 - 3 growing seasons), characterized by forbs and bare ground, supported greater avian densities and diversities than older fields (4 - 6 growing seasons). Older CRP fields, characterized by grasses and high litter cover, supported greater avian productivity. Results indicate that grassland birds in Michigan may require a diversity of age classes of CRP fields in agricultural landscapes to meet their habitat requirements. Continued enrollment of lands into the program and periodic manipulation of these lands, will create a mosaic of grassland successional stages important to a diversity of avian species.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Michigan Agricultural Experiment Station; Federal Aid in Wildlife Restoration Project W-127-R administered by the Michigan Department of Natural Resources, Wildlife Division; Michigan Chapters of Pheasants Forever; and the Frank M. Chapman Foundation. Thanks are extended to R. Payne and S. Curtiss from the ASCS for assisting in locating study sites; J. Swanson from the SCS for valuable information pertaining to CRP contracts in Gratiot County; and to all the cooperating landowners in Gratiot County. Without the help from these people, this project would not have been successful.

I am indebted to my committee members and thank them for their knowledge and continued support throughout this process. To my major advisor Dr. Scott Winterstein, I extend my sincere thanks for accepting me into the program and for having confidence in my abilities. I am truly humbled by your wealth of knowledge and believe my knowledge base has grown ten-fold since I began. I truly appreciate your "mellowness" because without it I would have been a total basket case. To Dr. Rigue Campa, I thank you for your patience and support throughout this journey. I also thank

you for re-introducing me to the world's greatest stress reliever, running. To both Scott and Rique, thank you for your friendship. Finally, to Dr. Don Beaver, thank you for agreeing to get involved with this adventure and for all of your wisdom.

Special thanks are extended to L. Furrow and R. Minnis who were instrumental in the collection of data. This work would not have been completed without your help. I also thank interns S. Miller, J. Reedy, and K. O'Brien for their efforts in data collection. Thanks are also extended to volunteers M. Smith, J. Fierke, L. Neely, and D. Hyde.

To my parents, Richard and Ann, and my sister, Lisa, I thank you for your unending support, encouragement, and love throughout this entire process. Finally, to my best friend, Jon, for waiting so patiently and always believing in me.

TABLE OF CONTENTS

	<u>Page</u>
LIST OF TABLES.....	vi
LIST OF FIGURES.....	x
INTRODUCTION.....	1
OBJECTIVES.....	5
STUDY AREA.....	6
METHODS.....	9
Vegetative structure and composition.....	9
Avian density and diversity.....	12
Avian productivity.....	14
Insect abundance and diversity.....	16
Landowner attitudes and future land use intentions.....	17
RESULTS.....	19
Vegetative structure and composition.....	19
Summer.....	19
Vegetation frequency.....	19
Comparisons of vegetation variables among age classes.....	21
Comparisons of vegetation variables between months.....	27
Principal components analysis.....	30
Winter.....	34
Avian density and diversity.....	37
Summer.....	37
Avian diversities.....	37
Avian densities.....	40
Vegetation variables and avian densities and diversities.....	45
Comparison between 1991 and 1992...	58
Winter.....	59
Avian productivity.....	60
Insect abundance and diversity.....	63
Landowner attitudes and future land use intentions.....	68

	<u>Page</u>
DISCUSSION.....	71
Vegetative structure and composition.....	71
Summer.....	71
Patterns in vegetation variables as	
fields age.....	71
Principal components analysis.....	76
Winter.....	78
Avian density and diversity.....	79
Summer.....	79
Avian densities.....	79
Avian diversities.....	81
Winter.....	81
Avian productivity.....	82
Insect abundance and diversity.....	83
Landowner attitudes and future land use	
intentions.....	84
RECOMMENDATIONS.....	86
LITERATURE CITED.....	90
APPENDICES.....	95

LIST OF TABLES

<u>Number</u>		<u>Page</u>
1	Number of replicates of Conservation Reserve Program (CRP) fields in each age class (growing season) sampled in 1991 and 1992 in Gratiot County, Michigan.....	6
2	Mean number of plant species encountered on different age Conservation Reserve Program (CRP) fields in 1991 and 1992 in Gratiot County, Michigan.....	20
3	Mean number of forb species identified on different age Conservation Reserve Program (CRP) fields in 1991 and 1992 in Gratiot County, Michigan.....	20
4	Mean (SE) vegetative characteristics of 3-, 4-, and 5-year old Conservation Reserve Program (CRP) fields in May 1991 in Gratiot County, Michigan.....	22
5	Mean (SE) vegetative characteristics of 3-, 4-, and 5-year old Conservation Reserve Program (CRP) fields in July 1991 in Gratiot County, Michigan.....	24
6	Mean (SE) vegetative characteristics on 6 age classes of Conservation Reserve Program (CRP) fields in May 1992 in Gratiot County, Michigan.....	25
7	Mean (SE) vegetative characteristics on 6 age classes of Conservation Reserve Program (CRP) fields in July 1992 in Gratiot County, Michigan.....	28

8	Mean (SE) vegetative characteristics on 3-, 4-, and 5-year old Conservation Reserve Program (CRP) fields in winter 1992 in Gratiot County, Michigan.....	35
9	Mean (SE) vegetative characteristics on 6 age classes of Conservation Reserve Program (CRP) fields in winter 1993 in Gratiot County, Michigan.....	36
10	Mean avian diversities (Shannon-Weaver) and standard errors on 3-, 4-, and 5-year old Conservation Reserve Program (CRP) fields in spring-summer 1991 in Gratiot County, Michigan.....	38
11	Mean avian diversities (Shannon-Weaver) and standard errors on 1 - 6 year old Conservation Reserve Program (CRP) fields in spring-summer 1992 in Gratiot County, Michigan.....	39
12	Mean avian diversities (Shannon-Weaver) on different age Conservation Reserve Program (CRP) fields for the entire census period 1991 and 1992 in Gratiot County, Michigan.....	41
13	Mean avian densities (birds/ha) and standard errors on 3-, 4-, and 5-year old Conservation Reserve Program (CRP) fields in spring-summer 1991 in Gratiot County, Michigan.....	42
14	Mean avian densities (birds/ha) and standard errors on 1 - 6 year old Conservation Reserve Program (CRP) fields in spring-summer 1992 in Gratiot County, Michigan.....	43
15	Mean avian densities (birds/ha) on different age Conservation Reserve Program (CRP) fields for the entire census period 1991 and 1992 in Gratiot County, Michigan.....	45
16	Mean avian densities (birds/ha) on different age Conservation Reserve Program (CRP) fields in winter 1992 and 1993 in Gratiot County, Michigan.....	60

17	Mean number of active nests, successful nests (fledging at least one young), and percent successful nests monitored on different age Conservation Reserve Program (CRP) fields in spring-summer 1991 and 1992 in Gratiot County, Michigan.....	62
18	Mean insect biomass (g/10 sweeps) on 1 - 6 year old Conservation Reserve Program (CRP) fields in June, July, and August 1992 in Gratiot County, Michigan.....	64
19	Mean insect diversities (Shannon-Weaver) on 1 - 6 year old Conservation Reserve Program (CRP) fields in June, July, and August 1992 in Gratiot County, Michigan.....	66
20	Mean insect diversities (Shannon-Weaver) and mean insect biomass (g/10 sweeps) for the entire census period on 1 - 6 year old Conservation Reserve Program (CRP) fields in summer 1992 in Gratiot County, Michigan.....	67
21	Response (%) to selected reasons for enrolling land in the Conservation Reserve Program (CRP) by a survey of Gratiot County, Michigan CRP participants (n = 17), 1992.....	68
22	Response (%) to selected reasons affecting the choice of cover crop planted on Conservation Reserve Program (CRP) lands by a survey of Gratiot County, Michigan CRP participants (n = 17), 1992.....	70
A-1	Seed mixtures (kg/ha) of selected Conservation Reserve Program (CRP) contracts in Gratiot County, Michigan.....	95
A-2	Questionnaire used to determine cooperating landowner attitudes and future land use intentions of enrolled Conservation Reserve Program (CRP) lands.....	96
A-3	Plant species encountered on Conservation Reserve Program (CRP) fields in 1991 and 1992 in Gratiot County, Michigan.....	97

A-4	Avian species observed on Conservation Reserve Program (CRP) fields in spring-summer 1991 and 1992 in Gratiot County, Michigan.....	101
-----	---	-----

LIST OF FIGURES

<u>Number</u>		<u>Page</u>
1	Study area location, Gratiot County, Michigan.	7
2	Mean principal component (PC) values of the first 3 principal components for different age Conservation Reserve Program (CRP) fields May 1992 in Gratiot County, Michigan. Age classes correspond to the appropriate number located at each point.....	32
3	Diagrammatic representation of changes in vegetative structure and composition on a Conservation Reserve Program (CRP) field from 1 - 6 growing seasons.....	33
4	Mean avian diversities (Shannon-Weaver) for the entire census period in spring-summer 1992 on different age Conservation Reserve Program (CRP) fields plotted against mean vegetation variables on each field in each age class. Plotted numbers are the age classes sampled...	46
5	Mean avian densities (birds/ha) for the entire census period in spring-summer 1992 on different age Conservation Reserve Program (CRP) fields plotted against mean vegetation variables on each field in each age class. Plotted number are the age classes sampled....	52
A-1	Mean vegetation variables on 1 - 6 year old Conservation Reserve Program (CRP) fields in May 1992 in Gratiot County, Michigan. Vertical bars are ± 1 SE.....	103
A-2	Mean avian diversities (Shannon-Weaver diversity index) and densities (birds/ha) on 1 - 6 year old Conservation Reserve Program (CRP) fields over the entire census period spring-summer 1992 in Gratiot County, Michigan. Vertical bars are ± 1 SE.....	107

A-3 Mean avian densities (birds/ha) for the entire census period on 1 - 6 year old Conservation Reserve Program (CRP) fields in May 1992 in Gratiot County, Michigan excluding 1 field in the 4th growing season. Vertical bars are ± 1 SE. See text for additional discussion.....108

INTRODUCTION

For almost 4000 years the Northern Great Plains were dominated by perennial grasslands (Higgins et al. 1987). These native prairie habitats once occupied 3.6 million km² of North America (Ryan 1986). However, over the past 150 years many of the natural plant communities associated with these grasslands have been converted into croplands or modified for other socio-economic uses (Higgins et al. 1987). Habitat changes caused by specialization and intensification of agricultural practices have contributed to dramatic declines in wildlife populations (Berner 1988). The production of extensive monoculture fields (rowcrops and grains) has decreased the diversity of vegetation types within and among the home ranges of many wildlife species, and destroyed many critical habitats used by these species (Berner 1988).

Along with declining wildlife populations, increased soil erosion and deteriorating water quality have also been associated with changing land use practices (Schenck and Williamson 1991). In an attempt to decrease soil erosion, increase water quality, alleviate excess commodity production, and increase wildlife habitat, the federal

government initiated land retirement programs in the mid-1930's (Berner 1984, 1988). Under various land retirement programs, cropland was taken out of production and either left idle or planted to a cover crop. These programs provided varying amounts and qualities of wildlife habitat (USDA 1972, Erickson and Wiebe 1973, Berner 1984, Cutler 1984, Edwards 1984, Leedy 1987, Berner 1988).

The most recent land retirement program is the Conservation Reserve Program (CRP). The CRP provisions of the 1985 Food Security Act (Farm Bill) provide economic incentives to landowners to remove environmentally sensitive cropland from production for 10 years. An estimated 18 million ha of sensitive cropland will be taken out of production by 1995 and planted primarily to a grass-legume perennial cover. Past studies demonstrated that multi-year set-aside programs are generally better for wildlife than annual set-aside programs because of the quality of habitat produced (Higgins et al. 1987). Past multi-year programs provided quality wildlife habitat because they promoted unmowed, residual cover for wildlife use. Similarly, the CRP requires that a permanent cover crop be planted and maintained on fields.

Nationwide, grass or herbaceous vegetation accounts for 88% of all CRP cover types (Schenck and Williamson 1991). Higgins et al. (1987) stated that grasslands established with similar mixtures, as those used in CRP plantings,

generally did not maintain their structural qualities for more than 7 years. These grasslands reached their maximum height and density during the third through fifth growing seasons with structural qualities being reduced in subsequent years. Schenck and Williamson (1991) suggest that periodic disturbances of grasslands through carefully executed management practices, such as mowing and burning, can have a pronounced effect on the vigor and productivity of vegetation. Periodic disturbances have been shown to enhance wildlife populations in grassland habitats (Kirsch 1974, Kirsch et al. 1978). Cody (1985), in particular, found that the composition of avian species varies with vegetative structure following disturbances thus promoting a diversity of bird species.

It has been well documented that vegetative characteristics, structural features, and habitat size are important factors determining the diversity of avian species in terrestrial communities (Mac Arthur and Mac Arthur 1961, Karr 1968, Dwyer 1972, Kricher 1973, Tomoff 1974, Balda 1975, Forman et al. 1976, Galli et al. 1976, Mac Clintock et al. 1977, Whitcomb 1977). Individual species of animals respond to, and select habitats primarily on the basis of habitat structure (Anderson and Shugart 1974). For example, Cody (1968) found that grass height was the principal factor affecting habitat selection by birds in grassland habitats. As the structural complexity or heterogeneity of a

vegetation type increases, the number of animals present in a given area also increases (Rosenweig and Winakur 1969, Cody 1974, Wiens 1974, Willson 1974, Roth 1976, Gauthreaux 1978, Shugart et al. 1978).

Since the CRP is a relatively new program, little is known about the benefits of the program to wildlife. The CRP provides a unique opportunity to view the successional dynamics of undisturbed grasslands and associated changes in wildlife populations for 10 years. Avian communities, particularly nongame species, should provide insight into the quality of habitat provided by the CRP because avian species are excellent indicators of habitat quality and respond quickly to environmental changes (Graber and Graber 1976). Data on avian communities and vegetative structure and composition would provide insight into the age of CRP field that supports the greatest abundance and diversity of avian species.

Determining which age of CRP field supports the greatest abundance and diversity of avian species allows management recommendations to be made for the creation of this specific habitat type. Once created and maintained, these grassland habitats should increase the overall avian abundance and diversity in a landscape dominated primarily by less diverse agricultural monocultures.

OBJECTIVES

The main objective of this study was to determine the relationship of different age classes of CRP fields to avian relative abundance, diversity, and productivity.

Specifically, this study quantified vegetative structure and composition of various age classes of CRP fields and the associated changes in avian relative abundance, diversity, and productivity. The results of this study will be used to make recommendations for managing CRP lands for avian species.

STUDY AREA

Nineteen 6.5 - 20 ha study sites were delineated in Gratiot County, Michigan (Fig. 1) in 1992 with 12 fields delineated in 1991. Ten of the 12 fields from 1991 were represented in 1992 (Table A-1). Each CRP field was in the first through sixth growing season (age class) (Table 1), and was planted to introduced grasses and legumes. Seed mixtures (kg/ha) per field are given in Table A-1. All fields identified had not been mowed or burned since contract initiation.

Table 1. Number of replicates of Conservation Reserve Program (CRP) fields in each age class (growing season) sampled in 1991 and 1992 in Gratiot County, Michigan.

Age Class	1991	1992
1		3
2		3
3	3	3
4	8	3
5	1	6
6		1

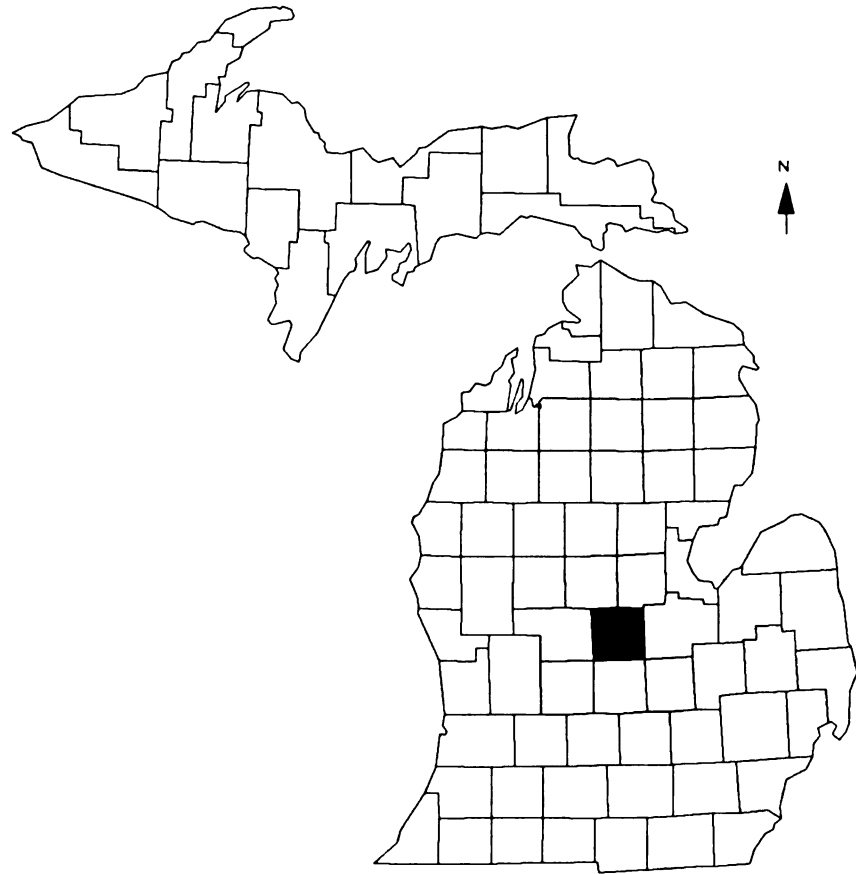


Fig. 1. Study area location, Gratiot County, Michigan.

Precipitation in Gratiot County is well distributed throughout the year but peaks during the summer months. Total annual precipitation averages 76.1 cm with 62% falling between April and September. Average seasonal snowfall is 105.9 cm (USDA 1975). Summer temperatures average 20.9 C while winter temperatures average -4.2 C (USDA 1975).

Approximately 83.4% of Gratiot County is in farmland. Corn and soybeans are the main crops in the county (USDA 1975).

Present topography and soil material are a result of glacial deposits and lake formations of the Wisconsin glacier. The western half of the county consists of a series of glacial moraines, tills, outplains, and channels (USDA 1975). The eastern half of the county is a level lake plain formed by the waters of a glacial lake (USDA 1975). Soil types of the selected study sites include Perrinton loam, Metamora-Capac sandy loam, Capac loam, and Ithaca loam.

METHODS

Vegetative Structure and Composition

Vegetative structure and composition data were collected along 6 permanent 100 m systematically-established transects in each field. Vegetation data were collected at 6 sampling points per line (every 20 m). Multiple sampling along each transect permitted the variance within fields to be estimated. Sampling occurred in April (pre-green up), May (peak avian breeding season), and July (peak growing season). April sampling was done immediately after snow melt to quantify the structural characteristics that CRP fields provide to birds during the winter months.

Horizontal cover was assessed 4 m from a Robel pole (Robel et al. 1970). Maximum height of living and standing dead vegetation were recorded at each sampling point. Percent canopy cover of live and dead vegetation; percent canopy cover of grasses, forbs, and woody vegetation; percent litter cover; and percent bare ground were assessed using a 50 x 50 cm Daubenmire frame (Daubenmire 1959). Frequency of herbaceous species occurring within the Daubenmire frame were recorded at each sampling point. Litter depth was also recorded at each sampling point. In winter, in addition to vegetation height and horizontal and

vertical cover, snow depth and percent snow cover of each field were estimated.

Relative frequencies of plant species were calculated for each CRP field. A Friedman's two-way analysis-of-variance (Siegel 1956) was used to test for differences in the relative frequencies of each plant species among fields within an age class. Failure to reject the null hypothesis would suggest that an age class of CRP field could be described by the dominant plant species present. The 5 plant species with the greatest relative frequencies on each field were included in the analysis. Blocking was done on the fields. A similar test was done with plant species grouped by similar structural qualities. Relative frequencies of species with similar structural characteristics (i.e. height, canopy, and shape) were combined and comparisons among fields within an age class were made. Failure to reject the null hypothesis would suggest that an age class of CRP field could be described by the structural qualities of the dominant plant species present.

Comparisons of vegetation variables among age classes were made using Kruskal-Wallis one-way analysis-of-variance (Siegel 1956). To determine which age classes were significantly different, with a significant Kruskal-Wallis result ($\alpha = 0.10$), the following multiple comparison (modified from Miller 1980) was used:

$$|\bar{R}_i - \bar{R}_{i'}| \leq (q_k^*) [k(kn+1)/12]^{1/2}$$

where $\bar{R}_i$ and $\bar{R}_{i'}$ are the ranked mean scores for the i and i' age classes, q_k is the studentized range value at $\alpha = 0.10$, k is the number of age classes, and n is the mean number of observations for all age classes. Mean values for each vegetation variable were plotted against field age to determine if a relationship exists between field age and the vegetation variables. Differences between vegetation on CRP fields in May and July were examined using a paired t-test (Ott 1988).

Principal components analysis (PCA) was used to examine relationships between field age and vegetative characteristics. Because vegetative variables that were measured may be related, PCA was used to reduce the number of variables to a few independent variables. The new variables, or principal components, were the linear combinations of the original vegetative variables. The linear combinations maximized the variance in the data and can be used to identify the original variables most significant in describing a particular age of CRP field. Analysis was done using a correlation matrix. Results were also used to determine if relationships exist among field age, vegetative characteristics, and avian densities and diversities.

Avian Density and Diversity

Bird census counts were conducted on each field from May - August to determine relative species abundance and diversity on different age classes of CRP fields. Census counts occurred from 15 May - 15 August in 1991. Counts occurred every 2 weeks except for the period of 15 May - 15 June which was censused once. Census counts occurred from 1 May - 15 August in 1992 with counts made every 2 weeks.

Censuses were made from transects established 25 m from a random corner of each field with subsequent lines every 50 m along the long axis of the field. Censuses were conducted from sunrise to 3 hours after sunrise. Counts were not made if it was raining, if wind speed was > 16 kph, or if it was < 0 C. Observers walked slowly along transect lines making frequent stops to scan for birds. Perpendicular distance from the transect line to all species seen or heard was recorded in 5 m increments up to 50 m. Distance of a bird to the nearest edge was also recorded. Gender was recorded whenever possible.

Avian species were also censused in January and February of each year to assess winter diversity and abundance on CRP lands. Bird census counts were conducted as stated previously; however, censuses occurred from mid-morning to mid-afternoon.

Comparisons of avian densities and diversities within an age class among birding periods and within a birding

period among age classes were made using Kruskal-Wallis one-way analysis-of-variance (Siegel 1956). The Kruskal-Wallis multiple comparison, mentioned previously, was used to determine which birding periods and age classes, respectively, were significantly different with a significant Kruskal-Wallis result ($\alpha = 0.10$). Friedman's two-way analysis-of-variance (Siegel 1956) was used to test for differences among age classes for avian densities and diversities over the entire sampling period. Blocking was done on the sampling periods. To determine which age classes were significantly different, with a significant Friedman result ($\alpha = 0.10$), the following multiple comparison (Miller 1980) was used:

$$|\bar{R}_i - \bar{R}_{i'}| \leq (q_k^\alpha)^{1/2} [k(k+1)/12n]^{1/2}$$

where $\bar{R}_i$ and $\bar{R}_{i'}$ are the ranked mean scores for the i and i' age classes, k is the number of age classes, q_k is the studentized range table value at $\alpha = 0.10$, and n is the number of birding periods. A Mann-Whitney U test (Siegel 1956) was used to compare avian densities and diversities within an age class between 1991 and 1992 and between the same fields between 1991 and 1992. Avian diversities were calculated using the Shannon-Weaver diversity index (Shannon-Weaver 1949).

A Spearman rank correlation (r_s ; Siegel 1956) was used to determine if a correlation exists between May 1992

vegetation variables and mean avian densities and diversities for the entire census period. No correlation was done with percent woody canopy due to the absence of woody vegetation in most age classes. Mean avian densities and diversities for the entire census period for each field in each age class and mean vegetation variables for each field in each age class were used for the correlation. May 1992 vegetation data were selected because spring vegetation is believed to be related to avian site selection (Brewer and Harrison 1975) and several different age classes of CRP fields were sampled in 1992.

Avian Productivity

Nest searches were conducted to quantify relative avian productivity and nesting success on different age classes of CRP fields. In 1991, 6 fields representing 2 age classes [3- (2 replicates) and 4-year old (4 replicates)] were searched in mid-June and again in mid-July. In 1992, 9 fields representing 3 age classes [1- (3 replicates), 4- (2 replicates), and 5-year old (4 replicates)] were searched in mid-May and mid-June. Searching times were changed in 1992 to obtain data during primary and secondary nesting periods.

Searches were conducted with 3 - 6 observers walking 1 - 2 m abreast until entire fields had been completely traversed. Nests were revisited every 2 - 3 days until the young had fledged or the nest was determined to be abandoned

or destroyed. Incidental discoveries were also monitored. Nesting species, nest outcome, and spherical densiometer readings (Lemmon 1956) were recorded for each nest. Spherical densiometer readings were made from the top of each nest only if eggs or young were present to assess percent vertical canopy cover above the nest. Densiometer readings were not recorded if eggs or young were not present during the monitoring period.

Percent nesting success for each age class of CRP field was calculated as follows:

$$\# \text{ successful nests} / \# \text{ active nests}$$

where a successful nest is defined as a nest that fledged at least one young and an active nest is defined as a nest having at least one egg or young within the monitoring period. Comparisons of percent nesting success among age classes in 1992 were made using Kruskal-Wallis one-way analysis-of-variance (Siegel 1956). A Mann-Whitney U test was used to test for differences between age classes in 1991 and to test for differences in the same fields between 1991 and 1992. A Mann-Whitney U test was also used to test for differences in spherical densiometer readings between successful and unsuccessful nests within an age class.

Insect Abundance and Diversity

Insects are considered an important food source for grassland birds which are generalized omnivores (Cody 1985). Insects were sampled to determine insect diversity and relative abundance on different age classes of CRP fields. Insects were collected in mid - August in 1991 on the 6 fields that were searched for nests. Insects were collected once each month from May - August on all fields in 1992. The sweepnet technique (Ruesink and Haynes 1973) was used to collect insects at 21 randomly located points per field with 10 sweeps per sampling point in 1992. Insects were collected at 6 randomly located points with 10 sweeps per sampling point in 1991. All insects were collected in daylight hours. Insects were identified to order, dried in a 60 C oven for 48 hours, and weighed to determine biomass.

Comparisons of insect biomass and insect diversities within an age class among months and within a month among age classes were made using Kruskal-Wallis one-way analysis-of-variance (Siegel 1956). The Kruskal-Wallis multiple comparison, mentioned previously, was used to determine which months and age class, respectively, were significantly different, with a significant Kruskal-Wallis result ($\alpha = 0.10$). Friedman's two-way analysis-of-variance was used to test for differences in insect diversity and biomass among age classes over the entire sampling period (Siegel 1956). Blocking was done on the months. The

Friedman's multiple comparison, mentioned previously, was used to determine which age classes were significantly different, with a significant Friedman result ($\alpha = 0.10$). Insect diversities were calculated using the Shannon-Weaver diversity index (Shannon and Weaver 1949).

Landowner Attitudes and Future Land Use Intentions

Questionnaires were mailed in August 1992 to all 19 cooperating CRP landowners to obtain information on their attitudes regarding the CRP and future land use intentions once CRP contracts expire. Knowledge of attitudes and future land use intentions provides valuable information for developing recommendations for managing CRP lands. No second mailing was required because of the good response to the initial mailing, with 17 of 19 questionnaires returned. Each landowner was mailed a cover letter, questionnaire (Table A-2), and a postage-paid return envelope. To assure landowner privacy and confidentiality of completed questionnaires, landowners were assigned a random number corresponding to each questionnaire. A master key of the numbers assigned was available only to the principal investigator with the key being destroyed 3 months after the initial mailing.

Questions were of 3 types: 2 questions required ranking of available choices, 2 questions required yes or no answers, and 1 question required respondents to chose an

answer which best described their situation. Specifically, landowners were asked to identify overall reasons for participating in the CRP, factors which contributed to their choice of cover crop planted, whether they believe the CRP has improved the quality of their land for wildlife use, what landowners intend to do with the property once contracts expire, and what landowners would require in land payments to keep their property in the CRP if contracts were extended. Percent response to each question was calculated.

RESULTS

Vegetative Structure and Composition

Summer

Vegetation frequency

Eighty-two plant species were encountered on 19 CRP fields, ranging from 1 - 6 growing seasons, in 1992. Sixty-six species were encountered on 12 CRP fields, representing 3 age classes, in 1991. A list of all plant species observed in 1991 and 1992 is given in Table A-3. In 1991, the mean number of plant species identified increased from 3- to 5-year old fields (Table 2). The number of plant species encountered in 1992 decreased from 1- to 4-year old fields, but increased in the fifth and sixth growing seasons (Table 2).

In 1991, the number of forb species identified declined with field age through the fourth growing season with an increase in the fifth growing season (Table 3). The high number of forbs encountered on the 5-year old field is likely an artifact of the field which was a mosaic of dry upland areas and low marsh areas. Younger CRP fields supported a greater number of forb species than older fields

Table 2. Mean number of plant species encountered on different age Conservation Reserve Program (CRP) fields in 1991 and 1992 in Gratiot County, Michigan.

Age Class	$\bar{x}$ # of Species (SE)	
	1991	1992
1		22(2.0)
2		21(6.8)
3	20(5.9)	18(2.3)
4	26(2.3)	16(3.9)
5	32	21(2.8)
6		27

Table 3. Mean number of forb species identified on different age Conservation Reserve Program (CRP) fields in 1991 and 1992 in Gratiot County, Michigan.

Age Class	$\bar{x}$ # of Forb Species (SE)	
	1991	1992
1		21.3(1.1)
2		19.3(6.3)
3	18.9(4.4)	14.0(6.7)
4	15.0(1.7)	13.0(3.5)
5	20.0	12.8(2.4)
6		20.0

in 1992 with the exception of the sixth growing season (Table 3). Again, the high number of forbs species on the 6-year old field, which is the same field as the 5-year old field in 1991, is likely an artifact of the field as explained previously.

Individual fields within each age class differed

(Friedman, $P < 0.10$) in the relative frequencies of plant species identified. Therefore, a particular age of CRP field could not be described by the composition of the dominant plant species. Similar results were obtained when species with similar structural qualities were grouped within a field and compared within an age class. Again, different age CRP fields could not be described by the structural qualities of the plant species.

Comparisons of vegetation variables among age classes

Several significant differences were found among age classes for vegetation variables in May 1991 and 1992 (Kruskal-Wallis (KW), $P < 0.10$). In 1991, significant differences among age classes were found for percent total canopy, percent dead canopy, and percent litter cover (Table 4). All other vegetation variables were not significantly different among age classes. Three-year old fields were significantly greater than 4-year old fields in percent total canopy. However, 3- and 4- year old fields were not significantly different from 5-year old fields in percent total canopy. There was significantly lower percent dead canopy on 4-year old fields than 5-year old fields while 3-year old fields were not significantly different from 4- or 5-year old fields in percent dead canopy. Percent litter cover was significantly different among age classes, however, use of a KW multiple comparison was unable to detect differences between age classes.

Table 4. Mean (SE) vegetative characteristics of 3-, 4-, and 5-year old Conservation Reserve Program (CRP) fields in May 1991 in Gratiot County, Michigan.

Characteristic	Age Classes [n]		
	3[3]	4[8]	5[1]
Horizontal cover (dm)	6.4(0.2)	5.2(0.5)	3.5
Live height (dm)	7.7(0.3)	6.8(0.7)	4.8
Dead height (dm)	3.9(0.4)	5.6(0.7)	4.6
% Total canopy*	101.9(7.1) ^A	78.9(1.5) ^B	83.8 ^{AB}
% Live canopy	74.6(7.4)	63.4(2.3)	55.6
% Dead canopy*	27.3(5.8) ^{AB}	15.6(1.5) ^A	27.9 ^B
% Grass canopy	50.3(5.8)	44.6(3.5)	39.8
% Forb canopy	27.9(3.8)	18.9(2.4)	15.8
% Woody canopy	<0.1(<0.1)	0.6(0.6)	0.1
% Litter cover*	10.7(1.2) ^A	21.2(2.8) ^A	12.1 ^A
% Bare ground	4.5(3.1)	5.8(1.8)	4.6

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$). Within the same row, means having the same letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

Percent total canopy was different among age classes (KW, $P < 0.10$) in July 1991 with cover on 3-year old fields greater than 5-year old fields (Table 5). No other age classes were significantly different in percent total canopy in July 1991. None of the other vegetative characteristics were significantly different (KW, $P > 0.10$) among age classes in July 1991.

Vegetative characteristics that were significantly different (KW, $P < 0.10$) among age classes in May 1992 include horizontal cover; percent total canopy, live canopy, dead canopy, and forb canopy; percent litter cover; percent bare ground; and litter depth (Table 6). One and 6-year old fields had significantly less horizontal cover than 4-year old fields. Also, 6-year old fields had significantly less percent total canopy than 2- and 4-year old fields while 1-year old fields had significantly less percent total canopy than 2-year old fields. One-year old fields had significantly less live canopy than 2-year old fields while 6-year old fields had significantly less percent live canopy than 2- and 4-year old fields. Four-year old fields had significantly greater percent dead canopy than 1-year old fields while 2-year old fields had significantly greater percent forb canopy than 3- and 6-year old fields. Four-year old fields had significantly greater percent litter cover than 1- and 2-year old fields and 1-year old fields

Table 5. Mean (SE) vegetative characteristics of 3-, 4-, and 5-year Conservation Reserve Program (CRP) fields in July 1991 in Gratiot County, Michigan.

Characteristic	Age Class [n]		
	3[3]	4[8]	5[1]
Horizontal cover (dm)	10.8(0.1)	9.3(0.9)	7.2
Live height (dm)	9.7(0.8)	8.9(0.6)	5.9
Dead height (dm)	2.4(0.2)	3.2(0.5)	2.2
% Total canopy*	99.0(1.8) ^A	92.2(1.8) ^{AB}	78.2 ^B
% Live canopy	92.4(2.9)	84.9(3.2)	71.8
% Dead canopy	6.6(0.6)	7.8(1.6)	6.4
% Grass canopy	60.5(6.8)	54.6(3.9)	38.4
% Forb canopy	48.3(3.5)	44.9(5.4)	39.3
% Woody canopy	0.0(0.0)	0.3(0.2)	1.1
% Litter cover	82.6(7.6)	82.9(5.8)	68.1
% Bare ground	11.6(7.6)	9.2(2.7)	9.4

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$). Within the same row, means having the same letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

Table 6. Mean (SE) vegetative characteristics on 6 age classes of Conservation Reserve Program (CRP) fields in May 1992 in Gratiot County, Michigan.

Characteristic	Age Class [n]					
	1[3]	2[3]	3[3]	4[3]	5[6]	6[1]
Horizontal cover (dm)*	2.5 ^A (0.4)	3.6 ^{AB} (0.6)	3.3 ^{AB} (0.3)	4.1 ^B (<0.0)	3.3 ^{AB} (0.2)	1.8 ^A
Live height (dm)	2.9 (0.5)	4.5 (0.9)	4.4 (0.5)	5.2 (0.2)	3.8 (0.4)	2.7
Dead height (dm)	7.4 (0.7)	9.2 (0.4)	9.2 (1.1)	9.4 (1.4)	9.3 (1.3)	9.1
% Total canopy*	55.1 ^{BC} (4.6)	84.3 ^A (1.5)	57.2 ^{ABC} (5.3)	82.8 ^{AC} (6.9)	63.2 ^{ABC} (2.0)	53.6 ^{BC}
% Live canopy*	51.4 ^{BC} (3.3)	74.6 ^A (1.6)	53.1 ^{AB} (5.6)	73.3 ^{AC} (5.6)	57.3 ^{AB} (2.3)	48.6 ^B
% Dead canopy*	3.9 ^A (0.9)	8.8 ^{AB} (0.5)	4.6 ^{AB} (1.1)	9.4 ^B (1.6)	5.9 ^{AB} (0.9)	5.0 ^{AB}
% Grass canopy	26.9 (4.2)	26.9 (11.1)	45.4 (7.8)	53.8 (2.6)	41.8 (3.5)	40.4
% Forb canopy*	29.1 ^{AB} (0.4)	54.8 ^A (10.6)	12.5 ^B (2.2)	28.4 ^{AB} (8.2)	21.3 ^{AB} (3.7)	11.7 ^B
% Woody canopy	0.0 (0.0)	0.8 (0.7)	<0.1 (<0.0)	0.0 (0.0)	0.2 (0.1)	0.1
% Litter cover*	25.6 ^A (12.2)	40.2 ^{AC} (3.4)	57.5 ^{BC} (3.8)	45.8 ^B (1.4)	54.6 ^{ABC} (2.3)	51.9 ^{ABC}
% Bare ground*	33.2 ^A (11.8)	7.1 ^A (2.7)	2.5 ^A (1.6)	2.2 ^A (1.2)	2.7 ^A (0.8)	1.8 ^A
Litter depth (cm)*	2.3 ^A (0.9)	3.1 ^{AB} (1.8)	11.3 ^B (3.2)	6.7 ^{AB} (1.1)	4.7 ^{AB} (0.8)	10.9 ^B

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$). Within the same row, means having the same letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

had significantly less percent litter cover than 3-year old fields. One-year old fields also had significantly less litter than 3- and 6-year old fields. Although a significant difference was found among age classes for percent bare ground, no differences were detected using a KW multiple comparison test. All other comparisons among age classes for a particular vegetative characteristic were not significantly different (KW, $P > 0.10$).

General patterns for horizontal cover, height of live vegetation, height of dead vegetation, percent total canopy, percent live canopy, percent dead canopy, and percent forb canopy, suggest an increase (but not necessarily significantly), with the exception of a decrease during the third growing season, from 1- to 4-year old fields in May 1992 (Figure A-1). These variables all decreased from the fourth through sixth growing seasons. Percent grass canopy increased, but not significantly, through the fourth growing season and decreased in subsequent years through the sixth growing season. Percent litter cover increased with field age, leveling off after the third growing season. Litter depth, however, reached a maximum during the third growing season, subsequently decreasing through the fifth growing season. Finally, percent bare ground decreased with field age from 1- to 6-year old fields in May 1992.

In July 1992, vegetative characteristics that were significantly different (KW, $P < 0.10$) among age classes

include percent grass canopy, percent forb canopy, and percent litter cover (Table 7). Using a KW multiple comparison, no differences were detected between age classes for percent grass canopy, however, 2-year old fields had significantly greater percent forb canopy than 4-year old fields. Also, 2-year old fields had significantly less percent litter cover than 3- and 6-year old fields. All other comparisons among age classes for a particular vegetative characteristic were not significantly different (KW, $P > 0.10$).

Comparison of vegetation variables between months

Vegetative characteristics that were significantly different (paired t-test, $P < 0.10$) between May and July 1991 include percent total canopy, percent live canopy, and percent grass canopy on 3-year old fields; and horizontal cover, live height, dead height, percent dead canopy, percent forb canopy, and percent litter cover on 3- and 4-year old fields. All other comparisons between vegetative characteristics within an age class in May and July on 3- and 4-year old fields were not significantly different (paired t-test, $P > 0.10$). No comparisons could be made between May and July 1991 for fields enrolled in 1986 (fifth growing season) due to the small sample size ($n = 1$).

Vegetative characteristics that increased, but not significantly, within each age class from May to July in 1991 include horizontal cover, height of live vegetation,

Table 7. Mean (SE) vegetative characteristics on 6 age classes of Conservation Reserve Program (CRP) fields in July 1992 in Gratiot County, Michigan.

Characteristic	Age Class [n]					
	1[3]	2[3]	3[3]	4[3]	5[6]	6[1]
Horizontal cover (dm)	6.7 (1.4)	7.3 (1.0)	6.9 (0.9)	9.0 (0.4)	6.1 (1.0)	6.2
Live height (dm)	9.1 (1.3)	11.1 (1.9)	8.2 (1.6)	11.3 (0.6)	9.5 (0.9)	9.0
Dead height (dm)	4.0 (1.8)	5.6 (1.0)	7.5 (1.5)	8.8 (0.3)	8.4 (1.0)	5.7
% Total canopy	74.7 (6.8)	96.8 (4.4)	92.8 (2.4)	92.5 (4.5)	84.1 (4.8)	78.3
% Live canopy	68.8 (6.6)	89.6 (4.3)	86.0 (2.5)	81.9 (4.8)	77.1 (4.9)	72.2
% Dead canopy	5.9 (0.4)	7.3 (0.7)	6.6 (1.9)	10.5 (0.3)	7.4 (0.7)	6.4
% Grass canopy*	27.6 ^A (6.9)	31.4 ^A (12.9)	62.0 ^A (6.0)	62.4 ^A (5.7)	50.9 ^A (5.3)	39.6 ^A
% Forb canopy*	50.5 ^{AB} (7.8)	64.9 ^A (9.3)	36.6 ^{AB} (6.2)	35.7 ^B (3.2)	41.7 ^{AB} (3.5)	42.5 ^{AB}
% Woody canopy	0.0 (0.0)	1.3 (1.3)	0.0 (0.0)	0.0 (0.0)	0.4 (0.3)	0.0
% Litter cover*	43.3 ^{AB} (15.5)	39.8 ^A (4.5)	86.9 ^B (10.0)	71.4 ^{AB} (8.8)	78.3 ^{AB} (7.7)	60.1 ^B
% Bare ground	33.4 (14.1)	10.1 (3.2)	2.5 (1.0)	4.3 (3.8)	4.1 (1.3)	3.5
Litter depth (cm)	1.3 (0.7)	2.1 (1.1)	5.6 (2.1)	3.4 (0.8)	3.2 (0.7)	3.8

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$). Within the same row, means having the same letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

percent live canopy, percent forb canopy, percent litter cover, and percent bare ground (Tables 4 and 5). Height of dead vegetation and percent dead canopy decreased within an age class for all age classes from May to July in 1991. Percent total canopy decreased between months on 3- and 5-year old fields and increased between months on 4-year old fields. Percent grass canopy decreased from May to July on 5-year old fields and increased on 3- and 4-year old fields while percent woody canopy decreased between months on 3- and 4-year old fields and increased on 5-year old fields.

In 1992, vegetative characteristics that were significantly different (paired t-test, $P < 0.10$) between May and July included horizontal cover on all age classes; height of live vegetation on 1-, 2-, 4-, and 5-year old fields; height of dead vegetation on 3-year old fields; percent total canopy and percent forb canopy on 1-, 3-, and 5-year old fields; percent live canopy on 1-, 3-, 4-, and 5-year old fields; percent litter cover on 1-, 2-, 3-, and 5-year old fields; percent bare ground on 5-year old fields; and litter depth on 1- and 2-year old fields. All other comparisons between vegetative characteristics within an age class in May and July were not significantly different (paired t-test, $P > 0.10$). No comparisons could be made between May and July 1992 for fields enrolled in 1986 (sixth growing season) due to the small sample size.

Vegetative characteristics that increased, but not

significantly, within each age class from May to July in 1992 included horizontal cover, height of live vegetation, percent total canopy, percent live canopy, and percent forb canopy. Percent dead canopy decreased from May to July on all age classes with the exception of an increase on 2-year old fields. Percent grass canopy increased from May to July on all age classes with the exception of a decrease on 6-year old fields. Likewise, percent litter cover increased from May to July on all age classes with the exception of a decrease on 2-year old fields. Percent bare ground also increased on all age classes from May to July, however, no change was noted between months on 3-year old fields. Percent woody canopy remained the same between months on 1- and 4-year old fields, increased on 2- and 5-year old fields, and decreased on 3- and 6-year old fields.

Principal components analysis

The first 3 principal components accounted for 81.5% of the variance in the vegetative variables in May 1992. Principal component 1 (PC 1), explaining 35.2% of the variance, is a gradient from percent total canopy and percent live canopy to percent litter cover and litter depth. It should be recognized that the components of percent total canopy include percent live canopy and percent dead canopy. Percent total canopy, however, does not include percent litter cover. Rather, percent total canopy, percent litter cover, and percent bare ground comprise the

total coverage within a Daubenmire frame. Therefore, it follows that as total canopy increases, litter cover decreases and vice versa.

The second principal component (PC 2), explained 32.5% of the variance and is a gradient from percent grass cover to percent forb cover. Finally, principal component 3 (PC 3), explaining 13.7% of the variance, is a gradient from percent bare ground to percent litter cover.

A plot of the mean principal component values, for the first 3 principal components, for each age of CRP field is given in Figure 2. One-year old fields are characterized by a moderate weighting toward litter cover, a high percent of forb canopy (PC 2), and greater bare ground to litter cover (PC 3). Two-year old fields are characterized by greater total canopy/live canopy to litter cover/litter depth (PC 1), greater litter cover than bare ground (PC 3), and a moderate percent of forb canopy (PC 2). Three-year old fields are also characterized by greater total canopy/live canopy to litter cover/litter depth (PC 1), moderate to high grass canopy (PC 2), and greater litter cover to bare ground (PC 3). Four-, 5-, and 6-year old fields are characterized by greater litter cover/litter depth than total canopy/live canopy, a moderate to high percent of grass canopy (PC 2), and greater litter cover to bare ground (PC 3). Figure 3 is a graphical representation of the changes in the measured vegetation variables as CRP fields age.

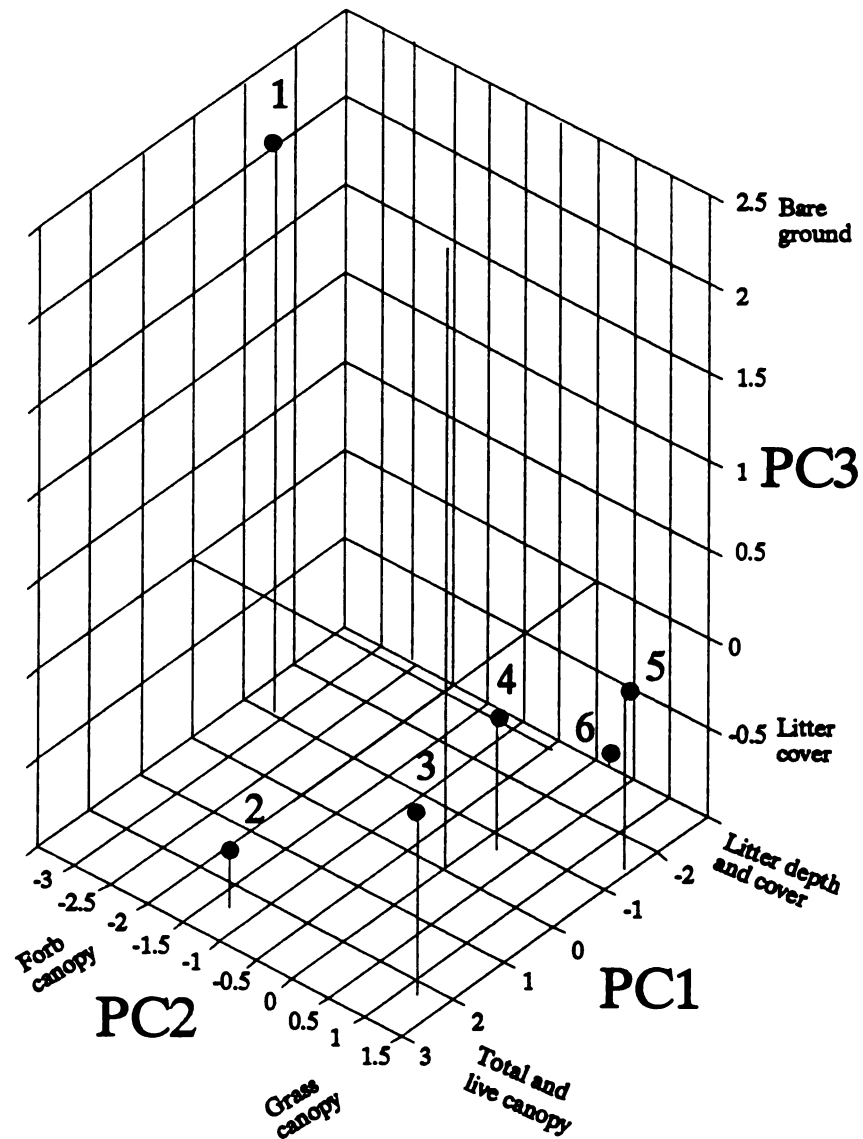


Fig. 2. Mean principal component (PC) values of the first 3 principal components for different age Conservation Reserve Program (CRP) fields in May 1992 in Gratiot County, Michigan. Age classes correspond to the appropriate number located at each point.

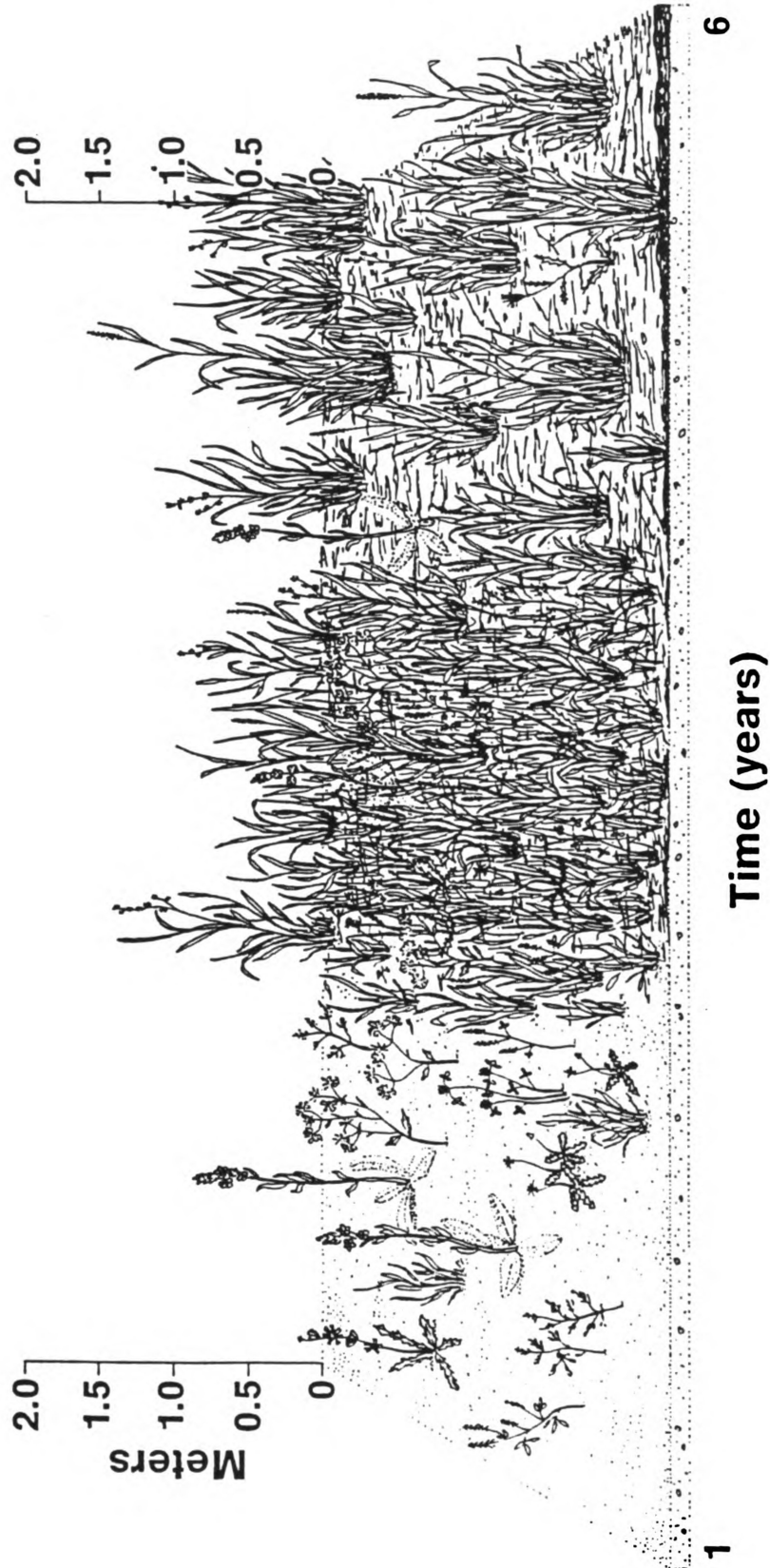


Fig. 3. Diagrammatic representation of changes in vegetative structure and composition on a Conservation Reserve Program (CRP) field from 1 - 6 growing seasons.

Winter

Vegetation variables that were significantly different among age classes in winter 1992 including height of live vegetation, percent live canopy, and percent grass canopy (KW, $P < 0.10$; Table 8). All other comparisons of vegetation variables among age classes were not significantly different. Four-year old fields had significantly less percent live canopy than 5-year old fields, however, no other age classes were significantly different from one another in percent live canopy in winter 1992. A KW multiple comparison test did not detect differences between age classes in height of live vegetation or percent grass canopy.

In winter 1993, percent live canopy, percent dead canopy, and percent forb canopy were significantly different (KW, $P < 0.10$) among age classes (Table 9). All other comparisons of vegetation variables among age classes were not significantly different. Three and 4-year old fields were significantly less than 6-year old fields in percent live canopy, while 1-year old fields were significantly greater than 3-year old fields in percent forb canopy. A KW multiple comparison test failed to detect differences in percent dead canopy among age classes.

Table 8. Mean (SE) vegetative characteristics on 3-, 4-, and 5-year old Conservation Reserve Program (CRP) fields in winter 1992 in Gratiot County, Michigan.

Characteristic	Age Class [n]		
	3[3]	4[6]	5[1]
Horizontal cover (dm)	1.8(0.3)	1.7(0.3)	1.2
Live height (dm)*	0.7(0.1) ^A	0.5(0.0) ^A	0.7 ^A
Dead height (dm)	9.3(0.6)	8.4(0.9)	8.2
% Total canopy	34.3(8.8)	30.2(8.1)	37.6
% Live canopy*	16.9(7.2) ^{AB}	5.1(1.2) ^A	19.2 ^B
% Dead canopy	22.9(8.0)	24.6(6.9)	20.1
% Grass canopy*	10.2(1.9) ^A	4.3(1.3) ^A	5.3 ^A
% Forb canopy	1.9(1.6)	0.8(0.3)	13.1
% Woody canopy	3.6(3.6)	<0.1(0.0)	0.1
% Litter cover	86.5(8.7)	88.3(7.7)	89.2
% Bare ground	5.3(2.5)	4.3(1.7)	2.8
Litter depth (cm)	4.9(1.2)	6.0(0.7)	5.1

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$). Within the same row, means having the same letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

Table 9. Mean (SE) vegetative characteristics on 6 age classes of Conservation Reserve Program (CRP) fields in winter 1993 in Gratiot County, Michigan.

Characteristic	Age Class [n]					
	1[3]	2[3]	3[3]	4[3]	5[5]	6[1]
Horizontal cover (dm)	2.3 (1.0)	2.3 (0.5)	1.9 (0.4)	2.5 (0.3)	2.6 (0.4)	1.2
Live height(dm)	0.7 (0.3)	0.6 (0.2)	0.4 (0.2)	0.4 (<0.1)	0.4 (0.1)	0.7
Dead height (dm)	3.4 (1.3)	5.4 (1.4)	2.9 (0.4)	4.6 (0.3)	4.5 (0.6)	4.1
% Total canopy	92.1 (5.4)	95.7 (1.9)	99.4 (0.3)	96.6 (1.6)	96.8 (2.1)	93.2
% Live canopy*	30.7 ^{AB} (8.8)	19.5 ^{AB} (12.6)	3.6 ^A (1.3)	3.4 ^A (0.9)	5.3 ^{AB} (0.7)	25.4 ^B
% Dead canopy*	37.7 ^A (8.2)	45.9 ^A (8.7)	54.1 ^A (19.4)	82.7 ^A (6.4)	84.5 ^A (6.7)	60.4 ^A
% Grass canopy	23.1 (11.3)	12.7 (9.6)	3.4 (1.5)	2.5 (0.4)	4.1 (1.2)	18.1
% Forb canopy*	11.7 ^A (1.9)	6.6 ^{AB} (6.1)	$<0.1^B$ (<0.1)	0.9 ^{AB} (0.7)	1.1 ^{AB} (0.9)	9.9 ^{AB}
% Woody canopy	0.0 (0.0)	<0.1 (<0.1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0
% Litter canopy	32.6 (3.3)	51.9 (16.2)	54.0 (19.8)	34.4 (3.0)	58.5 (9.5)	35.9
% Bare ground	8.1 (5.3)	4.2 (1.8)	0.6 (0.3)	3.2 (1.6)	0.9 (0.6)	6.8
Litter depth (cm)	3.8 (1.4)	4.2 (0.4)	6.8 (0.7)	4.6 (0.3)	5.0 (0.6)	3.0

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$). Within the same row, means having the same letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

Avian Density and Diversity

Summer

A total of 32 avian species were encountered on 19 CRP fields, ranging from 1 - 6 growing seasons, in 1992.

Twenty-two species were encountered on 12 CRP fields, representing 3 age classes, in 1991. A list of all avian species observed in 1991 and 1992 is given in Table A-4.

The most common species encountered in both years were red-winged blackbirds (*Agelaius phoeniceus*), song sparrows (*Melospiza melodia*), bobolinks (*Dolichonyx oryzivorus*), and sedge wrens (*Cistothorus platensis*).

Avian diversities

No significant differences were found in either 1991 or 1992 in bird diversities within an age class among the birding periods (KW, $P > 0.10$; Table 10 and 11, respectively). In 1991, a significant difference was found in the period 1 July - 15 July (period 5) among age classes (KW, $P < 0.10$), with 4-year old fields having significantly greater bird species diversity than 5-year old fields. Three-year old fields were not significantly different from 4- or 5-year old fields in period 5. All other comparisons of avian diversities within a period among age classes were not significantly different in 1991 (Table 10). No significant differences in avian diversities were detected in 1992 within a birding period among age classes (KW, $P > 0.10$; Table 11).

Table 10. Mean avian diversities (Shannon-Weaver) and standard errors on 3-, 4- and 5-year old Conservation Reserve Program (CRP) fields in spring-summer 1991 in Gratiot County, Michigan.

Age Class [n]	Birding Period						
	1 ^a	2	3	4	5 [*]	6	7
3[3]	NDC ^b	NDC	1.26 ^c (0.3)	1.20 (<0.1)	1.34AB ^d (<0.1)	1.49 (0.2)	1.72 (0.1)
4[8]	NDC	NDC	1.30 ^c (0.1)	1.55 (0.1)	1.48A (0.1)	1.48 (0.1)	1.15 (0.2)
5[1]	NDC	NCD	0.45 ^c	1.48	0.50B	1.33	1.33

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$).

^a period 1 = 1 May - 15 May, period 2 = 16 May - 31 May, period 3 = 1 June - 15 June, period 4 = 16 June - 30 June, period 5 = 1 July - 15 July, period 6 = 16 July - 31 July, and period 7 = 1 August - 15 August.

^b no data collected.

^c combined avian diversities for periods 2 and 3.

^d within a column, means with the same upper case letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

Table 11. Mean avian diversities (Shannon-Weaver) and standard errors on 1 - 6 year old Conservation Reserve Program (CRP) fields in spring-summer 1992 in Gratiot County, Michigan.

Age Class [n]	Birding Period						
	1 ^a	2	3	4	5	6	7
1[3]	1.23 (0.2)	1.46 (0.2)	1.15 (0.3)	1.46 (0.2)	1.65 (0.1)	1.32 (0.1)	1.34 (0.1)
2[3]	1.11 ^b	1.49 (0.1)	1.40 (0.2)	1.23 (0.5)	1.39 (0.1)	1.61 (0.3)	1.11 (0.3)
3[3]	1.73 (0.2)	1.07 (0.2)	1.38 (0.2)	1.31 (0.2)	1.39 (0.2)	1.09 (0.2)	1.01 (0.2)
4[3]	1.05 (0.1)	1.04 (0.1)	1.13 (0.2)	1.24 (0.1)	1.36 (0.1)	1.21 (0.1)	1.21 (0.1)
5[6]	1.18 (0.1)	1.18 (0.1)	0.77 (0.1)	1.15 (0.1)	1.35 (0.2)	1.15 (0.2)	1.07 (0.2)
6[1]	2.08	1.08	NDC ^c	1.11	1.13	0.68	1.05

^a period 1 = 1 May - 15 May, period 2 = 16 May - 31 May, period 3 = 1 June - 15 June, period 4 = 16 June - 30 June, period 5 = 1 July - 15 July, period 6 = 16 July - 31 July, and period 7 = 1 August - 15 August.

^b only one field sampled in this period and age class.

^c no data collected.

Mean avian diversities declined for the entire census period from 3- to 5-year old fields in 1991, however, no significant differences were found among age classes (Friedman, $P > 0.10$; Table 12). Diversities for the entire census period in 1992 declined from 1- to 5-year old fields with a slight increase after the fifth growing season (Table 12 and Figure A-2). Mean avian diversities were significantly different (Friedman, $P < 0.10$) for the entire census period among age classes in 1992. However, use of a Friedman multiple comparison was unable to detect differences between age classes.

Avian densities

In 1991, a significant difference was found in avian densities within 3-year old fields among the different birding periods (KW, $P < 0.10$; Table 13). A KW multiple comparison test failed to detect differences among the birding periods within 3-year old fields. No significant differences (Kruskal-Wallis, $P > 0.10$) were found within 4- and 5-year old fields among the birding periods in 1991.

Several significant differences were found in avian densities within a birding period among the different age classes in 1991 (KW, $P < 0.10$; Table 13). Five-year old fields had significantly lower bird densities than 3- and 4-year old fields and 3-year old fields had significantly greater bird densities than 4-year old fields in the periods 16 June - 30 June (period 4) and 16 July - 31 July (period

Table 12. Mean avian diversities (Shannon-Weaver) on different age Conservation Reserve Program (CRP) fields for the entire census period 1991 and 1992 in Gratiot County, Michigan.

Age Class	$\bar{x}$ Diversities (SE)	
	1991	1992*
1		1.37(0.07)
2		1.36(0.10)
3	1.40(0.07)	1.28(0.08)
4	1.39(0.06)	1.18(0.04)
5	1.02(0.22)	1.15(0.06)
6		1.19(0.19)

* significantly different among age classes (Friedman, $P < 0.10$). Use of Friedman's multiple comparison test failed to detect differences among age classes.

6). In the period 1 July - 15 July (period 5), 3-year old fields had significantly greater bird densities than 5-year old fields, but 3-year old fields were not significantly different from 4-year old fields. Four-year old fields were not significantly different from 5-year old fields in period 5. All other comparisons within a period among age classes were not significantly different (KW, $P > 0.10$).

No significant differences were found in avian densities within an age class among birding periods in 1992, except for 5-year old fields (KW, $P < 0.10$; Table 14), where the period of 16 June - 30 June (period 4) had significantly greater bird densities than the periods 16 May - 31 May (period 2), 16 July - 31 July (period 6), and 1 August - 15

Table 13. Mean avian densities (birds/ha) and standard errors on 3-, 4- and 5-year old Conservation Reserve Program (CRP) fields in spring-summer 1991 in Gratiot County, Michigan.

Age Class [n]	Birding Period						
	1 ^a	2	3	4 ^{**}	5 ^{**}	6 ^{**}	7
3[3] [*]	NDC ^b	NDC	4.61 ^c (0.5)	6.93A ^d (0.4)	6.11A (0.5)	7.19A (0.5)	5.29 (1.4)
4[8]	NDC	NDC	3.00 ^c (0.4)	4.07B (1.2)	3.77AB (0.5)	3.43B (0.9)	3.48 (0.3)
5[1]	NDC	NDC	0.62 ^c	1.95C	0.52B	0.52C	0.62

* significantly different (Kruskal-Wallis, $P < 0.10$) among periods. Use of Kruskal-Wallis multiple comparison test failed to detect differences among birding periods.

** significantly different among age classes (Kruskal-Wallis, $P < 0.10$).

a period 1 = 1 May - 15 May, period 2 = 16 May - 31 May, period 3 = 1 June - 15 June, period 4 = 16 June - 30 June, period 5 = 1 July - 15 July, period 6 = 16 July - 31 July, and period 7 = 1 August - 15 August.

b no data collected.

c combined avian densities for periods 2 and 3.

d within a column, means with the same upper case letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

Table 14. Mean avian densities (birds/ha) and standard errors on 1 - 6 year old Conservation Reserve Program (CRP) fields in spring-summer 1992 in Gratiot County, Michigan.

Age Class [n]	Birding Period						
	1 ^a	2	3	4	5	6	7 ^{**}
1[3]	2.52 (0.8)	1.87 (0.3)	3.15 (1.0)	6.31 (3.5)	3.20 (0.9)	7.04 (6.0)	5.63AB ^d 2.8
2[3]	2.35 ^b	3.48 (0.4)	3.99 (1.7)	4.84 (3.4)	3.39 (0.7)	3.52 (1.7)	3.53A (1.8)
3[3]	2.84 (0.5)	2.03 (0.9)	3.35 (1.1)	3.59 (1.1)	3.84 (2.0)	5.93 (1.8)	1.48AB (0.6)
4[3]	3.31 (1.1)	3.80 (1.0)	4.79 (1.8)	4.64 (1.5)	4.04 (1.7)	6.71 (2.7)	5.35A (0.8)
5[6]*	2.61 (0.4)	1.89 (0.2)	3.29 (0.2)	4.58 (0.8)	2.28 (0.5)	1.86 (0.5)	1.63AB (0.4)
6[1]	1.65	0.72	NFA ^c	1.24	0.72	0.51	0.41B

* significantly different (Kruskal-Wallis, $P < 0.10$) among periods. Period 4 significantly different from periods 2, 6, and 7.

** significantly different among age classes (Kruskal-Wallis, $P < 0.10$).

a period 1 = 1 May - 15 May, period 2 = 16 May - 31 May, period 3 = 1 June - 15 June, period 4 = 16 June - 30 June, period 5 = 1 July - 15 July, period 6 = 16 July - 31 July, and period 7 = 1 August - 15 August.

b only one field sampled in this period and age class.

c no field available.

d within a same column, means with the same upper case letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

August (period 7). Only the period of 1 August - 15 August (period 7) was significantly different in avian densities among age classes (KW, $P < 0.10$), with 6-year old fields having significantly lower avian densities than 2- and 4-year old fields.

In 1991, avian densities declined from 3- to 5-year old fields for the entire census period (Table 15). Densities for the entire census period in 1992 declined with field age with the exception of an increase in the fourth age class (Table 15 and Figure A-2). However, the unusually high mean density observed on 4-year old fields in 1992 is attributable to one field. In particular, this field supported a greater number of red-winged blackbirds. However, no factors have been identified that can adequately explain the unusually high density of birds on the field. If this field is removed from calculations, the density for 4-year old fields is 3.38 birds/ha. A graph with the new value is given in Figure A-3.

Mean avian densities were significantly different for the entire census period among age classes in 1991 and 1992 (Friedman, $P < 0.10$; Table 15). Three-year old fields had significantly greater avian densities than 4- and 5-year old fields and 4-year old fields had significantly greater avian densities than 5-year old fields. In 1992, 6-year old fields had significantly lower avian densities than 1-, 2-, 3, and 4-year old fields. No other fields differed

Table 15. Mean avian densities (birds/ha) on different age Conservation Reserve Program (CRP) fields for the entire census period 1991 and 1992 in Gratiot County, Michigan.

Age Class	$\bar{x}$ Densities (SE)	
	1991*	1992*
1		4.24(1.01)B
2		3.72(0.63)B
3	6.03(0.38)A ^a	3.30(0.50)B
4	3.55(0.26)B	4.67(0.57)B ^b
5	0.85(0.28)C	2.37(0.20)AB
6		0.88(0.19)A

* significantly different among age classes (Friedman, $P < 0.10$).

^a within a column, means with the same upper case letter are not significantly different (Friedman's multiple comparison, $\alpha = 0.10$, Miller 1980).

^b mean density = 3.38 birds/ha with one field not included. See text for additional discussion.

significantly from one another in 1992.

Vegetation variables and avian densities and diversities

Plots of mean avian diversities for the entire census period for each field in each age class against May 1992 vegetation variables suggest no correlation exists between avian diversities and vegetation variables (Spearman rank correlation, r_s , $-0.37 \leq r_s \leq 0.32$, $P > 0.10$; Fig. 4). However, moderate correlations are evident in mean avian densities when plotted against percent live canopy ($r_s = 0.41$, $P = 0.08$; Fig. 5) and percent litter cover ($r_s = -0.41$, $P = 0.08$; Fig. 5). Correlations were further

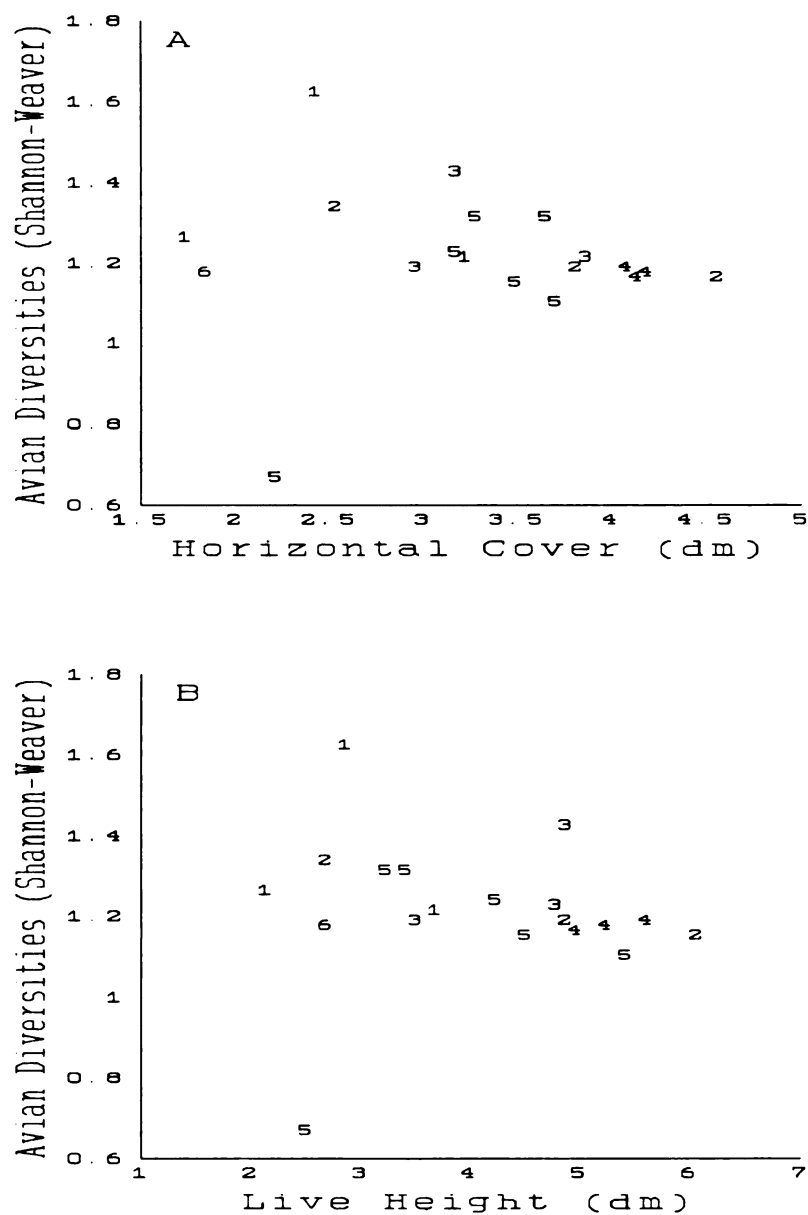


Fig. 4. Mean avian diversities (Shannon-Weaver) for the entire census period in spring-summer 1992 on different age Conservation Reserve Program (CRP) fields plotted against mean vegetation variables on each field in each age class. Plotted numbers are the age classes sampled.

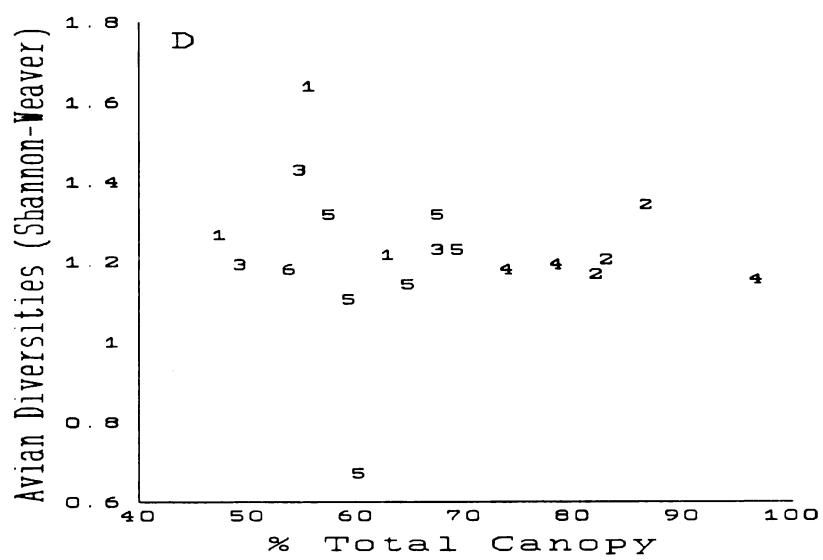
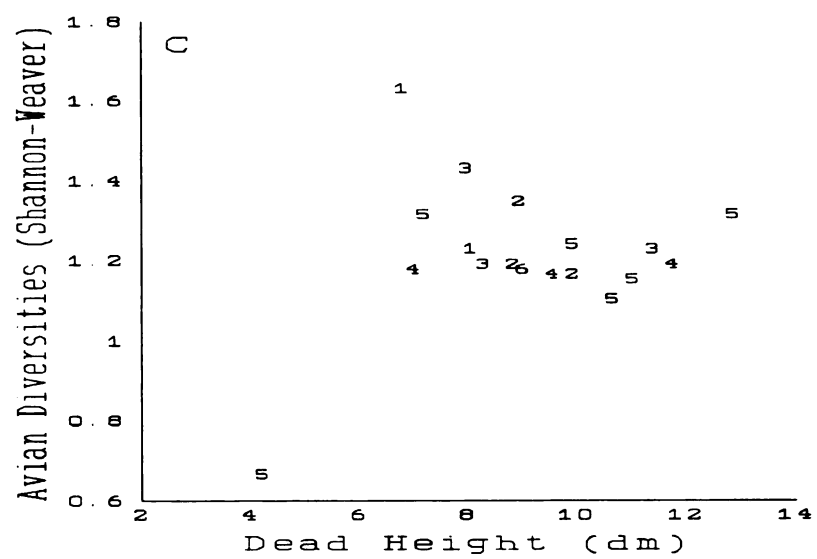


Fig. 4. Continued.

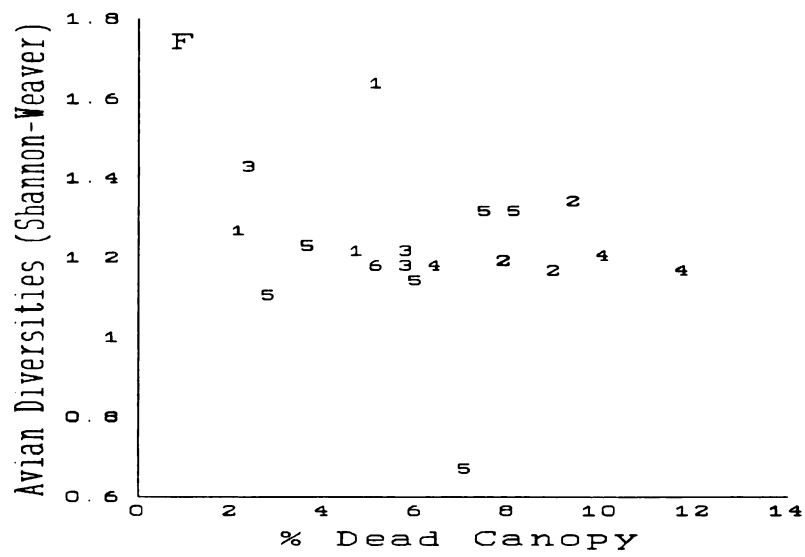
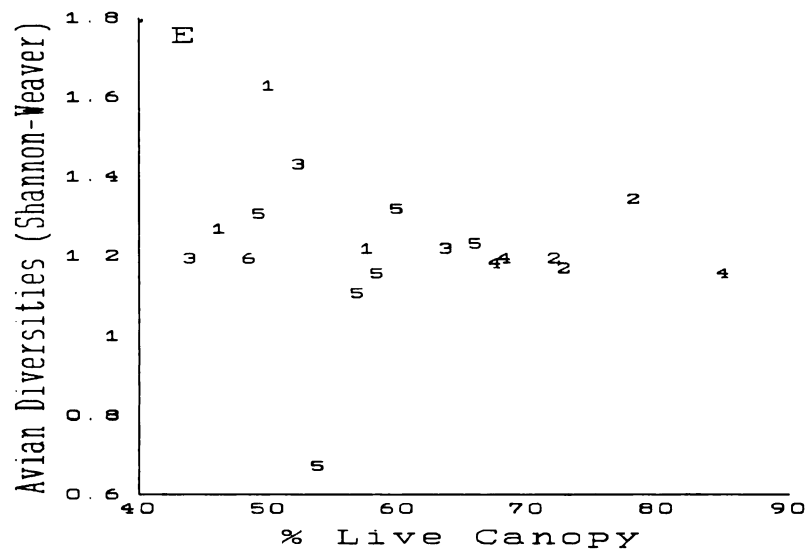


Fig. 4. Continued.

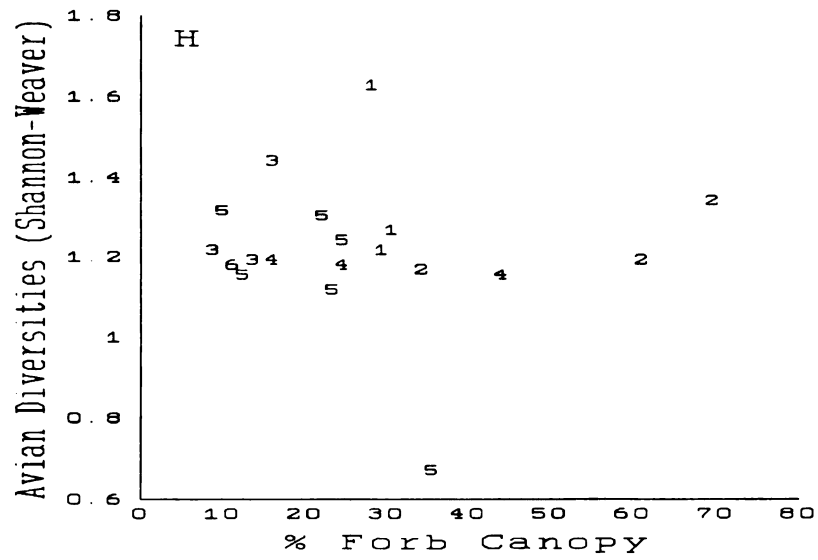
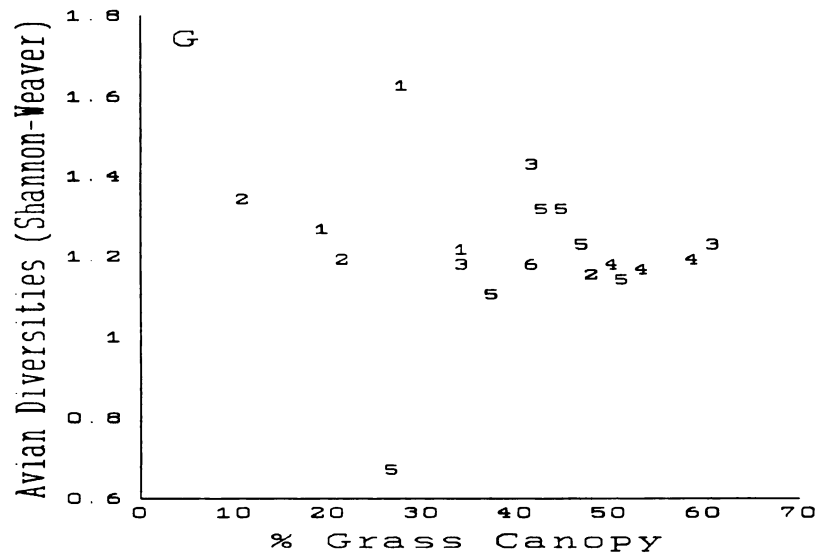


Fig. 4. Continued.

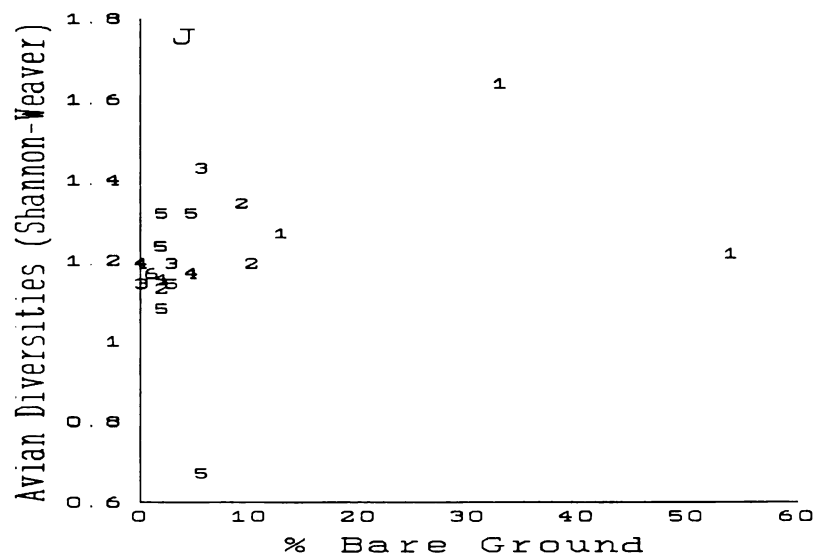
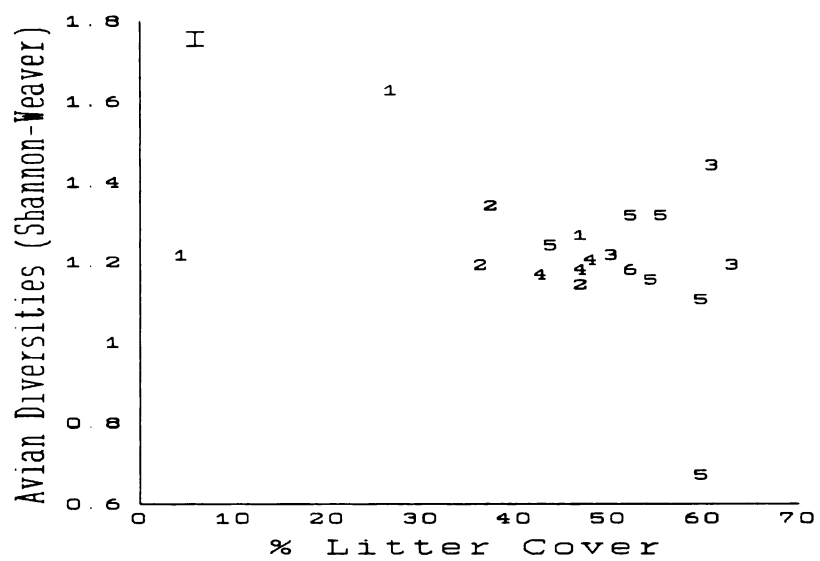


Fig. 4. Continued.

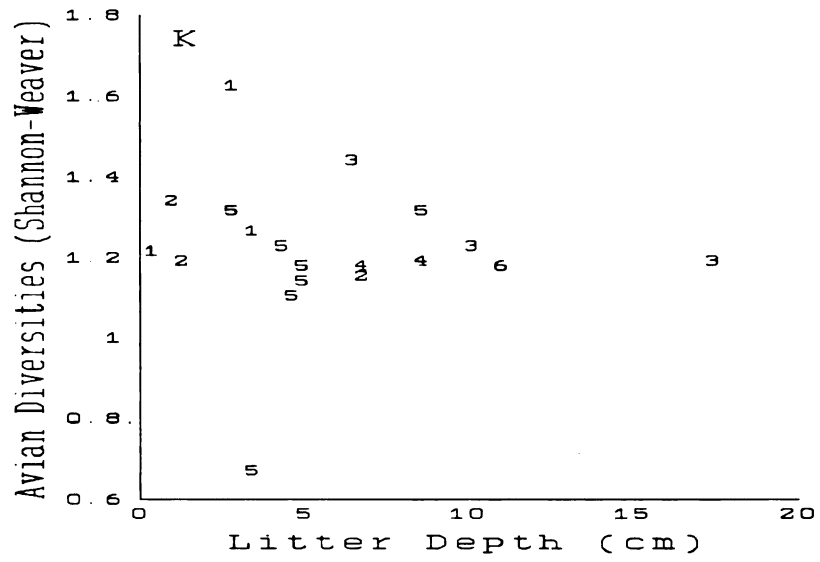


Fig. 4. Continued.

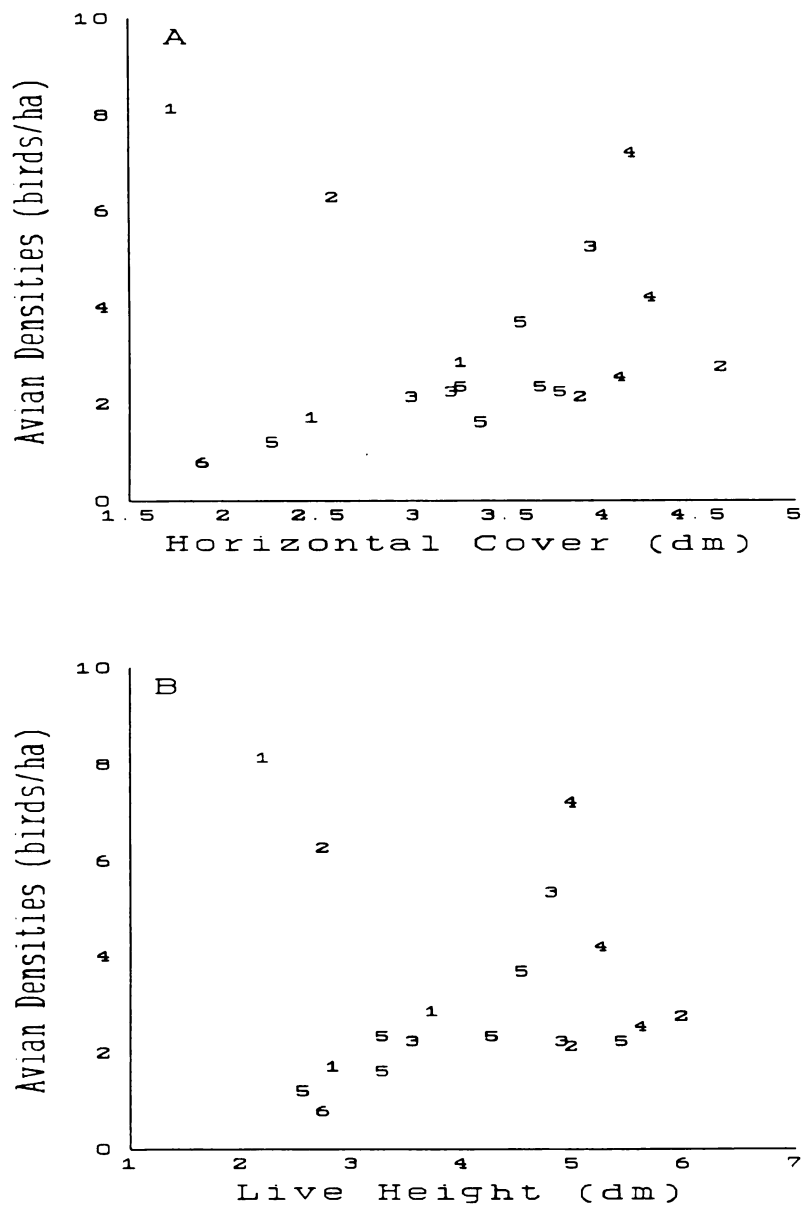


Fig. 5. Mean avian densities (birds/ha) for the entire census period in spring-summer 1992 on different age Conservation Reserve Program (CRP) fields plotted against mean vegetation variables on each field in each age class. Plotted numbers are the age classes sampled.

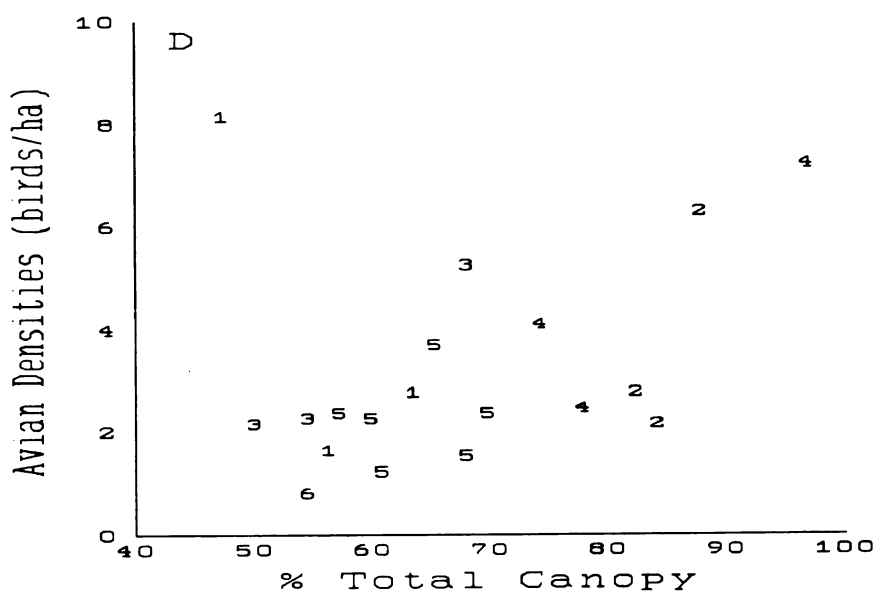
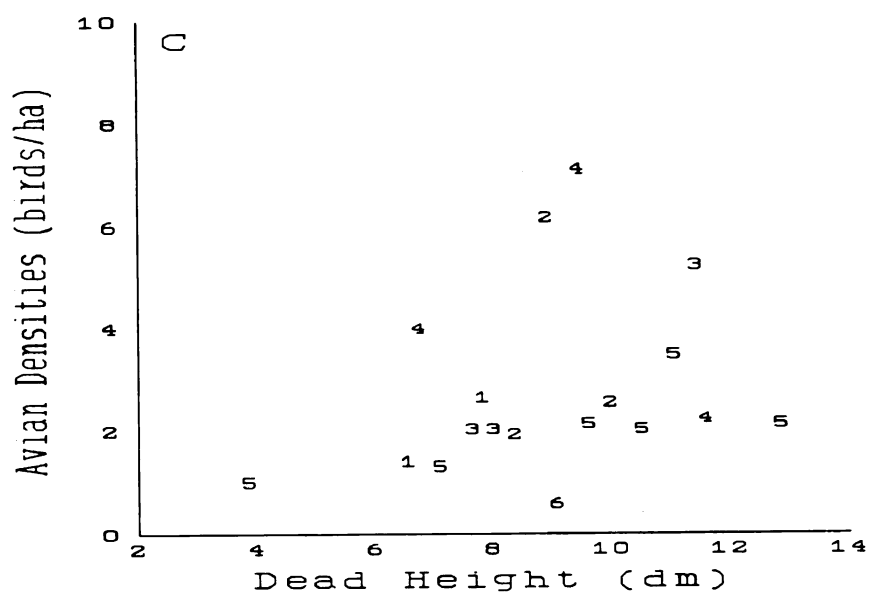


Fig. 5. Continued.

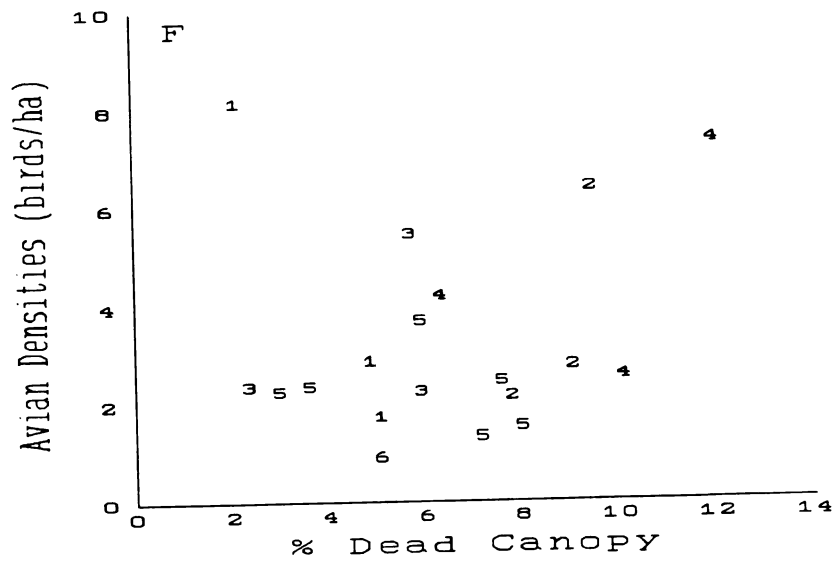
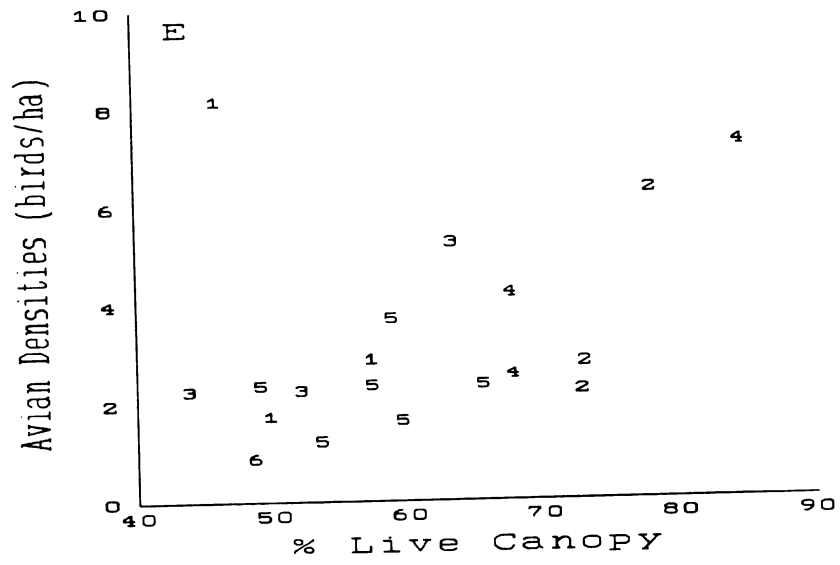


Fig. 5. Continued.

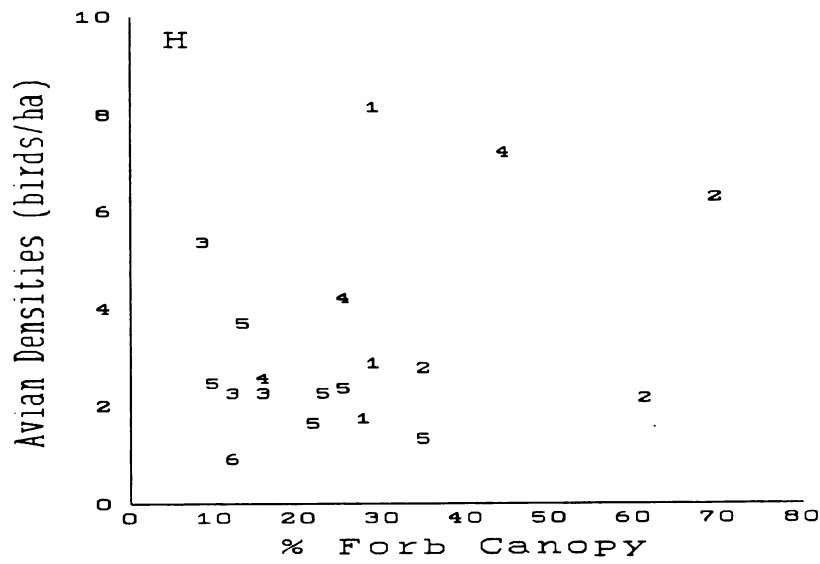
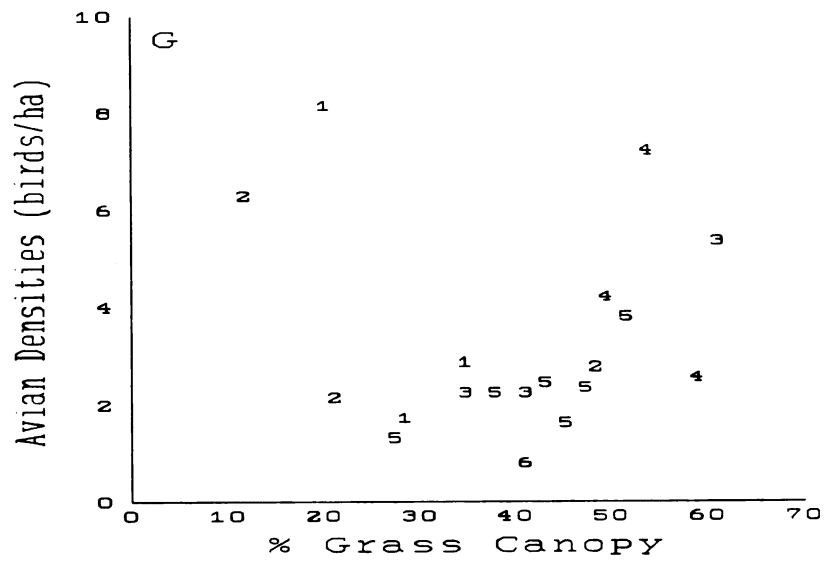


Fig. 5. Continued.

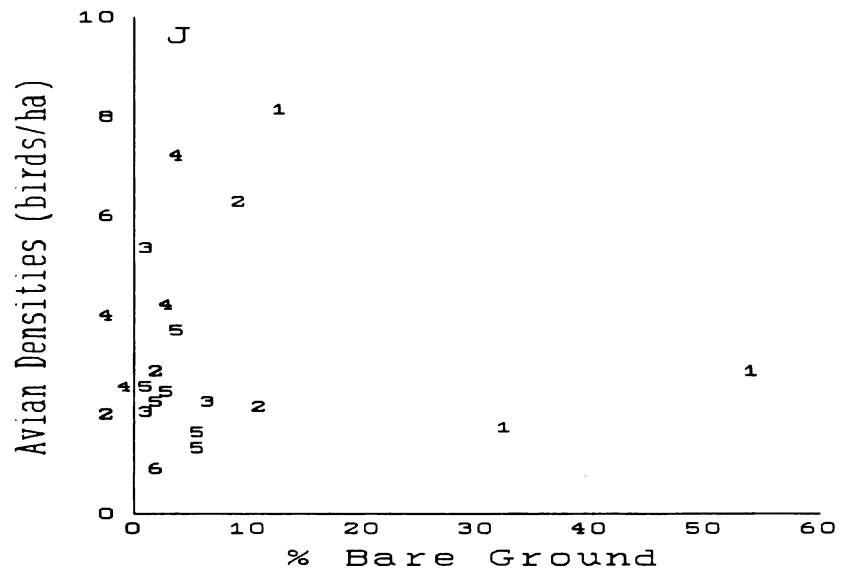
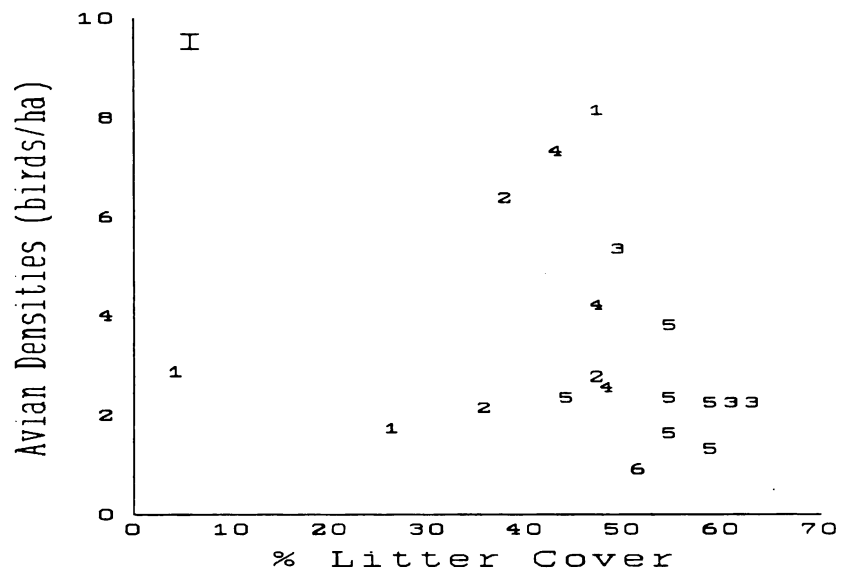


Fig. 5. Continued.

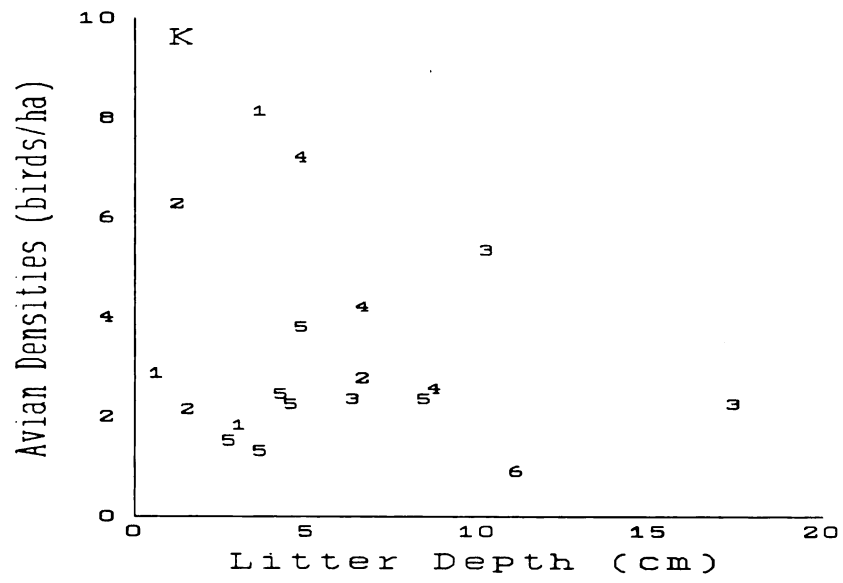


Fig. 5. Continued.

strengthened by removing a 1-year old field which had an unusually high density of birds. No factors, however, have been identified that can adequately explain the unusually high density of birds on that field. With the removal of the 1-year old field, positive correlations are strengthened and exist for horizontal cover ($r_s = 0.55$, $P = 0.01$), percent total canopy ($r_s = 0.60$, $P = 0.01$), percent live canopy ($r_s = 0.63$, $P < 0.01$), and percent grass canopy ($r_s = 0.48$, $P = 0.04$). A negative correlation also exists for percent litter cover ($r_s = -0.40$, $P = 0.10$). Although correlations exist for several of the vegetation variables when plotted against avian densities, no obvious relation within an age class exists.

Comparisons between 1991 and 1992

Significant differences in mean avian densities were found in 5-year old and 3-year old fields between 1991 and 1992 (Mann-Whitney U, $P < 0.10$). Mean bird densities were significantly greater on 5-year old fields in 1992 while densities were significantly less on 3-year old fields in 1992. However, avian densities were not significantly different (Mann-Whitney U, $P > 0.10$) on 4-year old fields between 1991 and 1992. Avian diversities, however, on 4-year old fields were significantly greater in 1991 (Mann-Whitney U, $P < 0.10$). Avian diversities on 5-year old and 3-year old fields were not significantly different (Mann-Whitney U, $P > 0.10$) between 1991 and 1992.

Significant differences (Mann-Whitney U, $P < 0.10$) were also found in avian densities and diversities between the same fields between 1991 and 1992. Fields that were in the third and fourth growing seasons in 1991 had significantly greater avian densities and diversities than their respective (fields in the fourth and fifth growing season) densities and diversities in 1992. However, fields in the fifth growing season in 1991 were not significantly different in avian densities or diversities from their respective (fields in the sixth growing season) densities and diversities in 1992.

Winter

Six avian species were encountered on all CRP fields in the winters of 1992 and 1993. Species observed included: American crow (*Corvus brachyrhynchos*), Cooper's hawk (*Accipiter cooperii*), horned lark (*Eremophila alpestris*), northern harrier (*Circus cyaneus*), northern shrike (*Lanius excubitor*), and ring-necked pheasant (*Phasianus colchicus*). The most common species encountered both years was the ring-necked pheasant.

Mean avian densities for the winter of 1992 and 1993 are given in Table 16. Due to a lack of diversity of avian species on CRP fields in the winter of 1992 and 1993, diversity values could only be calculated for 3- and 4-year old fields (0.171 and 0.111, respectively) in 1991 and 2-year old fields (0.105) in 1992. Due to the low number of

Table 16. Mean avian densities (birds/ha) on different age Conservation Reserve Program (CRP) fields in winter 1992 and 1993 in Gratiot County, Michigan.

Age Class	$\bar{x}$ Densities (SE)	
	1992	1993
1		0
2		0.067(0.044)
3	0.165(0.099)	0.213(0.213)
4	0.165(0.041)	0.251(0.198)
5	0	0.008(0.008)
6		0

avian species encountered during the winters, no statistical tests were performed on the data.

Avian Productivity

A total of 166 active nests were located on 3 age classes of CRP fields in 1992. Nesting species monitored include red-winged blackbird, vesper sparrow (*Pooecetes gramineus*), sedge wren, northern harrier, mallard (*Anas platyrhynchos*), ring-necked pheasant, and unidentified sparrow species. Forty-two active nests were located on 2 age classes of CRP fields in 1991. Nesting species monitored include red-winged blackbird, song sparrow, sedge wren, and northern harrier. Red-winged blackbirds were the primary nesting species observed in 1991 and 1992 with 54.8% and 83.1%, respectively, of the monitored nests belonging to Red-winged blackbirds.

Mean percent cover over successful red-winged blackbird nests in 1992 was 86.0%, 78.4%, and 74.7% on 1-, 4-, and 5-year old fields, respectively. Mean percent cover over unsuccessful red-winged blackbird nests in 1992 was 77.0%, 75.1%, and 81.4% on 1-, 4-, and 5-year old fields respectively. No significant differences (Mann-Whitney U test, $P > 0.10$) were found in mean percent cover between successful and unsuccessful nests in each age class in 1992. In 1991, mean percent cover over successful red-winged blackbird nests was 74.9% and 81.3% on 3- and 4-year old fields, respectively. Mean percent cover over unsuccessful nests on 3- and 4-year old fields was 60.8% and 56.6%, respectively. Mean percent cover over successful nests was significantly greater (Mann-Whitney U test, $P < 0.10$) than unsuccessful nests on 4-year old fields in 1991. However, no significant difference was found between mean percent cover over successful and unsuccessful nests on 3-year old fields. Due to the low number of other nesting avian species monitored, no spherical densiometer values (percent cover) will be given for those species.

No significant difference (Mann-Whitney U, $P > 0.10$) was found between 3- and 4-year old fields in 1991 in percent of successful nests. Four-year old fields had a greater percent of successful nests, however, the number of active and successful nests monitored on each age class was approximately the same. In 1992, no significant differences

(KW, $P > 0.10$) were found among 1-, 4-, and 5-year old fields in percent successful nests. However, 5-year old fields were greater than 4-year old fields and 4-year old fields were greater than 1-year old fields in mean number of active nests, mean number of successful nests, and mean percent of successful nests (Table 17).

A significant difference (Mann-Whitney U, $P < 0.10$) was found in percent of successful nests on fields in the fourth growing season in 1991 from their respective percent of successful nests in 1992. However, fields in the third growing season in 1991 were not significantly different (Mann-Whitney U, $P > 0.10$) in percent successful nests from their respective percent of successful nests in 1992.

Table 17. Mean number of active nests, successful nests (fledging at least one young), and percent successful nests monitored on different age Conservation Reserve Program (CRP) fields in spring-summer 1991 and 1992 in Gratiot County, Michigan.

Age Class (n)	$\bar{x}$ # Active Nests	$\bar{x}$ # Nests Successful	$\bar{x}$ % Successful
1991			
3(2)	8	4	50.0
4(4)	7	4	57.7
1992			
1(3)	10	3	32.2
4(2)	22	8	34.1
5(4)	23	10	45.6

Insect Abundance and Diversity

Seven orders and 1 class of insects were identified on CRP fields in 1991 and 1992. Orders identified include Lepidoptera (moths and butterflies), Orthoptera (grasshoppers and crickets), Coleoptera (beetles), Hemiptera (bugs), Homoptera (leaf hoppers), Diptera (flies), and Hymenoptera (bees and wasps). In 1992, the Neuroptera order (lacewings) was identified on 1- and 5-year old fields. The class Arachnida (spiders) was also identified in 1991 and 1992.

Significant differences (KW, $P < 0.10$) in insect biomass (g/10 sweeps) in 1992 were found among months within 3-, 4-, and 5-year old fields (Table 18). Use of a KW multiple comparison test did not detect differences among months for 5-year old fields. June had significantly greater insect biomass than August on 4-year old fields and significantly greater insect biomass than July on 3-year old fields. Significant differences (KW, $P < 0.10$) were also found in insect biomass in July and August among age classes (Table 18). In July, 2-year old fields had significantly greater insect biomass than 3-year old fields. In August, 2-year old fields had significantly greater insect biomass than 5-year old fields. No other comparisons among age classes within a month were significantly different (KW, $P > 0.10$).

No significant differences (KW, $P > 0.10$) were found in

Table 18. Mean insect biomass (g/10 sweeps) on 1 - 6 year old Conservation Reserve Program (CRP) fields in June, July, and August 1992 in Gratiot County, Michigan.

Age Class	$\bar{x}$ Biomass (SE)		
	June	July ^b	August ^c
1	0.0530 (0.0102)	0.0374 (0.0151)	0.0743 (0.0287)
2	0.0336 (0.0179)	0.0470 (0.0053)	0.0568 (0.0191)
3*	0.0886A ^a (0.0038)	0.0169B (0.0037)	0.0357AB (0.0079)
4*	0.0522A (0.0086)	0.0324AB (0.0046)	0.0206B (0.1120)
5*	0.0456A (0.0126)	0.0201A (0.0049)	0.0106A (0.0038)
6	INC ^d	INC	INC

* significantly different (Kruskal-Wallis, $P < 0.10$) among months within an age class.

^a within the same row, months having the same upper case letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

^b 2-year old fields significantly different from 3-year old fields in July (Kruskal-Wallis, $P < 0.10$).

^c 2-year old fields significantly different from 5-year old fields in August (Kruskal-Wallis, $P < 0.10$).

^d insects not collected.

1992 in insect diversities within an age class among months (Table 19). However, a significant difference (KW, $P < 0.10$) was found in June and August, but not July, among age classes in mean insect diversity (Table 19). Use of a KW multiple comparison was unable to detect differences between age classes in August, however, 2-year old fields had significantly greater insect diversity than 5-year old fields in June. No other age classes were significantly different from one another in insect diversities in June.

No significant differences in insect biomass (Friedman, $P > 0.10$) were found for the entire sampling period among age classes (Table 20). Significant results (Friedman, $P < 0.10$), however, were found over the entire sampling period among age classes for insect diversities (Table 20). Insect diversities on 1-, 2-, and 3-year old fields were significantly greater than 4- and 5-year old fields in insect diversities. All other comparisons among age classes for the entire census period for insect diversities were not significantly different.

In August 1991, mean insect biomass for 3- and 4-year old fields was 0.1689 g/10 sweeps and 0.1743 g/10 sweeps, respectively. No biomass per order or diversity values were calculated in 1991.

Table 19. Mean insect diversities (Shannon-Weaver) on 1 - 6 year old Conservation Reserve Program (CRP) fields in June, July, and August 1992 in Gratiot County, Michigan.

Age Class	$\bar{x}$ Diversities (SE)		
	June*	July	August*
1	1.555AB ^a (0.044)	1.223 (0.203)	1.539A (0.015)
2	1.598A (0.109)	1.284 (0.232)	1.074A (0.052)
3	1.484AB (0.232)	1.528 (0.130)	1.438A (0.167)
4	1.209AB (0.085)	1.210 (0.357)	0.593A (0.341)
5	1.032B (0.046)	1.199 (0.213)	0.623A (0.287)
6	INC ^b	INC	INC

* significantly different among age classes (Kruskal-Wallis, $P < 0.10$).

^a within a column, means having the same upper case letter are not significantly different (multiple comparison test, $\alpha = 0.10$, modified from Miller 1980).

^b insects not collected.

Table 20. Mean insect diversities (Shannon-Weaver) and mean insect biomass (g/10 sweeps) for the entire census period on 1 - 6 year old Conservation Reserve Program (CRP) fields in summer 1992 in Gratiot County, Michigan.

Age Class	$\bar{x}$ Diversities (SE)*	$\bar{x}$ Biomass (SE)
1	1.4327A ^a (0.079)	0.0552 (0.016)
2	1.3188A (0.107)	0.0458 (0.005)
3	1.4831A (0.026)	0.0419 (0.021)
4	1.0041B (0.177)	0.0351 (0.005)
5	0.9511B (0.127)	0.0255 (0.004)
6	INC ^b	INC ^b

* significantly different among age classes (Friedman, $P < 0.10$).

^a within a column, means having the same upper case letter are not significantly different (Friedman's multiple comparison, $\alpha = 0.10$, Miller 1980).

^b no insects collected.

Landowner Attitudes and Future Land Use Intentions

The overall questionnaire response rate was 89.5% (n = 17). No attempt was made to estimate nonresponse bias because of a high response rate and a small sample size.

Economic incentive and improvement of land for wildlife use were listed as the 2 most important reasons for enrolling lands in the CRP (Table 21). Idling land to replenish nutrients was listed as the most important reason for enrolling in the CRP by 29.4% of the respondents. Also, idling land to replenish nutrients and improvement of land for wildlife use were listed as having some importance for enrolling in the CRP by 47.1% and 29.4%, respectively, of the respondents. Most respondents (64.7%) listing economic incentive as the most important reason for enrolling land in the CRP intend to return their land to agricultural production once contracts expire.

Table 21. Response (%) to selected reasons for enrolling land in the Conservation Reserve Program (CRP) by a survey of Gratiot County, Michigan CRP participants (n = 17), 1992.

Reason	Most Important	Some Importance
Improve land for wildlife	41.1	29.4
Economic incentive	64.7	11.8
Personal retirement	17.6	17.6
Idle land to replenish nutrients	29.4	47.1
Other	11.8	0.0

Most respondents (88.2%) believe that the CRP has improved the quality of their land for wildlife use. Only 11.8% of the respondents were unsure if the CRP improved their land for wildlife use while no respondents believed the CRP was not beneficial to wildlife. Of the landowners responding favorably that the CRP has improved their land for wildlife use, 53.3% intend to return their land to agricultural production when CRP contracts expire, however, 46.7% would extend their contracts under the current agreement if the option became available.

When asked about plans for their CRP lands after contract expiration, only 11.8% of respondents plan to maintain their property in grass without haying or grazing. Most respondents (47.1%) plan to return their CRP land to agricultural production while 29.4% of respondents are unsure of the future of their property.

The primary factor (70.6%) affecting landowners' choice of cover crop planted was SCS suggestions (Table 22). Cost of seed (11.8%) and personal preference (11.8%) also influenced landowners' choice of cover crop planted. If the option was available to extend CRP contracts after the initial 10 years, 70.5% of all landowners would continue their participation in the CRP. Of those responding favorably, 50.0% would extend their present contracts for 5 - 20 years while 35.7% would require an increase in payment to continue their enrollment. One respondent would

continue in the CRP even if contract payments were decreased. Only 11.8% of respondents would not continue their enrollment in the CRP, primarily because they intended to sell their property.

Table 22. Response (%) to selected reasons affecting the choice of cover crop planted on Conservation Reserve Program (CRP) lands by a survey of Gratiot County, Michigan CRP participants (n = 17), 1992.

Reasons	Most Important	Some Importance
SCS recommendations	70.6	17.6
Personal preference	11.8	5.9
Easily till-able at contract end	5.9	23.5
Cost of seed	11.8	29.4
Other	11.8	0.0

DISCUSSION

Results from this study suggest a relationship between age of CRP field and avian relative abundance, diversity, and productivity. Age classes of CRP fields can be described by particular vegetation attributes. Changes in these vegetative characteristics are then responsible for changes in avian densities, diversities, and productivity. Younger CRP fields (1 - 3 year old), best described as a combination of forbs and bare ground, maintained the greatest diversity and density of avian species. Older CRP fields (4 - 6 year old), however, were a combination of grasses and deep litter cover and supported the greatest avian productivity.

Vegetative Structure and Composition

Summer

Patterns in vegetation variables as fields age

Most vegetation variables increased from May to July primarily due to the annual growth of vegetation. Vegetation data from May 1992 will be the focus of this discussion because of its' importance in avian site selection. Also, 1992 data provide the opportunity to view

the successional changes in vegetation over a greater number of age classes.

Several factors may be responsible for the observed changes in the vegetative variables as fields aged, including natural growth and succession of vegetation, original seed mixtures, soil types, and weather. However, because all CRP fields examined for this study were in close spatial proximity to one another, an assumption can be made that weather effects were similar on all fields regardless of age. Soil types will not be considered for this discussion because only a few soil types are associated with the 19 study sites.

All vegetation variables exhibited the same oscillatory pattern throughout the age classes (increasing through the second growing season, decreasing through the third, increasing through the fourth, and decreasing in the fifth and sixth growing seasons) with the exception of percent grass canopy, percent litter cover, percent bare ground, and litter depth (Fig. A-1). Percent grass canopy increased with field age through the fourth growing season, but decreased through the sixth growing season. The pattern observed in percent grass canopy will be discussed in detail below. Percent bare ground, however, decreased with field age as litter cover became greater. Percent litter cover and litter depth increased with field age due to an increase in the accumulation of dead and dying matter as fields aged.

Litter depth, however, decreased after the third growing season most likely due to the addition of dead matter subsequently causing compaction of the litter layer. No obvious trend exists for percent woody canopy due to the rare occurrence of woody species on all age classes of CRP fields.

Younger CRP fields were dominated by a greater proportion of forb cover to grass cover (Fig. 3). The forb canopy cover was proportionally greater on younger fields due to initial seed mixtures and the natural invasion of other plant species. The invasion of non-planted vegetation is evident in the high number of forb species present in the first year (Table 3). Although the initial seed mixtures of younger CRP fields contained both alfalfa and orchard grass (Table A-1), orchard grass takes several years to establish, while alfalfa is noted for its quick establishment (J. Swanson, Gratiot County SCS, pers. commun.). Alfalfa, however, has a relatively short life cycle and begins to die out after 2 growing seasons (J. Swanson, pers. commun.). As alfalfa begins to die back, grasses begin to dominate. Basu et al. (1978) state that vegetation on a legume dominated field undergoes successional changes, eventually becoming grass-dominated and sparser. As grasses begin to dominate and out compete existing forb species, forb cover decreases. The noticeable drop in forb cover occurring after the second growing season in May 1992 may be explained by the loss of

alfalfa and other forbs and the encroachment of grasses. It should be noted that proportionally grass canopy cover is greater than forb canopy cover throughout the age classes after the second growing season.

After the third growing season, however, forb canopy cover increased (Fig. 3). This may be an artifact of the original seed mixtures. Fields ≥ 4 growing seasons were planted to a mix of timothy, orchard grass, sweet clover, and alfalfa, while mixes for fields ≤ 3 growing seasons contained only alfalfa and orchard grass. The inclusion of sweet clover, not known for its' rapid establishment (J. Swanson, pers. commun.), on fields ≥ 4 years old, may be responsible for the increase in forb canopy cover after the third growing season. It is possible that sweet clover begins to thrive several years after planting, reaching its' peak after the third growing season, translating into an increase in forb canopy cover from 3- to 4-year old fields. The natural invasion of forb species may also account for the increase in forbs after the third growing season.

The shift in dominance from forbs to grasses explains the increase in grass canopy cover as fields age (Fig. 3). After the fourth growing season, however, percent grass canopy cover declined (Fig. A-1). This may be a result of an increase in litter cover that separates the grasses into distinct clumps (G. Dudderar, Mich. State Univ., pers. commun.). Litter cover serves as a mechanical barrier to

seedlings and clumps of grasses, decreasing the amount of light energy available for growth (Rice and Parenti 1978). Therefore, the productivity of the grass species declines, growth is isolated to the surviving clumps, grasses becomes less dense, and grass canopy cover measurements decline.

Grass, forb, and woody canopy cover are the 3 components of live canopy cover which, along with dead canopy cover, constitutes total canopy cover. Intuitively live canopy and total canopy should mirror the combined changes in grass canopy and forb canopy (Fig. A-1). Dead canopy also mirrors changes in forb canopy and grass canopy.

Changes in horizontal cover, as fields age, result due to the changes in the concentration of plant species and the shift in dominance from forbs to grasses (Fig. A-1). On 1-year old CRP fields, plant species begin to establish and are sparse, thus decreasing horizontal cover measurements. As forb and grass cover increased through the fourth growing season, horizontal cover also increased. Finally, as fields became more grass dominated and sparser, during the fifth and sixth growing seasons, horizontal cover decreased.

Changes in vegetation height can also be explained by the shift from forbs to grasses as fields aged (Fig. A-1). The decrease in vegetation height after the fourth growing season may be a result of effects of an extensive litter layer. Vogl (1974) and Peet et al. (1975) suggest that litter cover may contain toxins which leach out and inhibit

the growth of vegetation, thus decreasing vegetation height.

Principal components analysis

Results obtained from PCA suggest CRP fields may be described by certain structural components on each field. Fields studied in Gratiot County, Michigan may be described as a gradient from forb cover and bare ground (youngest) to grass cover and litter cover (oldest) (Fig.3).

Results from PCA aid in determining the vegetative variables most important in describing a particular age of CRP field. For example, percent bare ground, percent forb canopy, and percent total canopy/live canopy are the most important vegetation variables for describing 1-year old CRP fields (Fig. 2). Although total canopy cover was sparse on the youngest age class of CRP field, the canopy present was live canopy cover comprised mostly of forb species. Because of the recent disturbance of planting, bare ground dominated over litter cover.

Two-year old CRP fields, however, are best described by moderate forb to grass canopy, with a greater proportion of total canopy/live canopy to litter cover/litter depth, and a greater percent of litter cover to bare ground (Fig. 2). A more prominent total canopy/live canopy to litter cover/litter depth is logical because litter cover is not a component of total canopy. Total canopy/live canopy would be greater on younger fields than litter cover/litter depth because a substantial litter layer has not developed on

these fields. However, a litter layer is evident, and is proportionally greater than the amount of bare ground present. Two-year old fields also have a greater proportion of forb canopy cover to grass canopy cover. This can be explained by the shift in dominance from forbs to grasses mentioned previously.

Three-year old CRP fields are similar to 2-year old fields in relationships between total canopy/live canopy and litter cover/litter depth, and litter cover and bare ground (Fig. 2). Also, grass cover is more prevalent than forb cover in this age class. Again, the dominance in grass species after the second growing season can be explained by the change in dominance of forbs and grasses discussed previously.

Four-, 5-, and 6-year old fields can be described by a greater proportion of litter cover/litter depth to total canopy/live canopy and bare ground; and a greater percent of grass to forb canopy (Fig. 2). As explained previously, as CRP fields age, a litter layer develops decreasing the amount of bare ground as well as serving as a mechanical barrier to seeds of the existing plant species. This barrier, in turn, decreases the productivity of the vegetation, thus making the canopy cover sparse. The amount of litter cover present, therefore, is proportionally greater than the amount of total canopy/live canopy. The shift in dominance of forbs to grasses explains the increase

in grass canopy as CRP fields age.

Winter

Data from winter, 1993 will be the focus of this discussion due to the representation of a greater number of age classes than in winter 1992. Few vegetative variables were significantly different among age classes suggesting different age CRP fields are structurally similar during the winter months (Table 9). However, live canopy cover was greater on younger CRP fields due to the absence of an invasive litter layer. It was suggested previously that a litter layer inhibits seedling growth. With the absence of a litter layer, seeds may establish quicker and begin to grow earlier, thus causing the percent of live canopy cover to be greater on younger fields shortly after snow melt.

Grass and forb canopy cover were also greater on younger CRP fields (Table 9). Intuitively, grass and forb canopy should mirror live canopy because grass and forb canopy are components of live canopy.

Dead canopy increased with increasing field age (Table 9). Dead canopy was greater on older fields due to the increase in canopy cover as fields age, thus increasing the amount of dead canopy during the winter. Although no obvious trends exist in the vegetation variables as fields age during the winter months, results from a current Michigan study (Campa et al., unpublished data, 1992 Regional Project NC-203, Michigan Agricultural Experiment Station)

suggest that CRP fields generally provide greater cover than agricultural fields during the winter months.

Avian Density and Diversity

Summer

Few significant differences were found in either avian densities or diversities within an age class among months. Although fluctuations in diversities and densities existed throughout the summer, dramatic shifts in habitat use were unlikely. Therefore, mean diversity and density values for the entire census period will be the focus of this discussion because they provide a general overview of the changes in avian community structure as CRP fields age. Again, 1992 data will be focused on because of representation from a greater number of age classes of CRP fields.

Avian densities

It is widely accepted that vegetative complexity is associated with avian community structure (e.g. MacArthur and MacArthur 1961, Cody 1968, Karr and Roth 1971). Typically, both species diversity and density increase with increasing habitat complexity (May 1982). Although increased density and diversity may result with increasing habitat complexity, this may only be expressed on established habitat types (i.e. forests, old fields). This may not be valid, however, for newly established habitats,

such as 1-year old CRP fields.

Habitat complexity is not likely the primary factor driving the influx of birds onto 1-year old CRP fields. Several other factors may be involved in explaining higher avian densities on younger fields (Fig. A-2). Younger fields may meet a variety of habitat needs including feeding and nesting habitat. Although nesting did occur on younger CRP fields, productivity was less than that observed on older fields. Younger CRP fields may provide some suitable habitat for nesting, however, it is likely that the amount and quality of nesting habitat is limited. However, it may be possible that younger CRP fields were used primarily as feeding grounds. One-year old CRP fields were dominated by a greater percent of bare ground. While cover was present, the amount of cover provided was sparse. The sparseness of the field, however, promotes greater visibility allowing the observed grassland birds to successfully hunt for prey (primarily insects, Ehrlich et al. 1988), while at the same time allowing for faster recognition of predators. Results from work completed on insects suggests that a greater biomass and diversity of insects are available on younger CRP fields (Table 20).

Older CRP fields, however, did not support the same high avian densities as the younger fields. These fields may have provided the necessary structural components required for nesting. It may be possible that a greater

quality and availability of nesting habitat was provided on older CRP fields, thus supporting greater nesting than evidenced on younger CRP fields. The low densities may be a result of territorial defense of the nesting area which deters other birds from using these fields.

Avian diversities

Cody (1985) states that avian species composition, or diversity, varies with vegetation structure following a disturbance, thereby creating a diverse array of avian species. Species diversity observed on CRP fields supports this notion. One-year old CRP fields, newly disturbed by planting, supported the greatest diversity of avian species. As fields aged and became less disturbed, however, diversities declined. However, no correlation was observed between avian diversities and changes in vegetation variables (Fig. 4).

Winter

No impacts of field age on avian diversities or densities (Table 16) were evident in winter 1992 or 1993 due to the low number of avian species encountered. The majority of birds encountered during the summer months are neotropical migrants and winter in the south, therefore, numbers were low. Also, songbirds which remain in Michigan over the winter may require greater cover (i.e. conifers) than could be provided by the CRP fields. However, it should be noted that CRP fields may provide the necessary

requirements for ring-necked pheasants, which were the dominant species encountered in the winters of 1992 and 1993.

Avian Productivity

Although it is commonly accepted that density is a good indicator of habitat quality, Van Horne (1983) suggests that density is only one component of habitat quality. Van Horne (1983) states that both offspring production and survival are valuable components in the definition of habitat quality. Therefore, information on productivity and densities should aid in identifying quality wildlife habitat.

Both the number of active nests and successful nests were greatest on older CRP fields. The oscillatory patterns evidenced in the vegetation variables (Fig. A-1) make it difficult to find relationships in the increasing number of active and successful nests as fields aged (Table 17). However, Roseberry and Klimstra (1984 as cited in Burger et al. 1990) suggest that areas in annual weeds, or legumes, may provide inferior nesting cover because of a lack of dead grass stems used for nest construction by grassland birds.

While many factors may be responsible for the increase in productivity as fields aged, this increase may actually be an artifact of the most dominant nesting species encountered. The majority of nests located on all age

classes of CRP fields were red-winged blackbirds. Red-winged blackbirds are known to nest in a variety of locations with highly variable structural attributes (Granlund 1991). The conspicuous locations of red-winged blackbird nests allowed for easier detection. It is likely that many nests of other species were missed, therefore, results obtained only represent patterns in red-winged blackbird nesting and not productivity of the entire CRP avian community.

Insect Abundance and Diversity

Few significant differences were found in either insect abundance or diversities within an age class among months. These results suggest little variability in abundance or diversity throughout the census period, therefore, mean abundance and diversity values for the entire census period will be concentrated on for this discussion.

Although few significant differences were found among age classes for the entire census period, mean insect diversities and biomass generally decreased as fields aged (Table 20). Younger fields supported a greater diversity and biomass of insects than older CRP fields. Murdoch et al. (1972) suggest a correlation exists between habitat complexity and insect abundance. However, as explained previously with avian densities and habitat complexity, these patterns were undoubtedly evidenced in established

habitat types unlike the CRP. Burger (1989 as cited in Burger et al. 1990), however, observed higher invertebrate densities on CRP fields established in a grass-legume mixture than in fields established in a pure grass stand, similar to older CRP fields. The higher proportion of forb canopy cover in the grass-legume mixture may be responsible for higher invertebrate densities. Therefore, the higher abundance of insects on younger CRP fields in Gratiot County, Michigan may be attributable to the higher proportion of forb species present in these age classes. As fields age and grass canopy cover becomes dominant, insect biomass declined.

Landowner Attitudes and Future Land Use Intentions

The primary reason landowners in Gratiot County, Michigan enrolled in the CRP was economic incentive. However, approximately 70% of the landowners gave improvement of wildlife habitat at least some importance concerning enrollment in the CRP. Regardless of their reason for enrolling in the CRP, approximately 88% of the landowners believe the CRP has improved the quality of their land for wildlife use. Interestingly, although landowners are concerned about improvement of wildlife on their property, almost 50% of the landowners intend to return their land to agricultural production after contracts expire if the option to continue is not available. A strong

willingness among CRP landowners to extend contracts is evident, however, in most cases monetary consideration would be required.

The information gathered from the cooperating Gratiot County, Michigan CRP landowners is not unique. Similar findings were reported for North Dakota (Mortensen et al. 1989) and Missouri (Kurzejeski et al. 1992). Although landowners in all states are concerned about improvement of wildlife, an underlying protection of their own livelihood is evident. If the CRP is not renewed after 1995, gains in the establishment of millions of hectares of wildlife habitat throughout the United States will ultimately be lost, similar to losses incurred after the Soil Bank Program (Edwards 1984). To retain some of the wildlife benefits of the CRP if contracts are not renewed, carefully planned programs to encourage maintenance of permanent vegetation will be necessary. Unfortunately, economic incentives are likely to remain an important consideration in the ability of landowners to provide and manage wildlife habitat. Targeting landowners with an interest in wildlife may have the greatest impact on maximizing the wildlife benefits of future agricultural programs.

RECOMMENDATIONS

The CRP has potential to one of the most beneficial land retirement programs for wildlife (Berner 1988). However, wildlife benefits derived from the program will be largely dependent on proper management to achieve the goal of maintaining quality wildlife habitat. It is generally accepted that greater density, diversity, and productivity yield better quality habitat (e.g. Mac Arthur and Mac Arthur 1961, Van Horne 1983). Changes in vegetation structure and composition are strongly linked to changes in these measures. Because patterns in vegetative variables were found to be associated with field age (e.g. a shift in dominance from forbs to grasses, an increase in litter cover, and a decrease in bare ground as fields age) in this study, recommendations for altering vegetation will be made relative to field age.

Several studies have suggested that grasslands established with seed mixtures similar to planted CRP fields, generally did not maintain structural qualities for more than 7 years (Higgins et al. 1987). Disturbances on 3- to 5-year intervals have been shown to enhance wildlife production by more than 100% (Kirsch 1974, Kirsch et al.

1978). There is a general recognition (e.g. Schenck and Williamson 1991) that controlled, periodic treatments to revitalize cover by fire, grazing, or mowing may be necessary for the long-term maintenance of wildlife habitat. Results from this study indicate some form of perturbation may be necessary to maintain the greatest avian densities, diversities, and productivity on CRP fields after the fourth through sixth growing season.

Several factors, however, must be considered prior to initiating a perturbation on enrolled CRP fields including field size and shape, and proximity to other CRP fields. Perturbations which provide multiple successional stages of vegetation may best provide for simultaneously high avian density, diversity, and productivity. In areas where CRP fields are relatively small in size (i.e. < 20 ha), similar to those found in Gratiot County, Michigan, it may be more beneficial to alter vegetation taking a landscape approach. For example, regulation of lands enrolled in a given year or within a given area may create a mosaic of different aged CRP fields throughout the landscape, thus providing a variety of successional stages that may meet the habitat requirements of grassland birds.

However, it may be possible to create multiple successional stages of vegetation on one CRP field. This may prove most beneficial, however, when dealing with larger CRP fields (i.e. > 100 ha), such as those found in the

midwest states of Iowa, Kansas, and Nebraska. For example, a perturbation which includes mowing one-third of a field every year or every other year on a rotational basis may create a variety of grassland successional stages. Again, these perturbations would not be required until fields are in the fourth through sixth growing season. Altering vegetation on smaller CRP fields, such as those typical of Gratiot County, Michigan, may, however, produce patches too small to be effectively used by grassland birds.

Although it is likely that CRP fields require some form of rejuvenation during the 10-year enrollment period, Higgins et al. (1987) suggest only one treatment is necessary. However, Higgins et al. (1987) also suggest fields enrolled prior to 1989 may not require a perturbation if they were disturbed as a result of the emergency haying which occurred during the drought years of 1988 and 1989. This, however, does not pertain to any field in this study since none of the fields have been disturbed.

Many types of disturbances such as mowing, burning, disking, and grazing may create the desired changes in the vegetation. Regardless of the form of perturbation selected, it should be accomplished in as short of time as possible and scheduled to minimize the disruptive effects to nesting wildlife. Much information is available on the effects of a variety of disturbance practices on wildlife in grassland habitats (e.g. Kirsch et al. 1978). However, the

CRP is a unique habitat and little is known of the effects of the disturbances on wildlife using CRP fields. Therefore, additional information is needed on the maintenance and rejuvenation methods relative to planted CRP grasslands and the responses of wildlife to these management practices before an effective form of perturbation can be recommended. Overall, it may be necessary for wildlife managers to design strategies, policies, and safeguards that can be used as creative tools for enhancing wildlife on CRP fields.

While the importance of maintaining quality habitat on CRP fields has been emphasized, a more pressing issue is the continuation of the CRP once contracts expire. While the majority of the landowners in this study believed the CRP has improved their land for wildlife, almost half intend to return their land to agricultural practices once contracts expire. Therefore, natural resource professionals need to continue to communicate with CRP landowners on the value the CRP holds for wildlife in a monoculture dominated landscape. This message needs to be expressed prior to contract expiration so the merits of the program are sustained beyond the contract period for the long-term good of soil and water quality and wildlife populations in agricultural ecosystems.

LITERATURE CITED

LITERATURE CITED

- Anderson, S. H. and H. H. Shugart. 1974. Habitat selection of breeding birds in an eastern Tennessee deciduous forest. *Ecology*. 55(4):828-837.
- Balda, R. P. 1975. Vegetation structure and breeding bird diversity. Pages 59-80 in *Proceedings of a symposium on management of forest and range habitats for nongame birds*. USDA For. Serv. Gen. Tech. Rep. WO-1. 343pp.
- Basu, P. K., Jackson, H. R., and V. R. Wallen. 1978. Alfalfa decline and its cause in mixed hay fields determined by aerial photography and ground survey. *Can. J. Plant Sci.* 58:1041-1048.
- Berner, A. H. 1984. Federal land retirement program : a land management albatross. *Trans. N. Am. Wildl. Nat. Resour. Conf.* 49:118-131.
- . 1988. The 1985 farm act and its implications for wildlife. Pages 437-465 in W. J. Chandler, and L. Labate, eds. *Audubon wildlife report 1988/1989*. The National Audubon Society., New York, NY.
- Brewer, R., and K. G. Harrison. 1975. The time of habitat selection by birds. *Ibis*. 117:521-522.
- Burger, L. W., Jr., Kurzejeski, E. W., Dailey, T. V., and M. R. Ryan. 1990. Structural characteristics of vegetation in CRP fields in northern Missouri and their suitability as bobwhite habitat. *Trans. N. A. Wildl. and Nat. Res. Conf.* 55:74-83.
- Cody, M. L. 1968. On the methods of resource division in grassland bird communities. *Amer. Mid. Nat.* 102(924):107-147.
- . 1974. *Competition and the structure of bird communities*. Princeton Univ. Press, Princeton, NJ. 318pp.
- . 1985. *Habitat selection in birds*. Academic Press, Inc. Orlando, FL. 558pp.

- Cutler, M. R. 1984. Integrating wildlife habitat features in agricultural programs. *Trans. N. Am. Wildl. Nat. Resour. Conf.* 49:132-140.
- Daubenmire, R. F. 1959. A canopy coverage methods of vegetational analysis. *Northwest Sci.* 33:43-64.
- Dwyer, P. D. 1972. Feature, patch, and refuge area : some influences on the diversity of bird species. *Emu.* 72:149-152.
- Edwards, W. R. 1984. Early ACP and pheasant boom or bust! - a historical perspective with rationale. Pages 71-83 in R. T. Dumke, R. B. Stiehl, and R. B. Kahl, eds. *Proc. Perdix III/Gray partridge and ring-necked pheasant workshop*, WI Dept. Nat. Resour., Madison. 203 pp.
- Erhlich, P. R., Dobkin, D. S., and D. Wheye. 1988. *The Birder's Handbook*. Simon and Schuster, Inc. New York, NY. 785pp.
- Erickson, R. E., and J. E. Wiebe. 1973. Pheasants, economics, and land retirement in South Dakota. *Wildl. Soc. Bull.* 1:22-27.
- Forman, R. T., Galli, A. E., and C. F. Leck. 1976. Forest size and avian diversity in New Jersey woodlots with some land use implications. *Oecologia.* 26(1):1-8.
- Galli, A. E., Leck, C. F., and R. T. Forman. 1976. Avian distribution patterns in forest islands of different sizes in central New Jersey. *Auk.* 93(2):356-364.
- Gauthreaux, S. A. 1978. The structure and organization of avian communities in forests. Pages 17-37 in *Proceedings of the workshop : management of southern forests for nongame birds*. USDA For. Serv. Gen. Tech. Rep. SE-14. 176pp.
- Graber, J. W. and R. R. Graber. 1976. Environmental evaluations using birds in their habitat. *Biol. Notes* No. 97. Illinois Nat. Hist. Surv. Urbana, IL. 39pp.
- Granlund, J. G. 1991. Red-winged blackbird. Pages 494-495 in R. Brewer, G. A. Peek, and R. J. Adams, Jr., eds. *The atlas of breeding birds of Michigan*. Michigan State University Press, East Lansing. MI.

- Higgins, K. F., Nomsen, D. E., and W. A. Wentz. 1987. The role of the Conservation Reserve Program in relation to wildlife enhancement, wetlands, and adjacent habitat in the northern Great Plains. Pages 99-104 in J. E. Mitchell, ed. Impacts of the Conservation Reserve Program in the Great Plains. USDA For. Serv. Gen. Tech. Rep. RM-158. 134pp.
- Karr, J. R. 1968. Habitat and avian diversity on strip-mined land in east-central Illinois. Condor. 70:348-357.
- , and R. R. Roth. 1971. Vegetation structure and avian diversity in several New World areas. Amer. Nat. 105:423-435.
- Kirsch, L. M. 1974. Habitat management considerations for prairie chickens. Wildl. Soc. Bull. 2:124-129.
- , Duebbert, H. F., and A. D. Kruse. 1978. Grazing and haying effects on habitats of upland nesting birds. Trans. N. Am. Wildl. Nat. Resour. Conf. 43: 486-497.
- Kurzejeski, E. W., Burger, L. W., Monson, M. M., and R. Lenkner. 1992. Wildlife conservation attitudes and land use intentions of Conservation Reserve Program participants in Missouri. Wildl. Soc. Bull. 20:253-259.
- Kricher, J. C. 1973. Summer bird species diversity in relation to secondary succession on the New Jersey piedmont. Amer. Midl. Nat. 89(1):121-137.
- Leedy, D. L. 1987. The Ohio pheasant range revisited. Ohio Dept. Nat. Resour., Columbus. 70pp.
- Lemmon, P. E. 1956. A spherical densiometer for estimating forest overstory density. Forest Science. 2(1):314-320.
- Mac Arthur, R. H. and J. W. Mac Arthur. 1961. On bird species diversity. Ecology. 42(3):594-598.
- Mac Clintock, L., Whitcomb, R. F., and B. L. Whitcomb. 1977. Evidence of the value of corridors and minimization of isolation in preservation of biotic diversity. Amer. Birds. 31(1):6-16.
- May, P. G. 1982. Secondary succession and breeding bird community structure: patterns of resource utilization. Oecologia. 55:208-216.

- Miller, R. P. 1980. Simultaneous statistical inference. Second ed. Springer-Verlag, New York, NY. 299pp.
- Mortensen, T. L., Leistraits, F. L., Leitch, J. A., Coon, R. C., and B. L. Ekstrom. 1989. Landowner characteristics and the economic impact of the Conservation Reserve Program in North Dakota. J. Soil and Water Conserv. 44:494-497.
- Murdoch, W. W., Evans, F. C., and C. H. Peterson. 1972. Diversity and pattern in plants and insects. Ecology. 53:819-829.
- Ott, L. 1988. An introduction to statistical methods and data analysis. Third ed. PWS-Kent Publ. Co., Boston, MA. 582pp.
- Peet, M., Anderson, R., and M. S. Anderson. 1975. Effect of fire on big bluestem production. Amer. Midl. Nat. 94:15-26.
- Rice, E. L. and R. L. Parenti. 1978. Causes of decreases in productivity in undisturbed tall grass prairie. Amer. J. Botany. 65(10):1091-1097.
- Robel, R. J., Briggs, J. N., Dayton, A. D., and L. C. Hulbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. J. Range Manage. 23:295-298.
- Rosenweig, M. L. and J. Winakur. 1969. Population ecology of desert rodent communities : habitats and environmental complexity. Ecology. 50(4):558-572.
- Roth, R. R. 1976. Spatial heterogeneity and bird species diversity. Ecology. 57:773-782.
- Ruesink, W. G. and D. L. Haynes. 1973. Sweepnet sampling for the cereal leaf beetle. Envir. Entomology. 2:161-172.
- Ryan, M. L. 1986. Nongame management in grassland and agricultural ecosystems. Pages 117-136 in J. B. Hale, L. B. Best, and R. L. Clawson, eds. Management of nongame wildlife in the midwest: a developing art. The Wildlife Society.

- Schenck, E. W. and L. L. Williamson. 1991. Conservation Reserve Program effects on wildlife and recreation. Pages 37-42 in L. A. Joyce, J. E. Mitchell, and M. D. Skold, eds. The Conservation Reserve - yesterday, today, and tomorrow. USDA For. Serv. Gen. Tech. Rep. RM-203. 65pp.
- Shannon, C. E., and Weaver, W. 1949. The mathematical theory of communication. Univ. Illinois Press, Urbana. 177pp.
- Shugart, H. H., Smith, T. M., Kitchings, J. T., and R. L. Kroodsma. 1978. The relationship of nongame birds to southern forest types and successional stages. Pages 5-16 in Proceedings on the workshop : management of southern forests for nongame birds. USDA For. Serv. Gen. Tech. Rep. SE-14. 176pp.
- Siegel, S. 1956. Nonparametric statistics for behavioral sciences. Mc-Graw-Hill Book Co. New York, NY. 312pp.
- Tomoff, C. S. 1974. Avian species diversity in desert scrub. Ecology. 55(2):396-403.
- USDA. 1972. Final report : Conservation Reserve Program - summary of accomplishments 1956-1972. USDA-ASCS, Washington, DC. 17pp.
- USDA. 1975. Soil survey of Gratiot County, Michigan. Soil Conservation Service. 142pp.
- Van Horne, S. 1983. Density as a misleading indicator of habitat quality. J. Wildl. Manage. 47(4):893-901.
- Vogl, R. J. 1974. Effects of fire on grasslands. Pages 139-194 in T. T. Kozlowski and C. E. Ahlgren, eds. Fire and ecosystems. Academic Press, New York, NY.
- Whitcomb, R. F. 1977. Island biogeography and habitat islands of eastern forest. Amer. Birds. 31(1):3-5.
- Wiens, J. A. 1974. Habitat heterogeneity and avian community structure in North American grasslands. Amer. Midl. Nat. 91(1):195-213.
- Willson, M. F. 1974. Avian community organization and habitat structure. Ecology. 55:1017-1029.

APPENDICES

Table A-1. Seed mixtures (kg/ha) of selected Conservation Reserve Program (CRP) contracts in Gratiot County, Michigan.

Field	Size (ha)	Year Enrolled	Seed Mixture
2A	9.7	1986	2.2 kg timothy, 4.5 kg orchard grass, 2.2 kg sweet clover
1A	14.3	1987	2.2 kg timothy, 4.5 kg orchard grass, 2.2 kg alfalfa, 1.1 kg sweet clover
3A**	7.3	1987	Same as 1A
4A**	8.9	1987	Same as 1A
8A	14.4	1987	Same as 1A
9A	11.7	1987	Same as 1A
10A	7.7	1987	same as 1A
11A	8.1	1987	3.4 kg timothy, 2.2 kg alsike, 2.2 kg sweet clover
12A	11.1	1987	Same as 11A
5A	8.1	1988	2.2 kg timothy, 3.4 kg orchard grass, 2.2 kg alfalfa, 2.2 kg white sweet clover
6A	19.8	1988	Same as 5A
7A	12.2	1988	Same as 1A
89A*	12.2	1989	3.4 kg alfalfa, 3.4 kg orchard grass
89B*	8.6	1989	Same as 89A
89C*	10.1	1989	Same as 1A
90A*	7.7	1990	Same as 89A
90B*	12.1	1990	Same as 89A
90C*	12.8	1990	Same as 89A
91A*	15.1	1991	Same as 89A
91B*	10.4	1991	Same as 89A
91C*	12.1	1991	Same as 89A

* sampled in 1992 only.

** sampled in 1991 only.

Table A-2. Questionnaire used to determine cooperating landowner attitudes and future land use intentions of enrolled Conservation Reserve Program (CRP) lands.

1. What was your overall reason for participating in the CRP? Rank each choice: (1) Strong factor, (2) Somewhat of a factor, or (3) Not a factor.
 - ___ a) improve land for wildlife (specify type)
 - ___ b) economic incentive
 - ___ c) personal retirement
 - ___ d) idle land to replenish nutrients and reduce soil erosion between agricultural plantings
 - ___ e) other (please specify)
2. What factor contributed to your choice of cover crop planted? Rank each choice: (1) Strong factor, (2) Somewhat of a factor, or (3) Not a factor.
 - ___ a) SCS suggestions
 - ___ b) personal preference
 - ___ c) easily-tillable when contract expires
 - ___ d) cost of seed
 - ___ e) other (please specify)
3. Do you feel the CRP has improved the quality of your land for wildlife use?
 - a) yes (please specify)
 - b) no (please specify)
 - c) unsure
4. What are your plans for your land once the CRP contracts have expired, providing the present contracts are not extended?
 - a) maintain in grass without haying or grazing
 - b) maintain in grass for haying and/or grazing
 - c) plant to agricultural crop
 - d) other (please specify)
5. If the option is available, would you extend your participation in the CRP?
 - a) yes, under the current agreement for ___ years
 - b) yes, only if the annual payments were increased to \$ ___ per acre for ___ years
 - c) yes, even if the payments were decreased to \$ ___ per acre for ___ years
 - d) no (please specify)

Table A-3. Plant species encountered on Conservation Reserve Program (CRP) fields in 1991 and 1992 in Gratiot County, Michigan.

Common Name	Scientific Name
Alfalfa	<i>Medicago sativa</i>
American Basswood*	<i>Tilia americana</i>
American Elm*	<i>Ulmus americana</i>
Aster	<i>Aster</i> spp.
Avens*	<i>Genum</i> spp.
Bittercress*	<i>Cardamine</i> spp.
Black Medick	<i>Medicago lupulina</i>
Black Raspberry*	<i>Rubus occidentalis</i>
Bluegrass*	<i>Poa</i> spp.
Boneset**	<i>Eupatorium</i> spp.
Box Elder*	<i>Acer negundo</i>
Bouncing Bet	<i>Saponaria officinalis</i>
Bull Thistle	<i>Cirsium vulgare</i>
Canadian Bluegrass	<i>Poa compressa</i>
Canadian Thistle	<i>Cirsium arvense</i>
Chicory	<i>Cichorium intybus</i>
Chickweed	<i>Stellaria</i> spp.
Common Blackberry	<i>Gillenia allegheniensis</i>
Common Burdock**	<i>Arctium minus</i>
Common Dandelion	<i>Taraxacum officinale</i>
Common Groundsel	<i>Senecio vulgaris</i>
Common Hawkweed	<i>Hieracium vulgatum</i>
Common Mallow**	<i>Malva neglecta</i>
Common Mullein	<i>Verbascum thapsus</i>
Common Plantain	<i>Plantago major</i>
Common Potato**	<i>Solanum tuberosum</i>
Common Ragweed**	<i>Ambrosia artemisiifolia</i>

Table A-3. Continued.

Common Name	Scientific Name
Common Smartweed	<i>Polygonum hydropiper</i>
Common St. John's Wort**	<i>Hypericum perforatum</i>
Common Winter Cress*	<i>Barbarea vulgaris</i>
Crowfoot*	<i>Ranunculus</i> spp.
Curled Dock	<i>Rumex crispus</i>
Currant**	<i>Ribes</i> spp.
Daisy Fleabane	<i>Erigeron philadelphicus</i>
English Plantain	<i>Plantago lanceolata</i>
Evening Primrose	<i>Oenothera</i> spp.
Field Bindweed*	<i>Convolvulus arvensis</i>
Field Dogwood*	<i>Cornus racemosa</i>
Field Pennycress	<i>Thlaspi arvense</i>
Field Sorrel	<i>Rumex acetosella</i>
Goldenrod	<i>Solidago</i> spp.
Golden Saxifrage*	<i>Chrysosplenium americanum</i>
Grape*	<i>Vitis</i> spp.
Hairy Willow Herb**	<i>Epilobium hirsutum</i>
Hawthorn	<i>Crataegus</i> spp.
Hoary Alyssum**	<i>Berteroa incana</i>
Horsetail	<i>Equisetum</i> spp.
Joe-Pye Weed	<i>Eupatorium</i> spp.
Lady's Thumb	<i>Polygonum persicaria</i>
Lance-leaved Violet*	<i>Viola lanceolata</i>
Milkweed	<i>Asclepias</i> spp.
Mint**	<i>Mentha</i> spp.
Moss	Bryophyta
Mustard*	Cruciferae
Nettles*	<i>Urtica</i> spp.
Nodding Fescue**	<i>Festuca obtusa</i>

Table A-3. Continued.

Common Name	Scientific Name
Orchard Grass	<i>Dactylis glomerata</i>
Oxeye Daisy	<i>Chrysanthemum leucanthemum</i>
Path Rush*	<i>Juncus tenuis</i>
Poison Ivy*	<i>Rhus radicans</i>
Pussytoes*	<i>Antennaria</i> spp.
Purslane**	<i>Portulaca oleracea</i>
Quacking Aspen*	<i>Populus tremuloides</i>
Quackgrass*	<i>Agropyron repens</i>
Queen Ann's Lace	<i>Daucus carota</i>
Red Clover	<i>Trifolium pratense</i>
Red Elm*	<i>Ulmus rubra</i>
Red Maple*	<i>Acer rubrum</i>
Red-osier Dogwood*	<i>Cornus stolonifera</i>
Redtop	<i>Agrotis gigantea</i>
Reed Canary Grass**	<i>Phalaris arundinacea</i>
Rough Cinquefoil	<i>Potentilla norvegica</i>
Rough-fruited Cinquefoil	<i>Potentilla recta</i>
Ryegrass	<i>Lolium perenne</i>
Sandwort*	<i>Arenaria</i> spp.
Sedge*	<i>Carex</i> spp.
Slender Wheatgrass**	<i>Agropyron trachycaulum</i>
Slenderwort*	<i>Pyrola rotundifolia</i>
Smooth Brome	<i>Bromus inermis</i>
Speedwell*	<i>Veronica</i> spp.
Spotted Knapweed**	<i>Centaurea maculosa</i>
Squirrel-tail Grass*	<i>Hordeum jubatum</i>
Switch grass*	<i>Panicum virgatum</i>
Sugar Maple	<i>Acer saccharum</i>
Timothy Grass	<i>Phleum pratense</i>

Table A-3. Continued.

Common Name	Scientific Name
Umbrella Sedge**	<i>Cyperus spp.</i>
Upright Bindweed	<i>Convolvulus spithameus</i>
Virginia Creeper	<i>Parthenocissus quinquefolia</i>
Wheat*	<i>Triticum aestivum</i>
White Ash**	<i>Fraxinus americana</i>
White Champion**	<i>Lychnis alba</i>
White Clover**	<i>Trifolium repens</i>
White Sweet Clover	<i>Melilotus alba</i>
Whitlow Grass*	<i>Draba verna</i>
Wild Peppergrass*	<i>Lepidium virginicum</i>
Wild Lettuce*	<i>Lactuca canadensis</i>
Wild Strawberry	<i>Fragaria virginiana</i>
Wood Sorrel**	<i>Oxalis spp.</i>
Woodland Agrimony**	<i>Agrimonia striata</i>
Yarrow	<i>Achillea millefolium</i>
Yellow Goatsbeard*	<i>Tragopogon pratensis</i>
Yellow Sweet Clover	<i>Melilotus officinalis</i>
Yellow Wood Sorrel**	<i>Oxalis europaea</i>

* occurred in 1992 only.

** occurred in 1991 only.

Table A-4. Avian species observed on Conservation Reserve Program (CRP) fields in spring-summer 1991 and 1992 in Gratiot County, Michigan.

Species Code	Common Name	Scientific Name
AMBI**	American bittern	<i>Botaurus lentiginosus</i>
AMCR*	American crow	<i>Corvus brachyrhynchos</i>
AMGO	American goldfinch	<i>Carduelis tristis</i>
AMRO**	American robin	<i>Turdus migratorius</i>
BAOR*	Baltimore oriole	<i>Icterus galbula</i>
BLJA*	Blue jay	<i>Cyanocitta cristata</i>
BWTE*	Blue-winged teal	<i>Anas discors</i>
BOBO	Bobolink	<i>Dolichonyx oryzivorus</i>
BRTH*	Brown thrasher	<i>Toxostoma rufum</i>
CHSP*	Chipping sparrow	<i>Spizella passerina</i>
COYE	Common yellowthroat	<i>Geothlypis trichas</i>
DICK*	Dickcissel	<i>Spiza americana</i>
EABL*	Eastern bluebird	<i>Sialia sialis</i>
EAKI	Eastern kingbird	<i>Tyrannus tyrannus</i>
EAME	Eastern meadowlark	<i>Sturnella magna</i>
EAPH*	Eastern phoebe	<i>Sayornis phoebe</i>
EUST**	European starling	<i>Sturnus vulgaris</i>
FISP	Field sparrow	<i>Spizella pusilla</i>
GRSP	Grasshopper sparrow	<i>Ammodramus savannarum</i>
HOLA	Horned lark	<i>Eremophila alpestris</i>
HOWR*	House wren	<i>Troglodytes aedon</i>
INBU**	Indigo bunting	<i>Passerina cyanea</i>
MALL	Mallard	<i>Anas platyrhynchos</i>
MODO**	Mourning dove	<i>Zenaida macroura</i>
NOBO*	Northern bobwhite	<i>Colinus virginianus</i>
NOHA	Northern harrier	<i>Circus cyaneus</i>
NOMO*	Northern mockingbird	<i>Mimus polyglottos</i>
RTHA*	Red-tailed hawk	<i>Buteo jamaicensis</i>

Table A-4. Continued.

Species Code	Common Name	Scientific Name
RWBL	Red-winged blackbird	<i>Agelaius phoeniceus</i>
RTHU**	Ruby-throated hummingbird	<i>Archilochus colubris</i>
RNPH	Ring-necked pheasant	<i>Phasianus colchicus</i>
SAVS	Savannah sparrow	<i>Passerculus sandwichensis</i>
SEWR	Sedge wren	<i>Cistothorus platensis</i>
SOSP	Song sparrow	<i>Melospiza melodia</i>
TRSW*	Tree swallow	<i>Tachycineta bicolor</i>
VESP	Vesper sparrow	<i>Poocetes gramineus</i>
YEWA*	Yellow warbler	<i>Dendroica petechia</i>
WTSP*	White-throated sparrow	<i>Zonotrichia leucophrys</i>

* occurred in 1992 only.

** occurred in 1991 only.

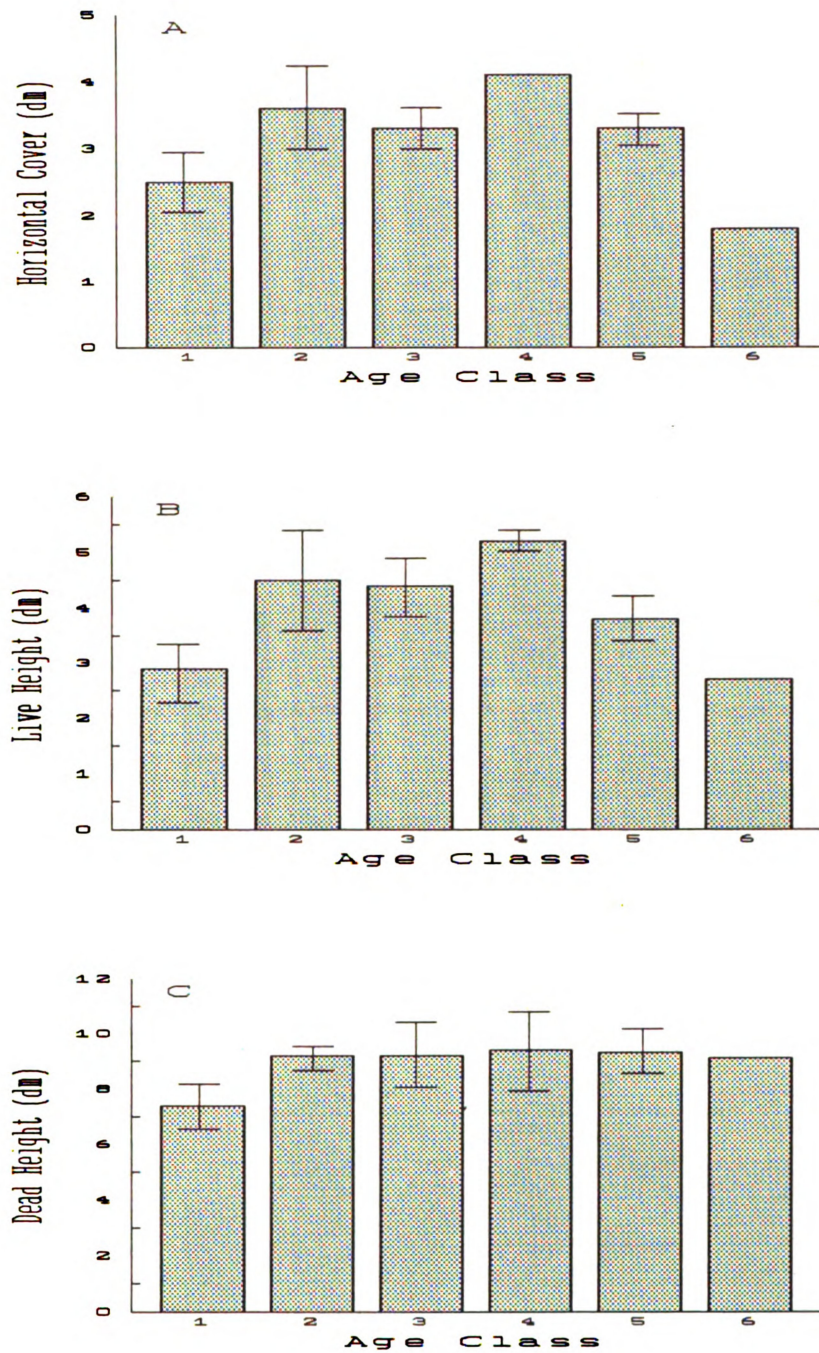


Fig. A-1. Mean vegetation variables on 1 - 6 year old Conservation Reserve Program (CRP) fields in May 1992 in Gratiot County, Michigan. Vertical bars are ± 1 SE.

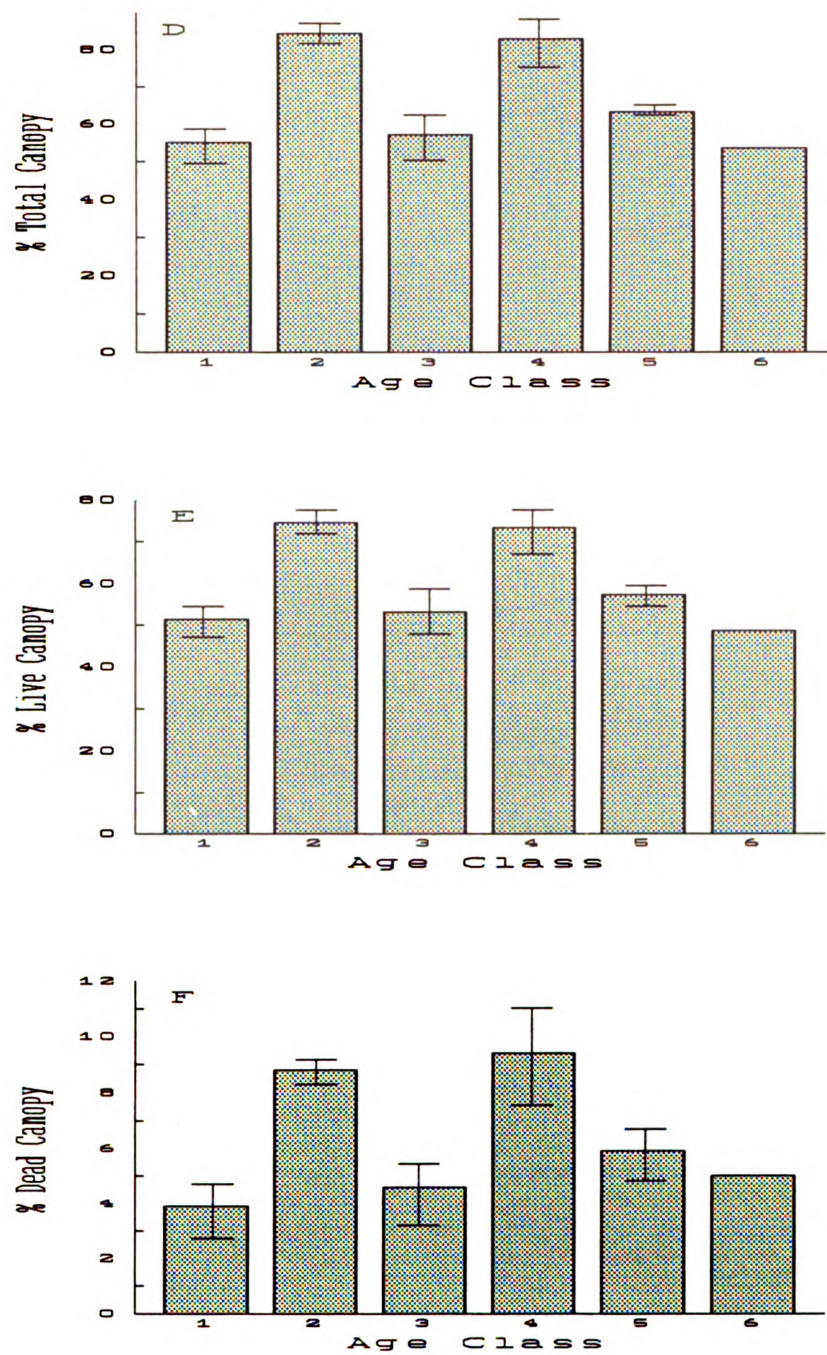


Fig. A-1. Continued.

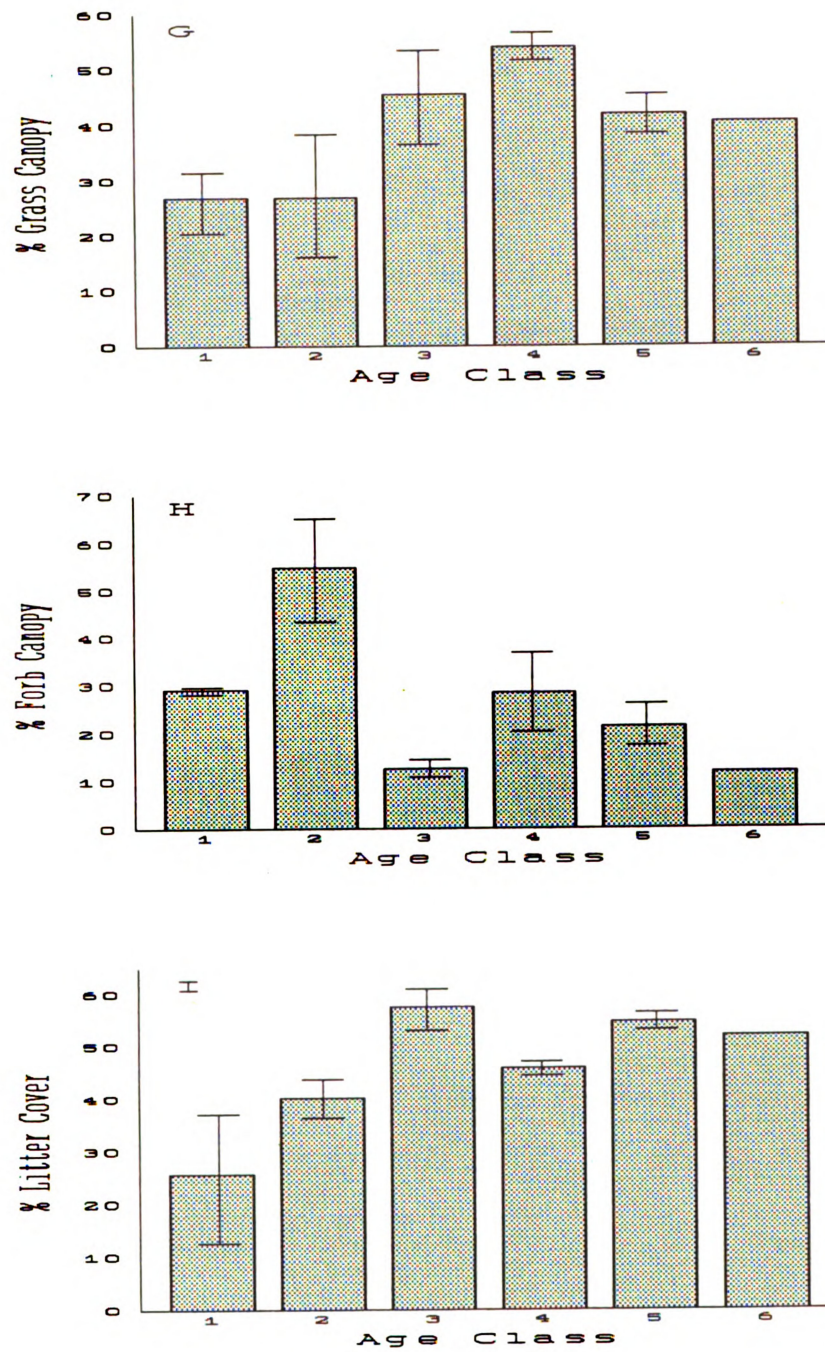


Fig. A-1. Continued.

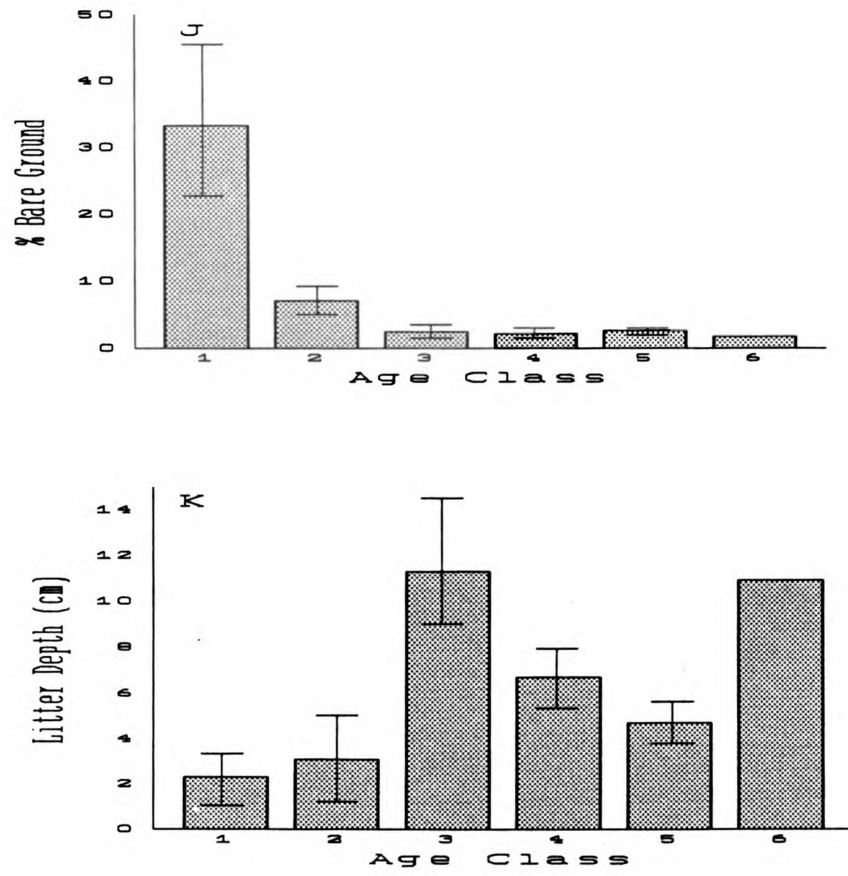


Fig. A-1. Continued.

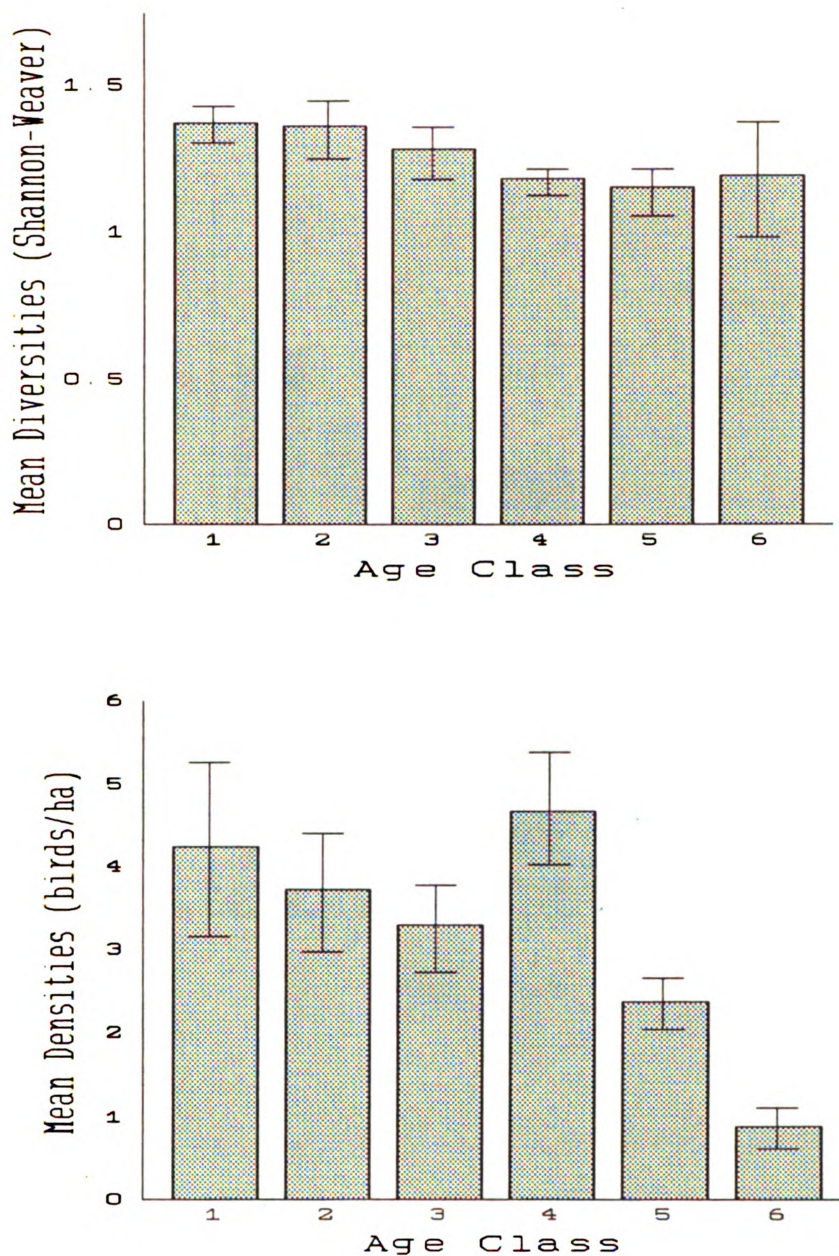


Fig. A-2. Mean avian diversities (Shannon-Weaver diversity index) and densities (birds/ha) on 1 - 6 year old Conservation Reserve Program (CRP) fields over the entire census period, spring-summer 1992 in Gratiot County, Michigan. Vertical bars are ± 1 SE.

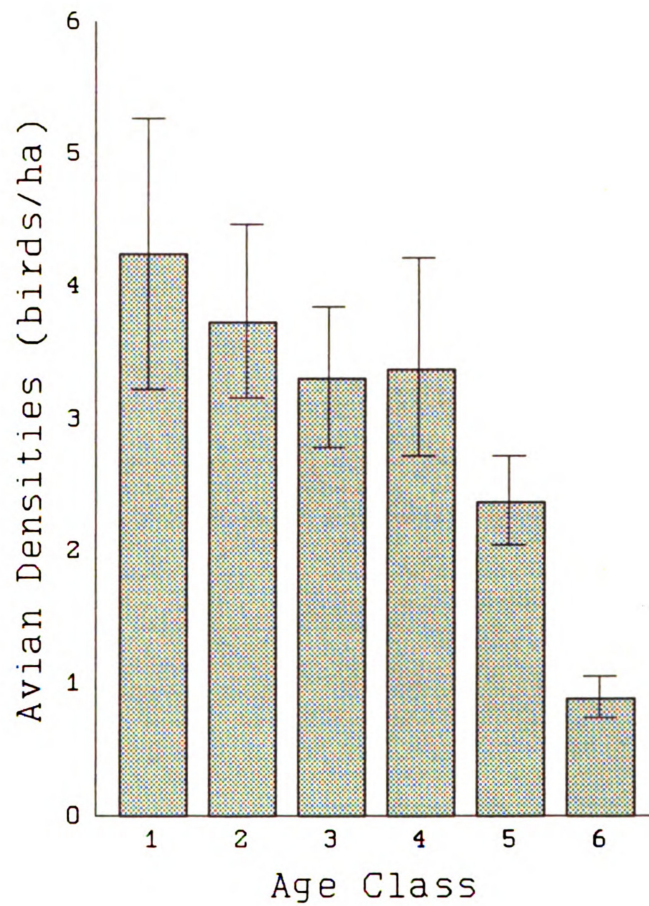


Fig. A-3. Mean avian densities (birds/ha) for the entire census period on 1 - 6 year old Conservation Reserve Program (CRP) in May 1992 in Gratiot County, Michigan excluding one field in the 4th growing season. Vertical bars are ± 1 SE. See text for additional discussion.

MICHIGAN STATE UNIV



3129301026