EFFECTS OF HERBICIDE APPLICATIONS ON WILDLIFE POPULATIONS

By

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Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1963

Submitted to the faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
MASTER OF SCIENCE
August, 1965

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ON WILDLIFE POPULATIONS

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ACKNOWLEDGMENTS

This study was made possible through a fellowship from the Oklahoma Cooperative Wildlife Research Unit.* The direction and counsel of my major professor Dr. F. M. Baumgartner, Assistant Leader of the Oklahoma Cooperative Wildlife Research Unit, is deeply appreciated. I am also grateful to Dr. A. M. Stebler, Leader of the Oklahoma Cooperative Wildlife Research Unit, and Dr. J. Crockett for their additional counsel. Appreciation is extended, also, to Sam Bigham, Douglas Donaldson, and Leland Hepworth for their assistance in the analysis of the vegetation of the areas.

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*Oklahoma Department of Wildlife Conservation, Oklahoma State University, U. S. Fish and Wildlife Service, and the Wildlife Management Institute cooperating.

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CHAPTER I

INTRODUCTION

In recent years it has become a common practice to herbicide stands of postoak (Quercus stellata),[1] blackjack (Quercus marilandica), and other woody species with herbicides. Most commonly used are 2,4,-D and 2,4,5,-T. In 1951 more than one million acres were sprayed with 2,4,-D and 2,4,5,-T in the United States (Cottam 1952). The amount of area treated has increased each year. This study was concerned with an estimation of changes in habitat conditions resulting from the use of herbicides and the effects of these changes on the bobwhite quail (Colinus virginianus), the cottontail rabbit (Sylvilagus floridanus), the fox squirrel (Sciurus niger), and several of the more common species of songbirds. Study areas were selected in the more heavily wooded portions of Creek and Lincoln Counties, Oklahoma. Field investigations were conducted from July 1964 through June 1965.

Much of the postoak-blackjack oak woodland in Oklahoma is used as pasture for cattle and other livestock. Before spraying, some of these areas contain very little grass and other forage plants, thus pasturing such areas is relatively unprofitable. The use of herbicides has made it appear promising to attempt to convert these areas to improved

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[1]Botanical Nomenclature according to Waterfall U. T. 1962. Keys to the Flora of Oklahoma.

pasturelands. After spraying, native and introduced grasses then have an opportunity to disseminate and became established in the pastures. This results in a change of habitat type from a situation of more or less densely wooded area with little ground cover to one of a more open stand of increased ground cover.

It has been a matter of speculation as to what extent the induced environmental changes may be affecting the wildlife populations on the sprayed woodlands. There are no known direct toxic effects to animals when 2,4,-D and/or 2,4,5,-T are used as prescribed (Rowe and Hymas 1954, Rudd 1954, and Hall 1952). This report will attempt to illustrate the extent to which the habitat is changed and how this change affects certain wildlife species.

CHAPTER II

DESCRIPTION OF STUDY AREAS

The study areas were selected in Lincoln and Creek Counties because of the extensive spraying program in that region of the state. These two counties are located in the postoak-blackjack or Cross Timbers belt of east-central Oklahoma (Duck and Fletcher ca. 1944). The areas were located in wooded pastures that ranged between 120 and 160 acres. Three sets of areas were selected. Each set included one sprayed plot and one unsprayed plot. In as far as possible the basis of selection was equality in size, and similarity in the amounts of and distribution of vegetative associations and water. This was done to obtain areas that were similar in habitat composition before the herbicide application. Area Number I is located in Creek County. The sprayed plot is in the S.E. 1/4 of Sect. 4,T19N-R7E. This plot was sprayed in June 1961 and in June 1963. It was burned over in May 1963. The matching control area is located in Creek County in the S.W. 1/4 Sect. 7,T19N-R17E. Area Number II is also located in Creek County. The sprayed plot is on the S.W. 1/4 of Sect. 27,T19N-R8E. It was sprayed twice, the first time being in May 1961 and again in May 1963. It was burned in the spring of 1962. The control for this area is in the N.E. 1/4 Sect. 33,T19N-R8E. Area Number III is located in the north edge of Lincoln County. The treated plot is in the N.E. 1/4 of Sect. 27,T17N-R6E.

This plot was sprayed in May 1962 and May 1963. Its matching control study area is the N.W. 1/4 of Sect. 3,T16N-R6E.

Vegetation on the study areas was predominantly postoak-blackjack with scattered clearing and prairie inclusions. Each plot included at least one small ravine system (Figs. 1 to 6) that supported other species of hardwoods. Each plot also had a pond or creek to provide a water supply for livestock and game species.

The soils that underlie these areas are shallow sand, sandy shale, and clay shale mixtures (U.S.D.A. Creek County Soil Survey, 1959). These soil types are the most common ones found in the Cross Timbers region. The shallow soil is apparently one of the major factors that contributes to the development of the oak woods. In the deeper soils along the intermittent streams other species of hardwoods are dominants. Trees growing in and along these bottoms showed a marked resistance to the herbicide treatments. Only part of the woody cover was destroyed by the herbicide treatment.

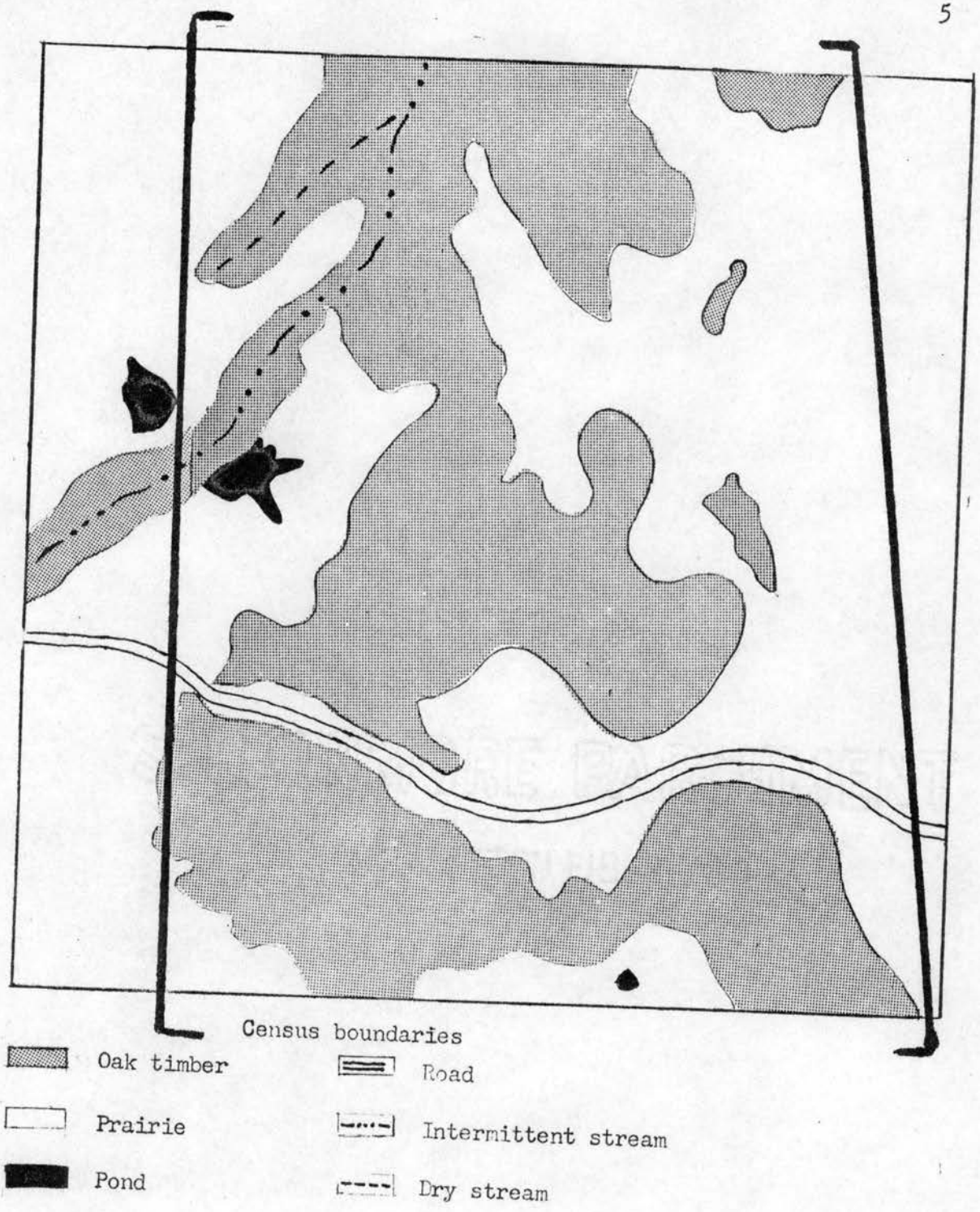

Fig. 1. Vegetation map of treated Area I.

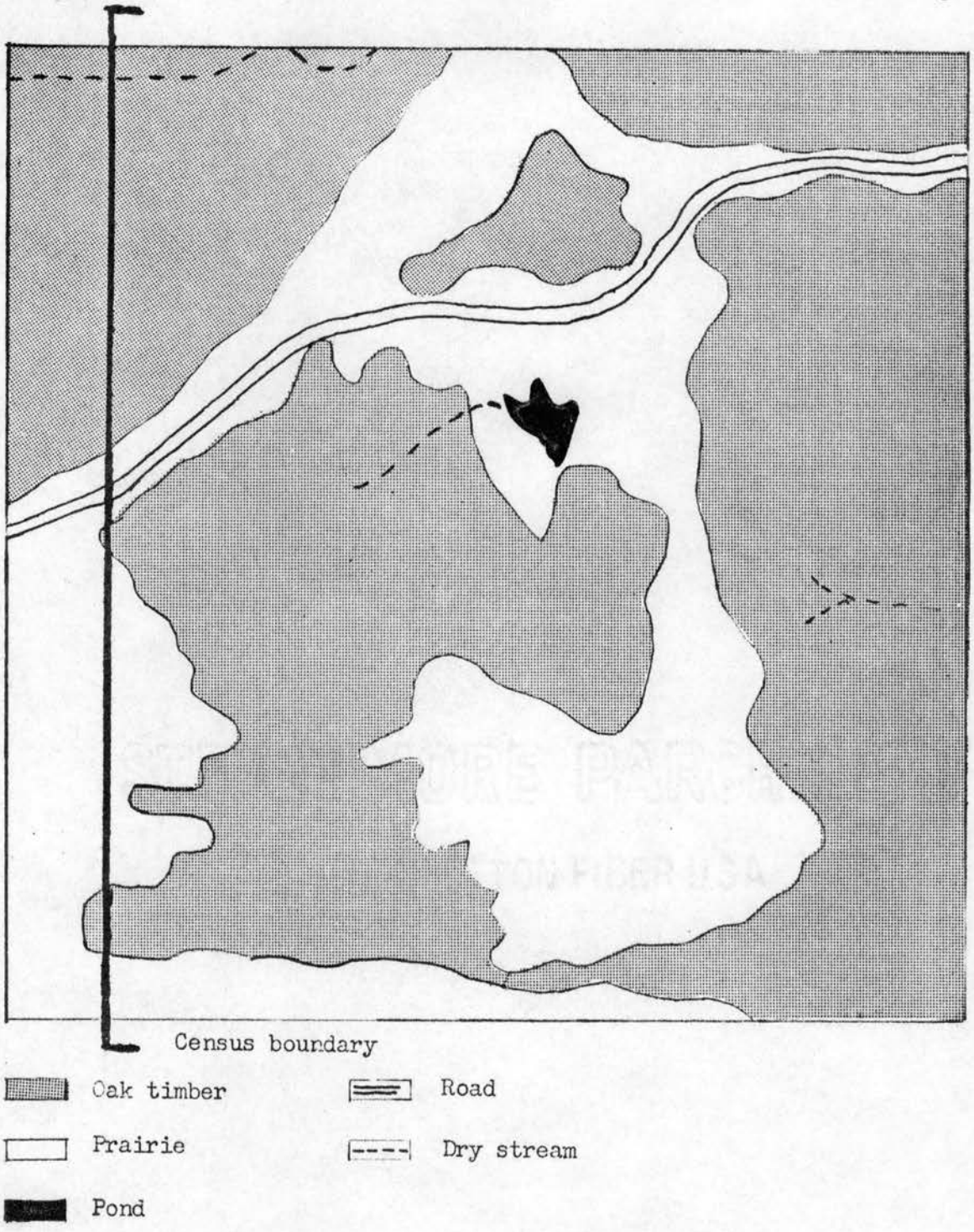

Fig. 2. Vegetation map of control Area I.

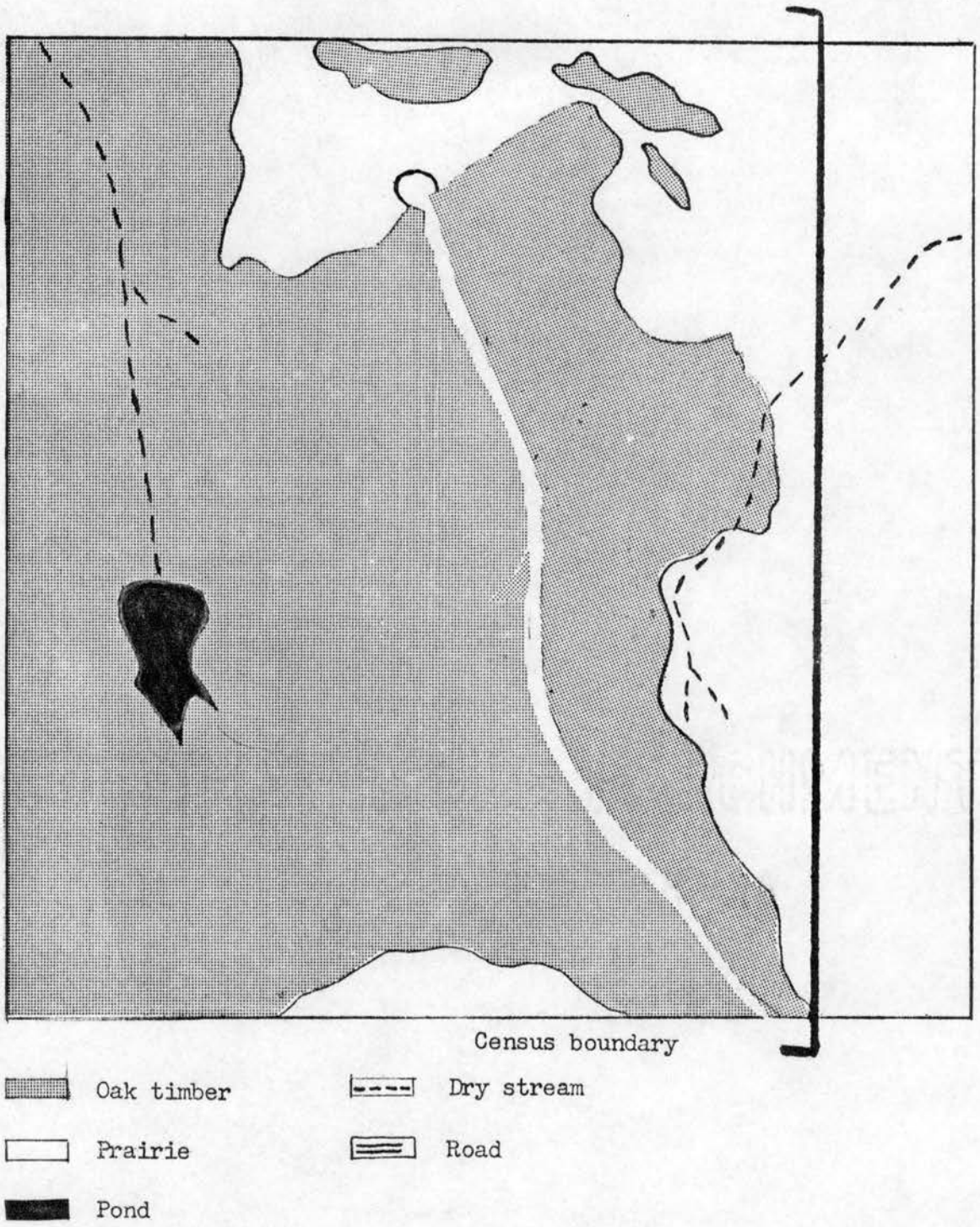

Fig. 3. Vegatation map of treated Area II.

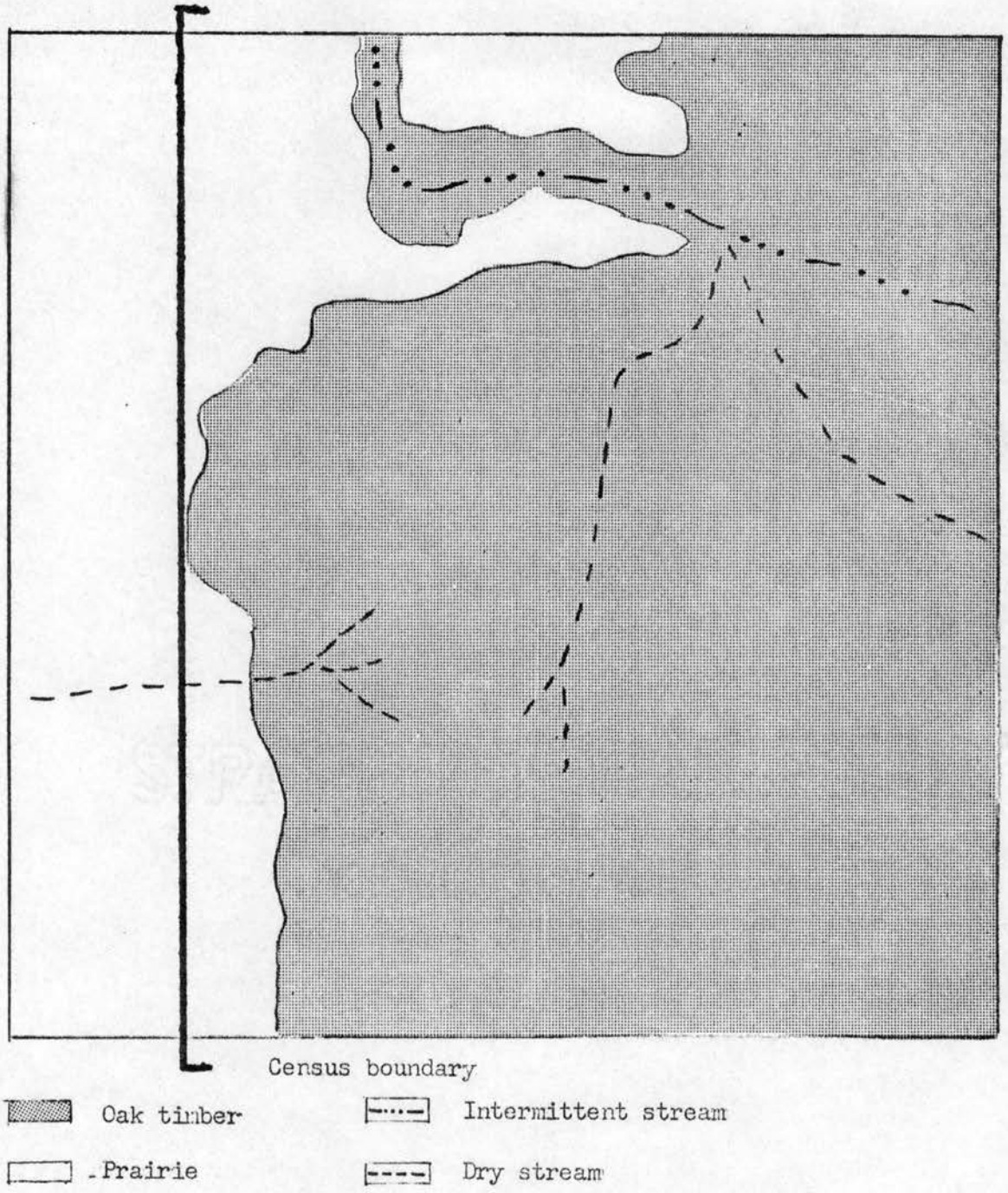

Fig. 4. Vegetation map of control Area II.

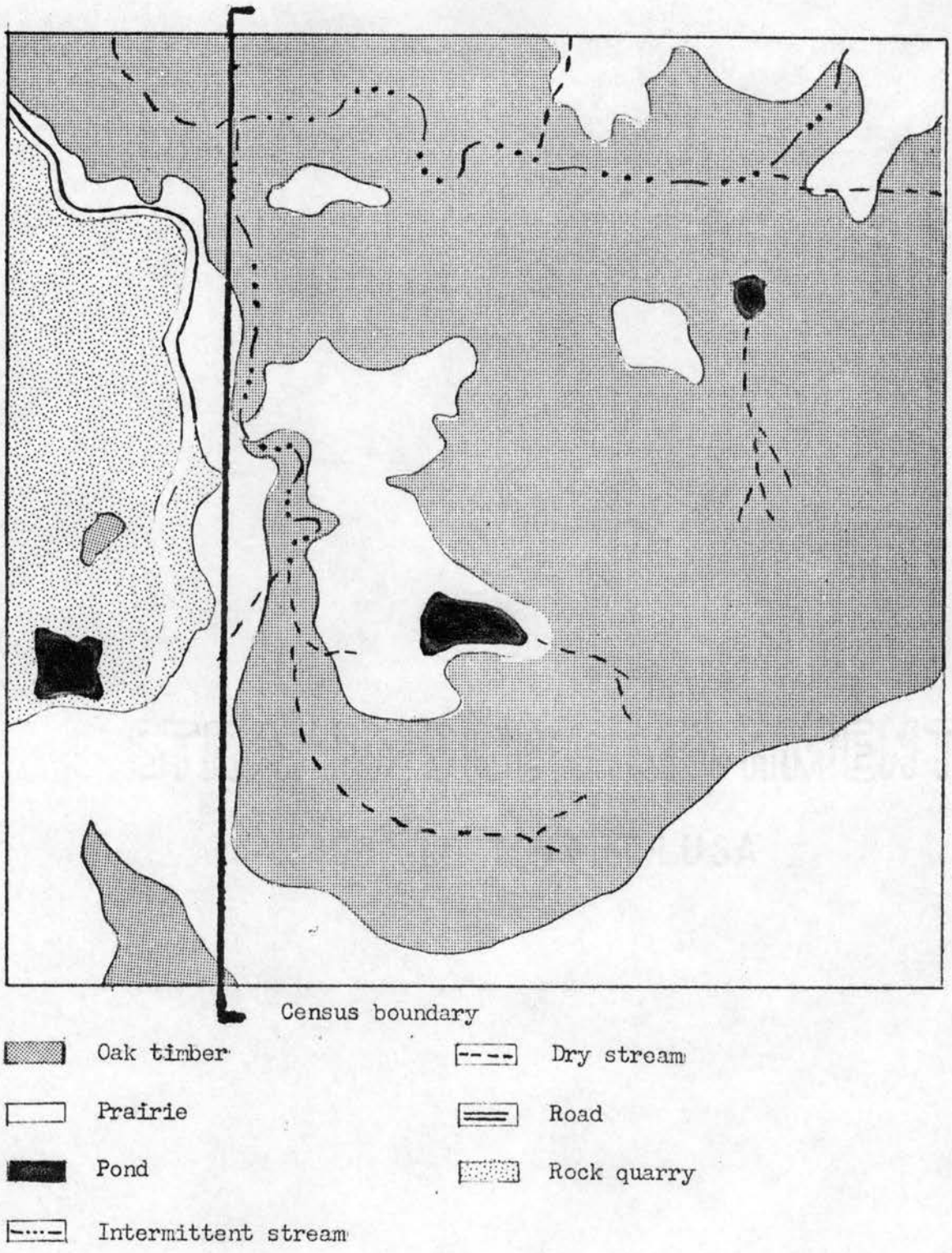

Fig. 5. Vegetation map of treated Area III.

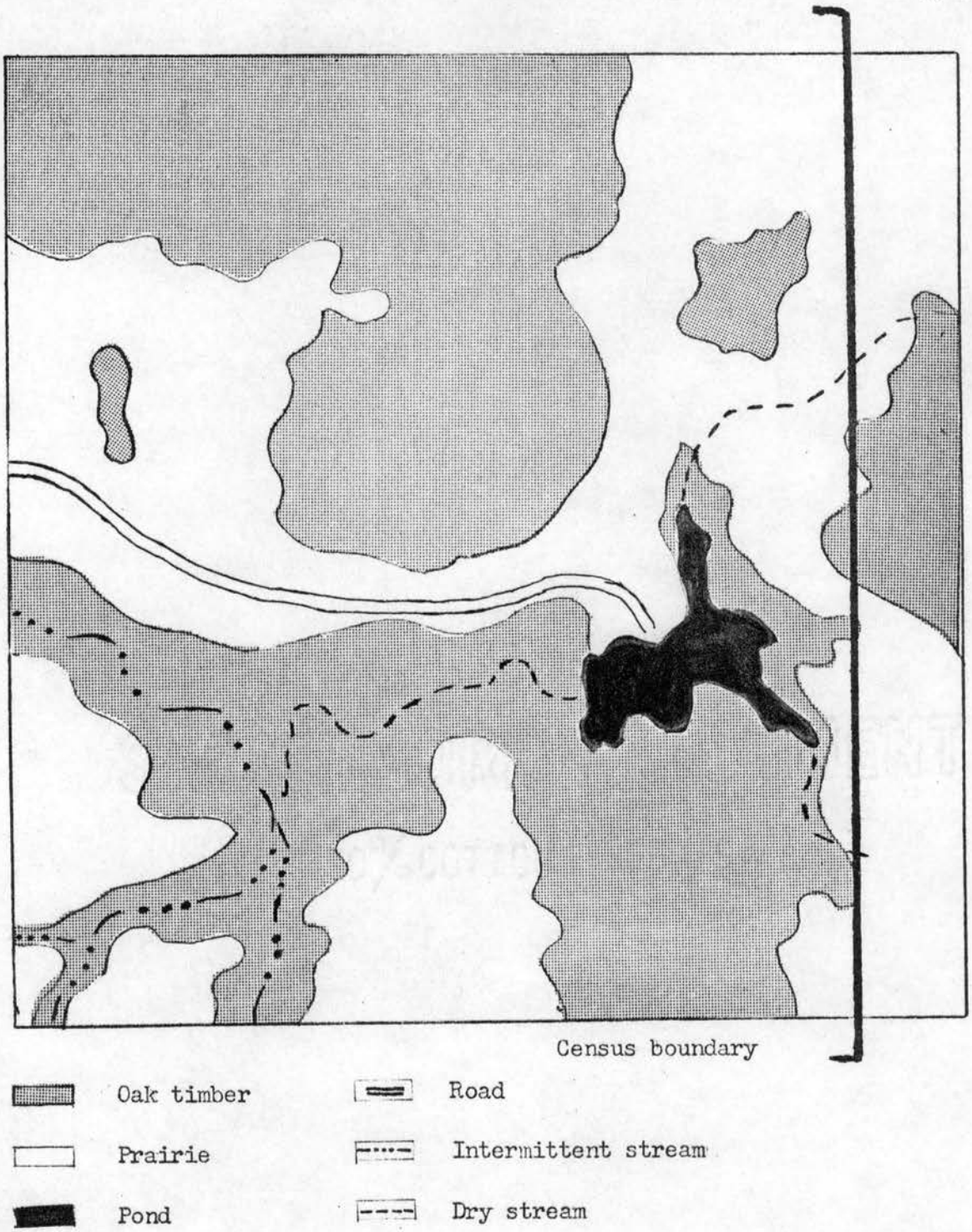

Fig. 6. Vegetation map of control Area III.

CHAPTER III

METHODS

In pursuing this study frequent censuses of the areas were conducted. Numbers of bobwhite quail, fox squirrels, cottontail rabbits, and several species of common songbirds seen were tallied on each census and a record was made of the habitat type in which each animal was found. Each study area was divided into upland timber, bottom timber, and prairie habitats. Censusing the area was accomplished by the observer aided by a Brittany spaniel bird dog. The plots were covered in 8 to 12 transects depending on the character of the woodland. Each transect was designed to cover a strip 80 to 88 yards in width. With the dog ranging on both sides and in front of the census taker, reasonably complete coverage of the plot was possible. During most of the year each area was completely censused twice per month. The study was carried on for one year to allow for seasonal variation in the use of the areas. One set of plots, treated and control, was censused on each day of observation. This was done to equalize the influence of certain variables such as general weather conditions. The time of day variable was compensated for by alternating the order in which the treated and control plots were censused.

The tree species were sampled to determine species' composition and the per cent of kill from the herbicide treatment. The "Arms' Length Rectangle Method" (Rice and Penfound 1955) was used for this purpose.

This method was used to find the density (trees per acre), frequency, and the relative frequency. The frequency is calculated as the number of points of occurrence of the species divided by the total points taken and then multiplied by 100. The relative frequency is a relationship of one species to all the other species recorded. These calculations were figured on trees and saplings and for both dead and live trees. Identification of dead trees on sprayed areas was by the leaf and bark characteristics. In recording dead and live individuals, any tree that had any green foliage was recorded as living. Many of the trees had been nearly or partially defoliated, but it was not known if the trees were making a recovery from the treatment or if they were dying.

CHAPTER IV

RESULTS AND DISCUSSION

Forest Stand Analysis

As shown by Table I the herbicide treatment does not appear to be clearly selective between the postoak and blackjack oaks. In Area I and II the percentage of kill was greater for the blackjack oak, but in the third treated area the percentage of kill of postoak saplings was much higher than the blackjack saplings.

TABLE I

A COMPARISON OF THE PERCENTAGE OF KILL BETWEEN MAJOR TREE SPECIES ON THE HERBICIDED PLOTS

Species	Area I Per Cent of Kill	Area II Per Cent of Kill	Area III Per Cent of Kill
Blackjack Trees	66%	67%	57%
Blackjack Saplings	85%	76%	17%
Blackjack Total	72%	72%	52%
Postoak Trees	53%	73%	57%
Postoak Saplings	64%	55%	55%
Postoak Total	57%	62%	57%

Many of the other tree species showed a much lower percentage of kill. This may have been due to their distribution along the ravine systems in the deeper, more moist soils.

The ground vegetation differed greatly between the sprayed and control areas. The sprayed plots had a denser, taller coverage of native grasses and forbs that were coming in after the spraying and burning. Western ragweed (Ambrosia psilostachya) was one of the most abundant of the successional plants. On sprayed plot Number III there was a heavy growth of poke weed (Phytolacca americana). The control areas in contrast had a moderate to light ground cover of native grasses with less forbs.

Postoak dominated Area Number I and blackjack dominated Area Number II (Tables II and III). Area III was intermediate to these plots in species conformation. The treated plot was mostly postoak, while the control was about 50 per cent postoak and 50 per cent blackjack (Table IV). Hickory (Carya sp.) frequently appeared in these areas. Other species were noted less frequently.

Songbird Populations and Habitat Preference

The songbirds censused were common birds which frequent this region in numbers sufficient to give a large sample size. Tables were constructed by seasonal units. Means were plotted (Fig. 7) for each of the three sets of areas. The three graphs each show the same seasonal variation between pairs of areas. Bird populations on the control areas were higher during the fall and winter months. The F test (Snedecor 1956) was used to test for significance between treated and control areas. The only area that

TABLE II

OCCURRENCES OF WOODY PLANT SPECIES ON TREATED AND CONTROL AREAS #1 BY THE ARMS LENGTH RECTANGLE METHOD

Species		Density/acre				Frequency %				Relative Frequency %			
		Live		Dead		Live		Dead		Live		Dead	
		T[1]	C[2]	T	C	T	C	T	C	T	C	T	C
Blackjack	Trees[3]	78	398	153	0	25	50	38	0	35	30	39	0
	Saplings[4]	15	45	88	0	5	20	25	0				
Postoak	Trees	153	502	173	0	30	80	30	0	41	48	32	0
	Saplings	73	105	130	0	20	35	28	0				
Hickory	Trees	0	40	0	0	0	23	0	0	0	13	0	0
	Saplings	0	105	0	0	0	40	0	0				
Dogwood	Trees	0	0	0	0	0	0	0	0	3	0	4	0
	Saplings	18	5	18	0	3	3	0	0				
Hackberry	Trees	3	10	0	0	3	5	0	0	3	3	2	0
	Saplings	0	10	0	0	0	8	0	0				
Chittamwood	Trees	3	3	3	0	3	3	25	0	3	1	14	0
	Saplings	0	5	3	0	0	0	3	0				
Elm	Trees	5	5	0	0	8	5	3	0	10	3	3	0
	Saplings	0	0	0	0	5	0	0	0				
Persimmon	Trees	0	3	38	0	0	3	0	0	0	1	2	0
	Saplings	3	0	35	0	3	0	3	0				
Chinquapin	Trees	0	2	0	0	0	3	0	0	0	1	0	0
	Saplings	0	2	0	0	3	3	0	0				
Redbud	Trees	3	0	0	0	3	0	0	0	3	0	0	0
	Saplings	43	3	0	0	5	0	3	0				

Total Kill 66%

/1 T = Treated area
/2 C = Control area
/3 Trees - an individual with diameter breast high (DBH) greater than 3".
/4 Sapling - an individual with DBH between 1" and 2.9".

TABLE III

OCCURRENCES OF WOODY PLANT SPECIES ON TREATED AND CONTROL AREAS #2 BY THE ARMS LENGTH RECTANGLE METHOD

Species		Density/acre				Frequency %				Relative Frequency %			
		Live		Dead		Live		Dead		Live		Dead	
		T	C	T	C	T	C	T	C	T	C	T	C
Blackjack	Trees	83	268	165	0	40	70	63	0	76	38	83	0
	Saplings	65	70	210	0	28	40	48	0				
Post oak	Trees	13	195	35	0	5	53	10	0	10	28	13	0
	Saplings	33	35	40	0	8	18	13	0				
Hickory	Trees	18	55	18	0	3	28	3	0	5	1	3	0
	Saplings	8	40	10	0	5	33	5	0				
Dogwood	Trees	0	0	0	0	0	0	0	0	0	5	0	0
	Saplings	0	3	0	0	0	5	0	0				
Chittamwood	Trees	0	0	0	0	0	0	0	0	0	0	0	0
	Saplings	0	3	0	0	0	3	0	0				
Elm	Trees	0	23	0	0	0	8	0	0	0	4	0	0
	Saplings	0	0	0	0	0	0	0	0				
Chinquapin	Trees	5	18	5	0	3	18	0	0	5	9	0	0
	Saplings	0	30	0	0	0	13	0	0				
Willow	Trees	0	0	0	0	3	3	0	0	5	14	3	0
	Saplings	8	15	0	0	3	3	0	0				
Plum	Trees	0	0	0	0	0	0	0	0	0	0	0	0
	Saplings	0	10	0	0	0	3	0	0				
Cottonwood	Trees	0	5	0	0	0	5	0	0	0	2	0	0
	Saplings	0	0	0	0	0	0	0	0				

Total Kill 49%

TABLE IV

OCCURRENCES OF WOODY PLANT SPECIES ON TREATED AND CONTROL AREAS #3 BY THE ARMS LENGTH RECTANGLE METHOD

Species		Density/acre				Frequency %				Relative Frequency %			
		Live		Dead		Live		Dead		Live		Dead	
		T	C	T	C	T	C	T	C	T	C	T	C
Blackjack	Trees	65	265	85	0	30	58	33	0	32	33	28	0
	Saplings	15	113	3	0	8	48	8	0				
Post oak	Trees	170	148	230	40	45	0	48	0	42	23	40	0
	Saplings	25	223	30	38	18	0	20	0				
Hickory	Trees	10	50	0	0	10	20	10	0	8	11	8	0
	Saplings	18	108	13	0	8	30	13	0				
Dogwood	Trees	0	0	0	0	0	0	0	0	3		8	
	Saplings	10	58	3	58	8	13	5	0				
Chittamwood	Trees	8	10	0	0	0	8	0	0	0	4	10	0
	Saplings	13	28	15	0	0	13	0	0				
Elm	Trees	0	18	3	0	8	10	0	0	6	6	0	0
	Saplings	5	13	0	0	5	10	0	0				
Chinquapin	Trees	0	18	0	0	0	8	0	0	0	4	0	0
	Saplings	0	5	0	0	0	0	0	0				
Plum	Trees	5	0	0	0	3	0	0	0	2	0	0	0
	Saplings	3	8	0	0	5	3	0	0				
Persimmon	Trees	0	0	0	0	0	0	0	0	0	0	0	0
	Saplings	0	0	30	0	0	0	5	0				
Redbud	Trees	0	8	0	0	0	8	0	0	0	4	0	0
	Saplings	0	30	0	0	0	8	0	0				
Hackberry	Trees	5	5	5	0	5	5	5	0	4	3	4	0
	Saplings	5	15	5	0	8	10	5	0				
Pecan	Trees	0	0	3	0	3	0	0	0	2	0	0	0
	Saplings	0	0	0	0	0	0	0	0				
Bur oak	Trees	0	8	5	0	0	13	3	0	0	7	2	0
	Saplings	0	15	0	0	0	8	0	0				
Locust	Trees	0	0	0	0	0	0	0	0	0	0	0	0
	Saplings	0	3	0	0	0	3	0	0				
Mulberry	Trees	0	5	0	0	0	5	0	0	0	3	0	0
	Saplings	0	3	0	0	0	0	0	0				
Total Kill	50%												

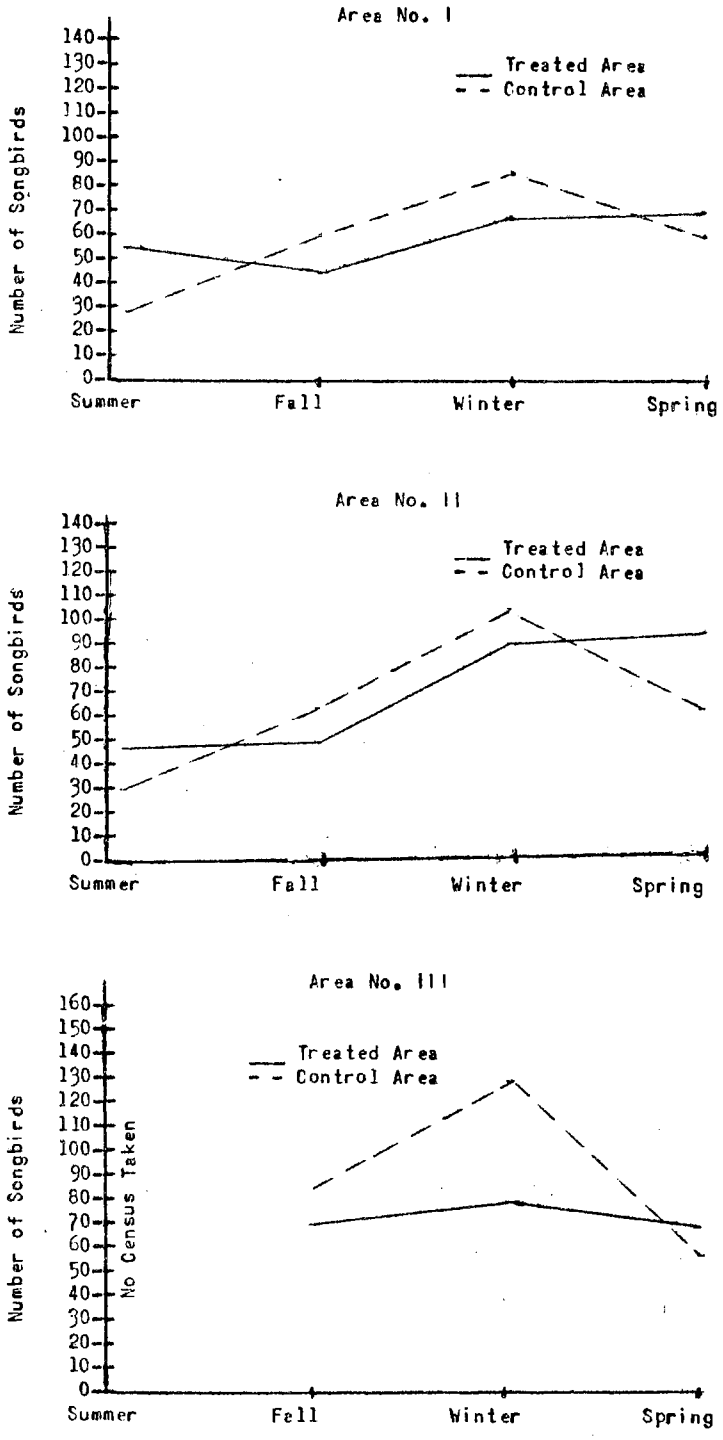

Fig. 7. Seasonal distribution of songbirds by area based on the means of monthly observations.

showed significance for the F test was Area III, where the F value for treatment was 4.25. There appeared to be interaction due to treatment on Area III. Data for Area I and for Area II showed no significance for the F test because the F values on these two areas were less than one. The fact that the three graphs all show close similarity suggests that the treatment may have affected songbird populations on all areas in a like manner. It was not the primary objective of the observer to obtain absolute numbers of wildlife populations on the areas. Rather, the primary objective was to obtain a comparison of relative numbers of wildlife between the treated and control areas. During the census period of one year the census error was assumed to be about equal between the areas (Kendeigh 1944).

For the pooled total, the control areas showed a larger number of bird sightings. The census on the control produced 3,040 individuals in 40 observations, while the treated plots totaled 2,729 individuals. It can be assumed from this that the treatment had little effect on the overall songbird population. There was, however, a marked effect on certain individual species as shown in Table V. Herbicidal treatment appeared to favor five species of songbirds; namely, the eastern bluebird, the meadowlark, the Bewick's wren, the field sparrow, and the lark sparrow. The meadowlarks and the lark sparrow were the only species that were found consistently on the prairie habitat (Tables VI to IX). Spraying provided increased ecotone and open prairie, which should increase the occurrence of these two species on sprayed land. The eastern bluebird, Bewick's wren, and field sparrow were observed primarily in the treated upland timber. The upland timber type proved to be richest in variety of species and also in the number of individuals

TABLE V

COMPARATIVE NUMBERS OF SONGBIRDS BY SPECIES ON THE COMBINED CONTROL AND ON THE COMBINED TREATED AREAS

Species	Control	Treated
Eastern Bluebird	58	213
Blue-gray Gnatcatcher	94	84
Blue Jay	485	201
Cardinal	84	73
Carolina Chickadee	347	267
Junco Sp.	169	154
Meadowlarks	225	297
Tufted Titmouse	438	332
Bewick's Wren	46	73
Field Sparrow	348	548
Lark Sparrow	21	45
Downy Woodpecker	45	38
Red-bellied Woodpecker	12	9
Yellow-shafted Flicker	164	134

TABLE VI

HABITAT TYPE PREFERENCE FOR THE SPRING* SEASON ON THE POOLED CONTROL AND POOLED TREATED AREAS

	CONTROL						TREATED					
	Prairie		Bottom		Upland		Prairie		Bottom		Upland	
Species	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed
Bobwhite	-	-	-	-	100%	5	-	-	19%	6	81%	25
Eastern Bluebird	-	-	-	-	100%	7	5%	3	16%	10	79%	49
Blue-gray Gnatcatcher	-	-	7%	6	93%	76	-	-	21%	18	79%	66
Blue Jay	-	-	31%	11	69%	25	-	-	-	-	100%	16
Cardinal	-	-	12%	1	88%	13	-	-	44%	8	56%	10
Carolina Chickadee	-	-	12%	5	88%	37	-	-	14%	6	86%	37
Juncos	-	-	40%	2	60%	3	-	-	-	-	-	-
Meadowlarks	94%	15	-	-	6%	1	36%	35	3%	3	61%	59
Tufted Titmouse	-	-	2%	6	98%	50	-	-	21%	21	79%	80
Bewick's Wren	-	-	25%	1	75%	3	-	-	21%	4	79%	15
Field Sparrow	-	-	17%	18	83%	90	-	-	6%	7	94%	118
Lark Sparrow	33%	2	10%	1	57%	3	60%	6	-	-	40%	4
Downy Woodpecker	-	-	-	-	100%	3	-	-	9%	1	91%	10
Red-bellied Woodpecker	-	-	-	-	100%	3	-	-	50%	2	50%	2
Yellow-shafted Flicker	-	-	-	-	-	-	-	-	17%	1	83%	5
Cottontail Rabbit	-	-	-	-	100%	3	-	-	-	-	100%	2
Fox Squirrel	-	-	-	-	100%	1	-	-	100%	1	-	-

* Spring - April, May, June

TABLE VII

HABITAT TYPE PREFERENCE FOR THE SUMMER* SEASON ON THE POOLED CONTROL AND POOLED TREATED AREAS

	CONTROL						TREATED					
	Prairie		Bottom		Upland		Prairie		Bottom		Upland	
Species	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed
Bobwhite	-	-	-	-	100%	22	5%	2	-	-	95%	38
Eastern Bluebird	-	-	-	-	-	-	-	-	-	-	100%	21
Blue-gray Gnatcatcher	-	-	-	-	-	-	-	-	-	-	-	-
Blue Jay	-	-	33%	3	67%	6	-	-	-	-	100%	6
Cardinal	-	-	100%	4	-	-	-	-	-	-	-	-
Carolina Chickadee	-	-	40%	6	60%	9	-	-	-	-	100%	7
Juncos	-	-	-	-	-	-	-	-	-	-	-	-
Meadowlarks	38%	9	17%	4	45%	11	51%	30	-	-	49%	29
Tufted Titmouse	-	-	-	-	100%	6	-	-	14%	1	86%	6
Bewick's Wren	-	-	-	-	100%	6	-	-	14%	1	86%	6
Field Sparrow	-	-	35%	7	65%	13	2%	1	24%	13	74%	40
Lark Sparrow	67%	2	-	-	33%	1	77%	10	-	-	23%	3
Downy Woodpecker	-	-	33%	2	67%	4	-	-	67%	2	33%	1
Red-bellied Woodpecker	-	-	-	-	-	-	-	-	-	-	100%	2
Yellow-shafted Flicker	-	-	39%	12	61%	19	-	-	9%	3	91%	29
Cottontail Rabbit	-	-	-	-	100%	3	-	-	-	-	100%	5
Fox Squirrel	-	-	60%	3	40%	2	-	-	-	-	-	-

* Summer - July, August, September

TABLE VIII

HABITAT TYPE PREFERENCE FOR THE FALL* SEASON ON THE POOLED CONTROL AND POOLED TREATED AREAS

	CONTROL						TREATED					
	Prairie		Bottom		Upland		Prairie		Bottom		Upland	
Species	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed
Bobwhite	-	-	35%	15	65%	28	-	-	21%	15	79%	56
Eastern Bluebird	-	-	13%	3	87%	21	-	-	-	-	100%	34
Blue-gray Gnatcatcher	-	-	42%	5	58%	7	-	-	-	-	-	-
Blue Jay	-	-	23%	40	77%	132	2%	2	27%	27	71%	71
Cardinal	-	-	46%	12	54%	14	-	-	31%	4	69%	9
Carolina Chickadee	-	-	28%	27	72%	71	-	-	29%	28	71%	68
Juncos	-	-	41%	13	59%	19	-	-	82%	18	18%	4
Meadowlarks	38%	37	26%	25	36%	35	51%	28	-	-	49%	27
Tufted Titmouse	-	-	34%	13	66%	25	-	-	32%	9	68%	19
Bewick's Wren	-	-	57%	13	43%	10	-	-	29%	6	71%	15
Field Sparrow	2%	2	24%	24	74%	73	-	-	16%	27	84%	138
Lark Sparrow	80%	8	-	-	20%	2	18%	3	-	-	82%	14
Downy Woodpecker	36%	5	-	-	64%	9	-	-	29%	2	71%	5
Red-bellied Woodpecker	-	-	33%	1	67%	2	-	-	100%	1	-	-
Yellow-shafted Flicker	-	-	34%	16	66%	31	-	-	29%	18	71%	45
Cottontail Rabbit	-	-	14%	1	86%	6	-	-	25%	2	75%	6
Fox Squirrel	-	-	36%	5	64%	9	-	-	-	-	-	-

* Fall - October, November, December

TABLE IX

HABITAT TYPE PREFERENCE FOR THE WINTER* SEASON ON THE POOLED CONTROL AND POOLED TREATED AREAS

	CONTROL						TREATED					
	Prairie		Bottom		Upland		Prairie		Bottom		Upland	
Species	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed	%	No. Observed
Bobwhite	-	-	-	-	100%	16	-	-	-	-	100%	34
Eastern Bluebird	12%	3	18%	5	70%	19	5%	5	2%	2	93%	89
Blue-gray Gnatcatcher	-	-	-	-	-	-	-	-	-	-	-	-
Blue Jay	-	-	28%	74	72%	194	-	-	12%	8	88%	71
Cardinal	-	-	13%	5	87%	35	-	-	24%	10	76%	32
Carolina Chickadee	-	-	19%	37	81%	155	-	-	17%	20	83%	101
Juncos	-	-	52%	68	48%	64	-	-	30%	39	70%	93
Meadowlarks	13%	11	15%	13	72%	64	47%	41	-	-	53%	45
Tufted Titmouse	2%	5	17%	57	81%	276	-	-	18%	35	82%	161
Bewick's Wren	-	-	31%	4	69%	9	-	-	-	-	100%	26
Field Sparrow	-	-	12%	15	88%	106	3%	7	7%	15	90%	182
Lark Sparrow	-	-	100%	2	-	-	40%	2	40%	2	20%	1
Downy Woodpecker	-	-	45%	10	55%	12	-	-	6%	1	94%	16
Red-bellied Woodpecker	-	-	33%	2	67%	4	-	-	-	-	100%	2
Yellow-shafted Flicker	-	-	28%	24	72%	62	-	-	33%	11	67%	22
Cottontail Rabbit	17%	1	-	-	83%	5	-	-	-	-	100%	6
Fox Squirrel	-	-	50%	5	50%	5	-	-	-	-	-	-

* Winter - January, February, March

seen. For the most part the bluebird can be considered as an upland bird. Occasional sightings were made in the prairie and bottom timber, but out of 427 sightings, 92 per cent were in the upland timber. This habitat type provided an open situation with scattered live clumps of oaks and the dead oaks and snags. Dead snags with hollows are thought to provide the bluebird with increased nesting areas. Several families of young were observed on the treated areas which indicated that the bluebirds had a successful nesting season.

There were five species that the treatment appeared to affect adversely. The blue jay, the Carolina chickadee, the Junco spp., the tufted titmouse, and the yellow-shafted flicker were found in larger concentrations on the control plots. These species were observed frequently in the bottom timber. The fact that they preferred the heavier timber may be the reason they did not frequent the sprayed areas. The cardinal was seen in the bottom habitat type more than one-third of the time (Tables VI to IX). The cardinal is known primarily as a bird of brushy cover along ravine systems (Baumgartner and Lawrence 1953).

Bobwhite Populations and Habitat Preference

The bobwhite population for this region was generally considered to be low during the year of this study. Low population was one factor that made it difficult to compare quail populations between the treated and control areas. Fig. 8 indicates that the number of quail varied from month to month. The bobwhite has a relatively extensive home range and some coveys may have not been on the study areas at the time when the census was taken. Furthermore, coveys of bobwhite are not easy to

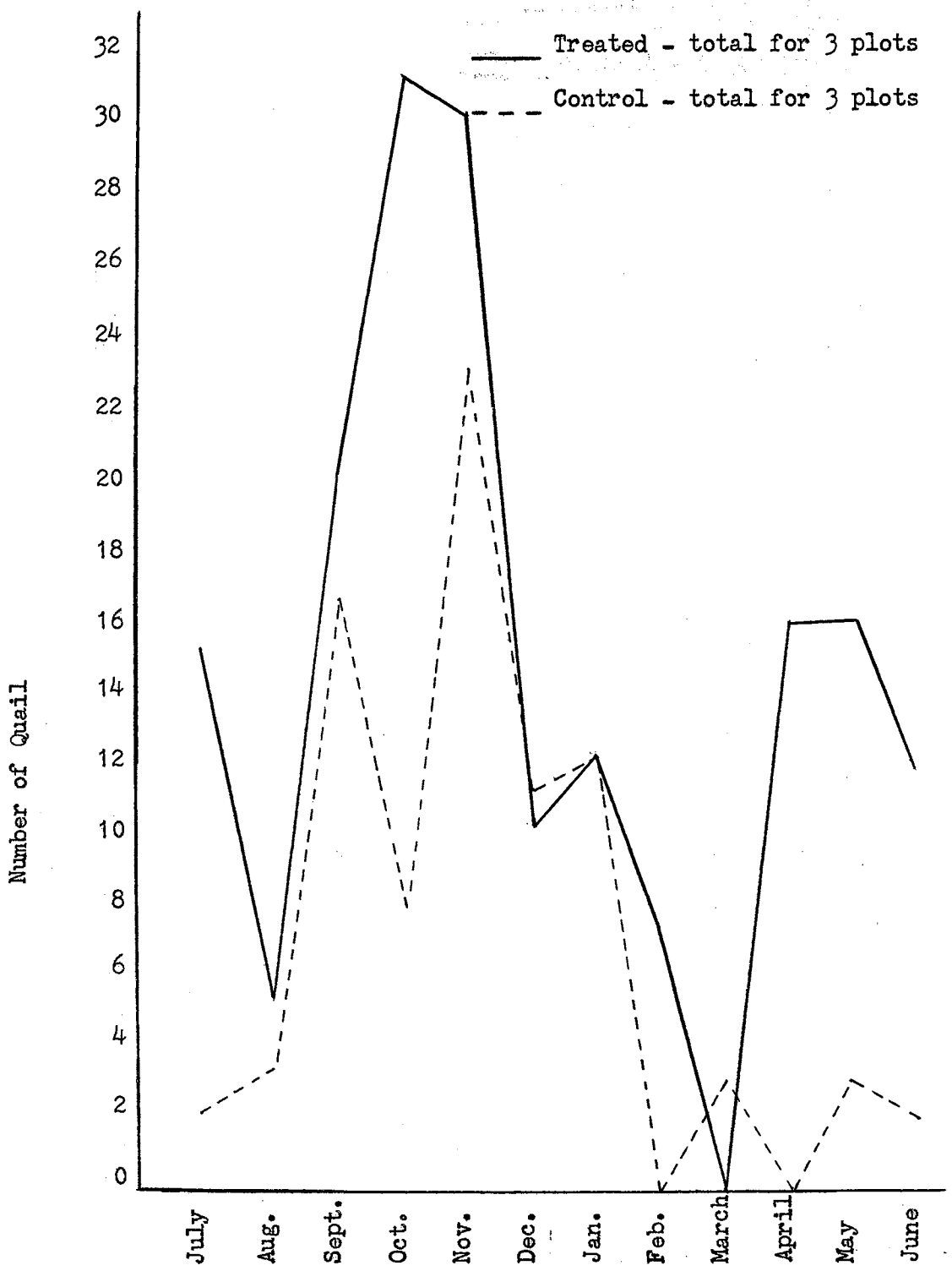

Fig. 8. Number of bobwhites counted per month on study areas.

locate. Census tallies showed that the treated area supported a larger population of bobwhite. Based on a total of 40 observations for each area, there were 176 quail sightings on the three treated areas and 86 sightings on the control areas. These results suggest that the treated areas hold a larger percentage of bobwhite. Bobwhite were encountered primarily in the upland timber on both treated and control areas. On all the areas a combined total of 224 quail sightings were made in upland timber habitat while only 36 sightings were recorded in the bottomland timber and two in the prairie association. The heaviest use of the bottom cover took place during the fall (Table VIII). A higher density of population would have made it possible to make enough observations to draw more definite conclusions.

Cottontail Rabbit Populations and Habitat Preference

Only 40 sightings of rabbits were made, 21 on the treated areas and 19 on the control areas. Insufficient sample size makes it impossible to draw any definite conclusions as to effects of treatment. There appeared to have been no marked adverse effects. Since no crowding was apparent it was assumed that the cottontail occupied the most desirable habitat situations available. If this is true, the cottontail found equally suitable habitat on the sprayed areas and on the control areas. Of the 40 sightings of rabbits observed, 90 per cent were found in the upland timber.

Fox Squirrel Populations and Habitat Preference

Fox squirrels showed a marked reaction to the herbicide treatment. In the 40 censuses of the treated areas, only one squirrel was sighted. This is in sharp contrast to 30 sightings made on the control areas.

Fresh signs, e.g., diggings, tracks, and hulled nuts were observed regularly throughout the year in the control areas. New nests and den trees were also located in the control areas. Many live clumps and scattered individual trees could provide cover for the squirrels on the treated areas. The absence of squirrels would lead one to believe that factors other than adequate cover and the presence of den trees influence their distribution

Fox squirrels were sighted more often in the fall and winter (Tables VIII and IX), when the absence of foliage increased visibility. The data collected (Tables VI to IX) fail to show a marked preference on the part of the fox squirrel either for bottomland timber or for upland timber.

In the years to come the composition of the vegetation on the treated areas may continue to change. The proportion of the woodlands may decrease as additional trees die. Dependent upon grazing practices, weather, and other environmental factors there may be a recovery of the woody species. Escape cover, nesting sites, and food provided by woody plants are essential elements in the habitat types of many game and non-game species.

If present wildlife populations are to be maintained a planned spraying program to leave strips or blocks of oak cover will be necessary. If this program is not undertaken then prairie inhabiting species should increase and species that require woodlands will decline in numbers.

CHAPTER V

SUMMARY AND CONCLUSIONS

This study was undertaken to provide information on the environmental effects which the herbicidal spraying of postoak-blackjack woodlands may have on wildlife populations. Control and treated areas were established and a monthly census of these areas was made for the year, July 1964 to June 1965. The species censused were the bobwhite quail, cottontail rabbit, fox squirrel, and several species of songbirds.

Songbirds and fox squirrels showed a more definite response to the destruction of dense oak woods than either the bobwhite or cottontail rabbit. In general the songbirds exhibited a preference for the treated areas in the spring and summer months but were more numerous in the control areas during the fall and winter months. Bobwhites were seen more often in the upland timber of the herbicided plots. The cottontail rabbit's distribution apparently was not affected by the treatment. The fox squirrel showed the most drastic reaction to the spraying. The squirrels' habitat was apparently altered to such a degree that most of the squirrels left the treated plots. No nests or signs were found in any of the treated plots and only one squirrel was seen on a treated plot during the entire year.

These data suggest that spraying with the herbicide did not alter the attractiveness of the areas to any major degree for the bobwhite quail, the cottontail rabbit, or certain species of songbirds. The

data imply that, for all practical purposes, the fox squirrel habitat was completely destroyed.

If the bobwhite quail and cottontail rabbits had been more numerous, more conclusive information concerning the effects of the herbicide application to vegetation on their welfare might have been obtained. Results of this study suggest that continued investigation would be desirable in evaluating the effects of herbicides on the habitats of wildlife species and ultimately the densities of their populations.

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APPENDIX

Common and Scientific Names of Trees Sampled on the Areas

Blackjack oak	- *Quercus marilandica*
Postoak	- *Quercus stellata*
Burroak	- *Quercus macrocarpa*
Chinquapin oak	- *Quercus muhlenbergii*
Hickory	- *Carya* spp.
Dogwood	- *Cornus drummondii*
Hackberry	- *Celtis* spp.
Chittamwood	- *Bumelia lanuginosa*
Elm	- *Ulmus* spp.
Persimmon	- *Diospyros virginiana*
Red bud	- *Cercis canadensis*
Willow	- *Salix nigra*
Plum	- *Prunus* spp.
Cottonwood	- *Populus deltoides*
Pecan	- *Carya illinoensis*
Locust	- *Gleditsia tricanthos*
	- *Robinia pseudoacacia*
Mulberry	- *Morus rubra*

Common and Scientific Names of Songbirds Observed on the Areas

Eastern bluebird	- *Sialia sialis*
Blue-gray gnatcatcher	- *Polioptila caerulea*
Blue jay	- *Cyanocitta cristata*
Cardinal	- *Richmondena cardinalis*
Carolina chickadee	- *Parus carolinensis*
Juncos	- *Junco* spp.
Meadowlarks	- *Sturnella* spp.
Tufted titmouse	- *Parus bicolor*
Bewick's wren	- *Thryomanes bewicki*
Field sparrow	- *Spizella pusilla*
Lark sparrow	- *Chondestes grammacus*
Downy woodpecker	- *Dendrocopos pubescens*
Red-bellied woodpecker	- *Centurus carolinus*
Yellow-shafted flicker	- *Colaptes auratus*

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