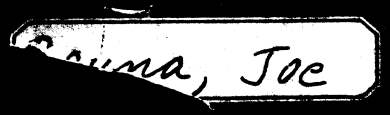
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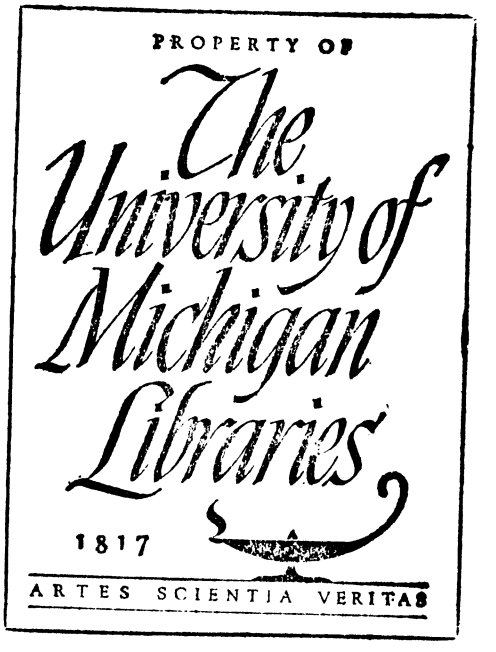

PHEASANT POPULATION FLUCTUATIONS ON AN AREA OF MEDIUM TO LOW PRODUCTIVITY IN SCIO TOWNSHIP, WASHTENAW COUNTY, MICHIGAN

by

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLE OF MAPS AND FIGURES

TABLE OF TABLES

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The author would like to express sincere appreciation to Drs. Warren Chase and E. C. O'Roke for advice and help in compiling this manuscript. The sympathy and encouragement of Dr. Warren Chase has made the task seem worthwhile. Mr. Charles Shick and R. A. MacMullan, of the Michigan Game Division, graciously furnished state-wide pheasant information. My sincere thanks to Mr. John Gwin, University administrative assistant, for the use of his fine dog for census work.

I

INTRODUCTION

Research in pheasant ecology is not new and has been going on for some twenty years. Most of the ecological and population studies have been conducted on areas of medium to high pheasant density. There are exceptions such as the Michigan Rose Lake Wildlife Experiment Station studies (1939-1949).

In many cases areas of medium to low pheasant density are the only ones available to numerous hunters because of time limitations or prohibitive distances to more productive areas. These areas act as buffers for the highly productive pheasant lands and absorb their share of the hunting pressure. The mortality and productivity rate for these "low" areas is not well known. For this reason the study was conducted on such a low producing area in order to ascertain the level of pheasant populations and their productivity. It was started the first week of September, 1948, and all field work terminated on May 19, 1948. A previous population and nesting study was started in the spring of 1948, but met with disaster when the author was hospitalized. Some of the material collected during this previous study

will be used in this manuscript when deemed necessary to strengthen or substantiate a point under discussion.

The history of the ring-necked pheasant (Phasianus colchicus torquatus) in Michigan, since its introduction in 1893, reveals that it was successful from the start in a farming economy. Regular state releases began in 1917 (Linduska, 1947) and have continued since then. Pheasant populations have increased so rapidly that by 1925 an open season was declared. The peak was attained in 1944 when the hunting kill reached 1.5 million. Since then, the kill has been steadily declining, but recent census data indicates that the birds are on their way up again.

The army of pheasant hunters has been steadily increasing over the years and may continue for some time. For this reason all available pheasant range should be open to hunting in order to distribute hunting pressure. The "low" areas will become increasingly more important if the hunter trend continues. Therefore, more should be known about their productivity for future management purposes.

II

STUDY AREA

Size and Location

The study area is located six miles due west of Ann Arbor and consists of sections 28, 29, 31, 32, and 33, Scio Township, Washtenaw County, Michigan. The area is easily accessible from Ann Arbor by good secondary gravel roads. Liberty Road leads directly from Ann Arbor to the area and bisects it. The area is bordered on the south by Scio-Church Road, on the west by Parker Road, and by Zeeb Road on the east. The 3,150 acres are divided among nineteen land owners mostly of German-Lutheran extraction.

Soils

A majority of the soils on the area are of the glacial non-porous type and were deposited by the Huron-Erie lobe as terminal and ground moraines. There are also some glacial porous soil types. They are predominantly loams and sandy-loans which are not durable and the majority are rated as first and second class in productivity (Veatch, Wheeting, Bauer, 1930). The largest soil type is Bronson loam followed by Carlisle muck and Miami loam. There are nine soil types represented on the area.

The retreating glacier deposited till, leaving behind a gently rolling topography. Although a majority of the area is level, well-drained land, some parts have slopes with gradients up to ten percent. Most of the area is naturally drained. The general elevation of the highest land is 898 feet.

Two small creeks run through the area and their beds have been dredged for their entire distance.

Cover Types and Acreage

The marsh and woodland types are generally well distributed for wild pheasant purposes. Woodlot sizes range from two to 104 acres while the largest marsh is sixty-five and the smallest two acres. Woods average 12.6 percent and marshes 8.18 percent of the total land area (Table 3).

Woodlots are composed of various associations of hardwoods, in which the principal species are red oak, white oak, elm, basswood, hickory, ash, and sugar maple. Tamarack, aspen, and willow are the principal trees of the wetter swamps.

In the marshes the characteristic growth is brome grass, sedges, cattails, willow, red-osier dogwood, spirea, and shrubby cinquefoil. The best marsh for pheasants, fall and winter, is the spirea-willow marsh in the northeast corner of section 32 adjoining Liberty Road. In all further

reference it will be called spirea-willow marsh as that is the dominant cover type. This marsh is extremely dense toward the center making it difficult, but not impossible, for a man to go through it.

Climate

The climate of Washtenaw County is characterized by fairly cold winters and mild summers (Veatch, Wheeting, and Bauer, 1930). Wind movement and evaporation are low; humidity is moderately high and the county receives 50 percent of possible sunshine.

The average length of the frost-free period is 164 days, from May 2 to October 13, and this is ample time to mature the crops grown. The mean annual precipitation is 31.3 inches including melted snow, and is fairly evenly distributed throughout the year. Snowfall averages about 37 inches yearly. The mean annual temperature is 47.4° Fahrenheit. The prevailing winds are westerlies and rarely attain high velocities.

For the last several years there have been heavy rains in late April and early May. They may have had some affect on pheasant brook and nest survival as the population has been decreasing during this time. If these rains come early enough in the spring, they discourage lowland nesting and consequently the nest loss is not as great in case of flooding. However,

if the heaviest rains fall after nesting is well along there is a high nesting loss caused by flooding of the lowlands.

TABLE I

NORMAL MONTHLY MEAN TEMPERATURE AND PRECIPITATION AT ANN ARBOR, WASHTENAW COUNTY, MICHIGAN (Veatch, Wheeting, and Bauer, 1930)

	Average Temp. °F.	Aver. Precip. Inches	Aver. Snow Depth Inches
January	22.6°	1.89"	9.4"
February	23.2	1.81	9
March	33	2.21	5.6
April	45.8	2.63	.8
May	57.5	3.52	.2
June	67	3.44	
July	71.7	2.94	
August	69.2	2.72	
September	62.8	2.95	
October	50.6	2.64	.1
November	37.8	2.49	.3
December	27	2.07	9.1

Type of Agriculture

Hill (1939) classified 65 percent of the farms in this area as general and dairy farms in the 1930 census. Regions that are not especially well adapted to one or more enterprises, usually have a variety, which is characteristic of this area.

About 64 percent of the area is tillable, while the

rest is in woodlots, marshes, and idle land. Woodlots make up 12.6 percent of the total land area, marshes 8.18 percent and pasture 13.9 percent.

The major livestock enterprise is dairying, and most of the milk is sold as fluid milk. The large nearby markets encourage dairy and poultry production. There is some rolling and non-tillable pasture which favors the sheep enterprise. Livestock, poultry, sheep, and hogs are each about equal in importance as far as income is concerned.

Table IV shows that 64 percent of the total marsh area is grazed. Many of these grazed marshes are beaten down and full of hummocks which decrease their value for wildlife cover. The grazing season is about seven months long, starting in mid-April and running into late October or early November.

The main crops are winter wheat, hay, corn, oats, and barley. Many of the crops are for home consumption or are fed to the livestock. The few cash crops are corn and winter wheat.

The average amount of the total area in corn is 17.44 percent or 549.4 acres. Section 31 had the largest acreage in corn, followed by sections 29, 33, 32, and 28 in order of occurrence. Leedy and Hicks in Ohio (McAtee 1945) found the ideal land conditions for pheasants were to have 25-35 percent

of the area in corn, 25-30 percent in other grains and 5-10 percent in brush and woods. Table III shows that the area falls somewhat short of the ideal condition.

All the farmers practice rotation farming and there is little variation among their systems. The length of rotation is about five or six years, depending upon the individual farmer. Usually, corn and grain were followed by legumes to keep up soil fertility. The amount of hay crops and length of time they occupy in the rotation, depends upon the numbers of livestock raised.

The following rotation was the most commonly used, but was modified by individual farmers to meet their requirements.

TABLE II

COMMON ROTATION

Year	1	2	3	4	5
Crop	Corn	Oats or barley	Wheat or barley	Timothy, clover or alfalfa	Timothy and clover or alfalfa

Clover is usually sown as a cover crop with the grains. The timothy and clover are usually held over for three years, but alfalfa may be left for as long as four years.

Only 37.4 percent of the woodlots was grazed, mainly

TABLE III

ACREAGE IN COVER TYPES AND CROPS BY SECTIONS

Section 33:

	Woods	Corn	Marsh	Pasture	Others	Totals
Acres	90.9	135.7	18.9	56.6	327.9	630
Percent of total	14.42	21.53	3.0	8.98	45.77	100

Section 32:

	Woods	Corn	Marsh	Pasture	Others	Totals
Acres	39.2	79.9	79	84.2	347.7	360
Percent of total	6.22	12.68	12.53	13.36	55.21	100

Section 31:

	Woods	Corn	Marsh	Pasture	Others	Totals
Acres	40.6	145.7	26.8	95.1	87.8	630
Percent of total	6.45	23.12	4.25	15.09	51.09	100

Section 29:

	Woods	Corn	Marsh	Pasture	Others	Totals
Acres	90.9	135.7	18.9	56.6	327.9	630
Percent of total	14.42	21.53	3.0	8.98	45.77	100

Section 28:

	Woods	Corn	Marsh	Pasture	Others	Totals
Acres	159.4	74.9	57	136.7	202	630
Percent of total	25.3	11.88	9.04	21.69	32.09	100

Average for Total Area:

	Woods	Corn	Marsh	Pasture	Others	Totals
Acres	396.9	54.94	257.8	439.3	1506.6	3150
Percent of total	12.6	17.44	8.18	13.94	47.84	100

because many are too wet to admit livestock. Practically all the woodlots were heavily cut during the winter or at some previous time. Very little timber is used for lumber as most of it is cord wood and fence post material.

A majority of the farmers brush out fence rows or ditch bank cover early in the spring, thus destroying valuable cover and travel lanes for pheasants. They also plow as close to the fence row as possible. Spring burning of marshes is not a general practice on this area, much to the benefit of wildlife.

TABLE V

UNGRAZED AND GRAZED WOODS AND PASTURE

	Grazed Woods	Ungrazed Woods	Grazed Marsh	Ungrazed Marsh
Acres	147.2	248.4	187.6	92.6
Percent of Total	37.42	62.58	64.09	35.91

Cover Maps

The cover type maps were obtained from the school's Department of Wildlife Management and were produced by students in previous years as part of their wildlife training. The procedure was to map each section by compass and pacing,

putting in the various cover types in symbols which were developed by Graham (1945). To check the accuracy of the maps and the possibility of changing fence lines and cover types, each section was covered thoroughly on foot and all corrections made in the field. Crops shown are for the year 1948. Since corn was the most important crop and major staple pheasant food during fall and winter it was designated on the maps.

N

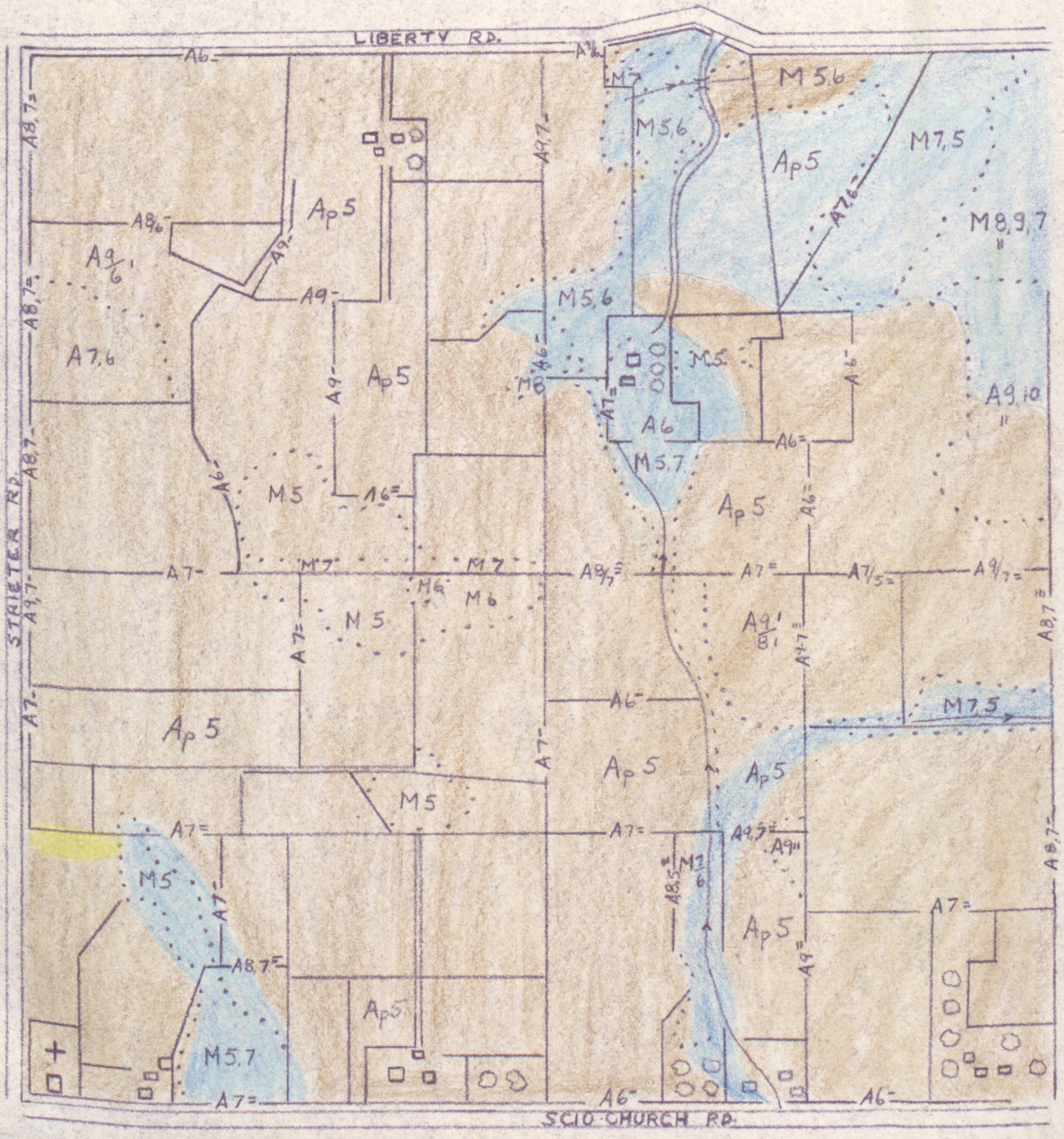
SEC. 33 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE

SOIL MAP

LEGEND:

- BRONSON LOAM
- BRONSON SANDY LOAM
- CARLISLE MUCK
- MIAMI LOAM
- BROOKSTON LOAM



SOIL MAP

LEGEND

BRONSON LOAM

CARLISLE MUCK

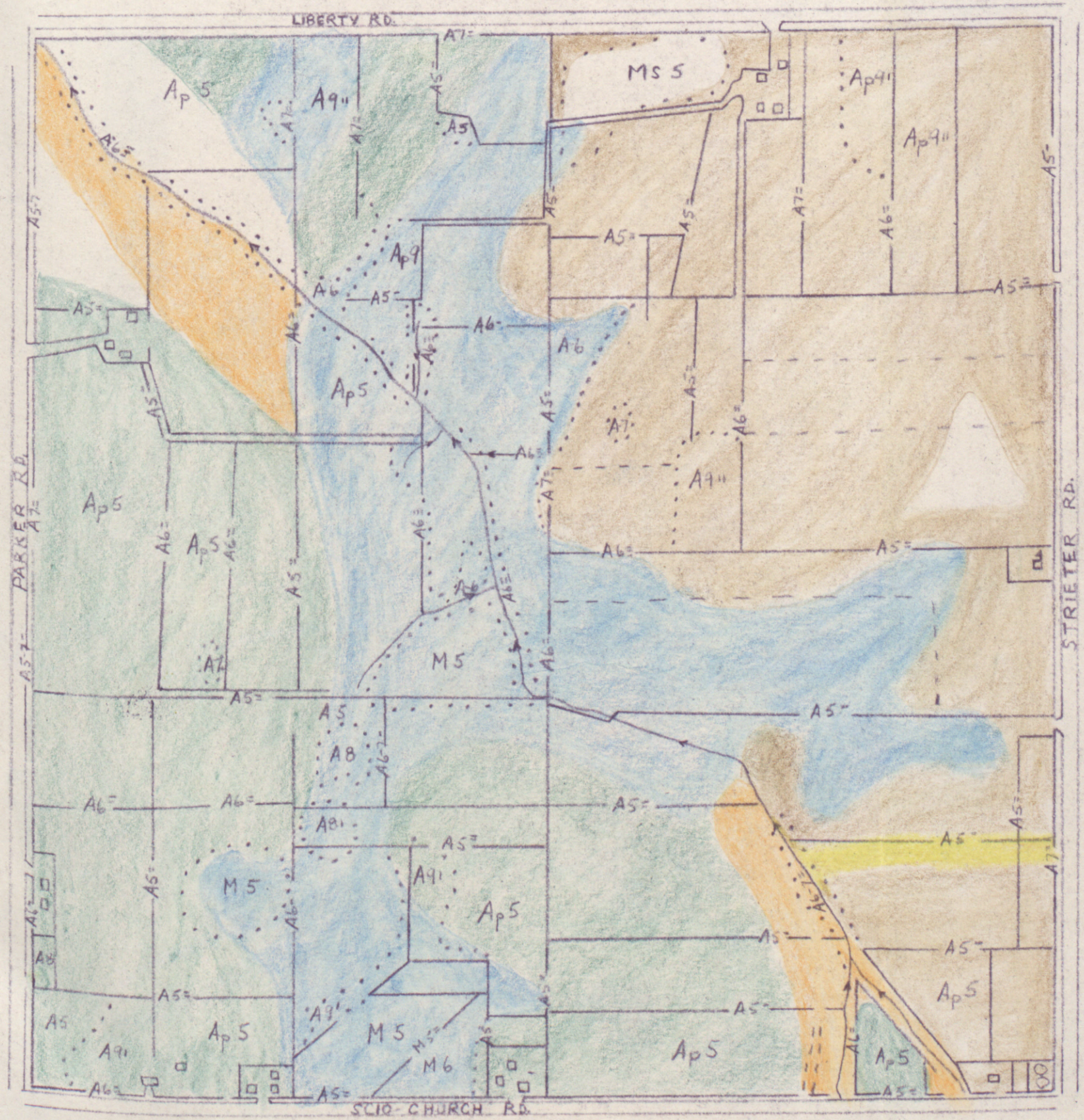
WASHTENAW LOAM

N

SEC.32 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:

1/8 MILE



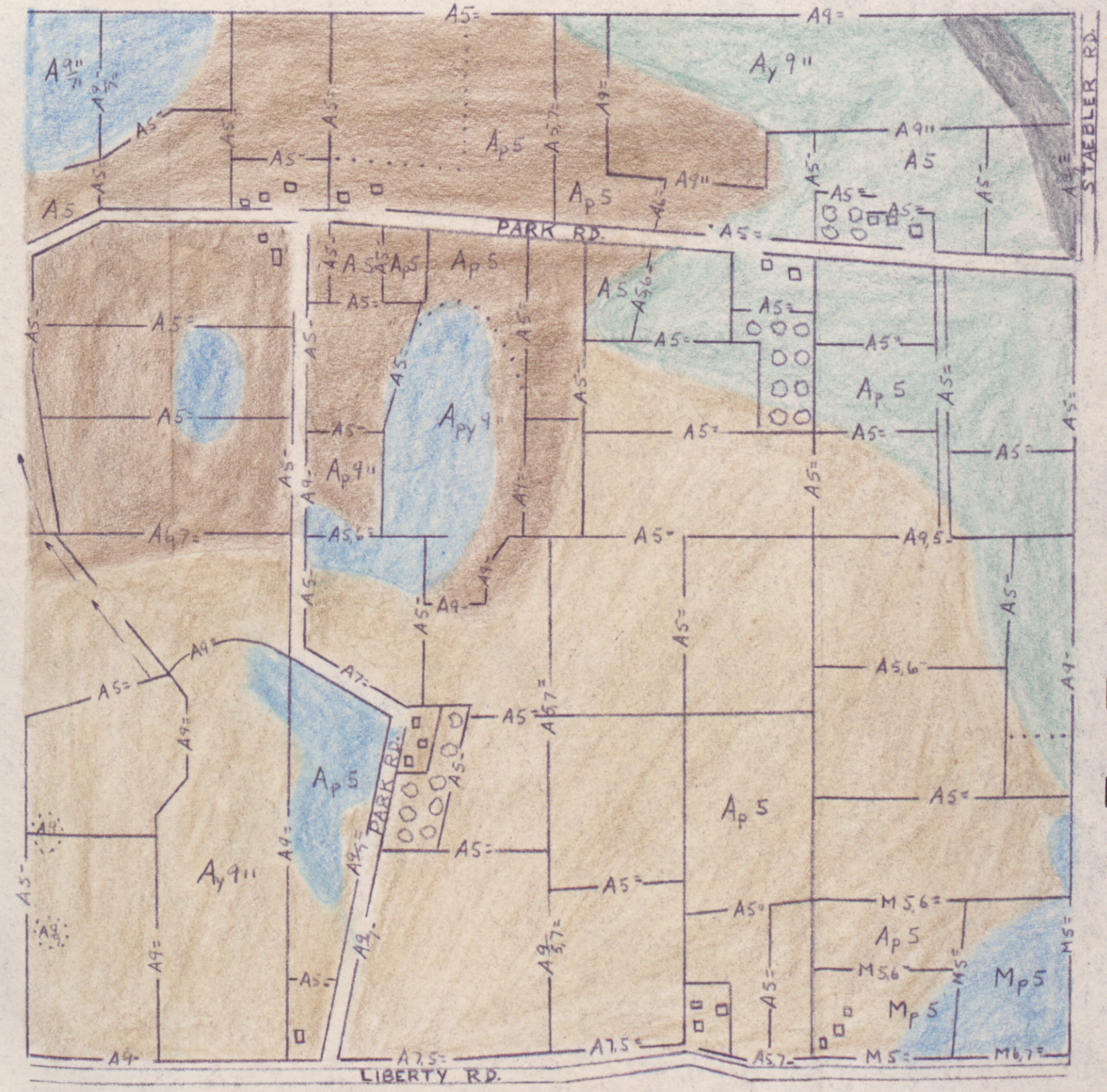
SOIL MAP

LEGEND

- BRONSON LOAM
- CARLISLE MUCK
- BROOKSTON LOAM
- GRIFFIN LOAM
- MIAMI LOAM
- WASHTENAW LOAM

SEC. 31 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE



SOIL MAP

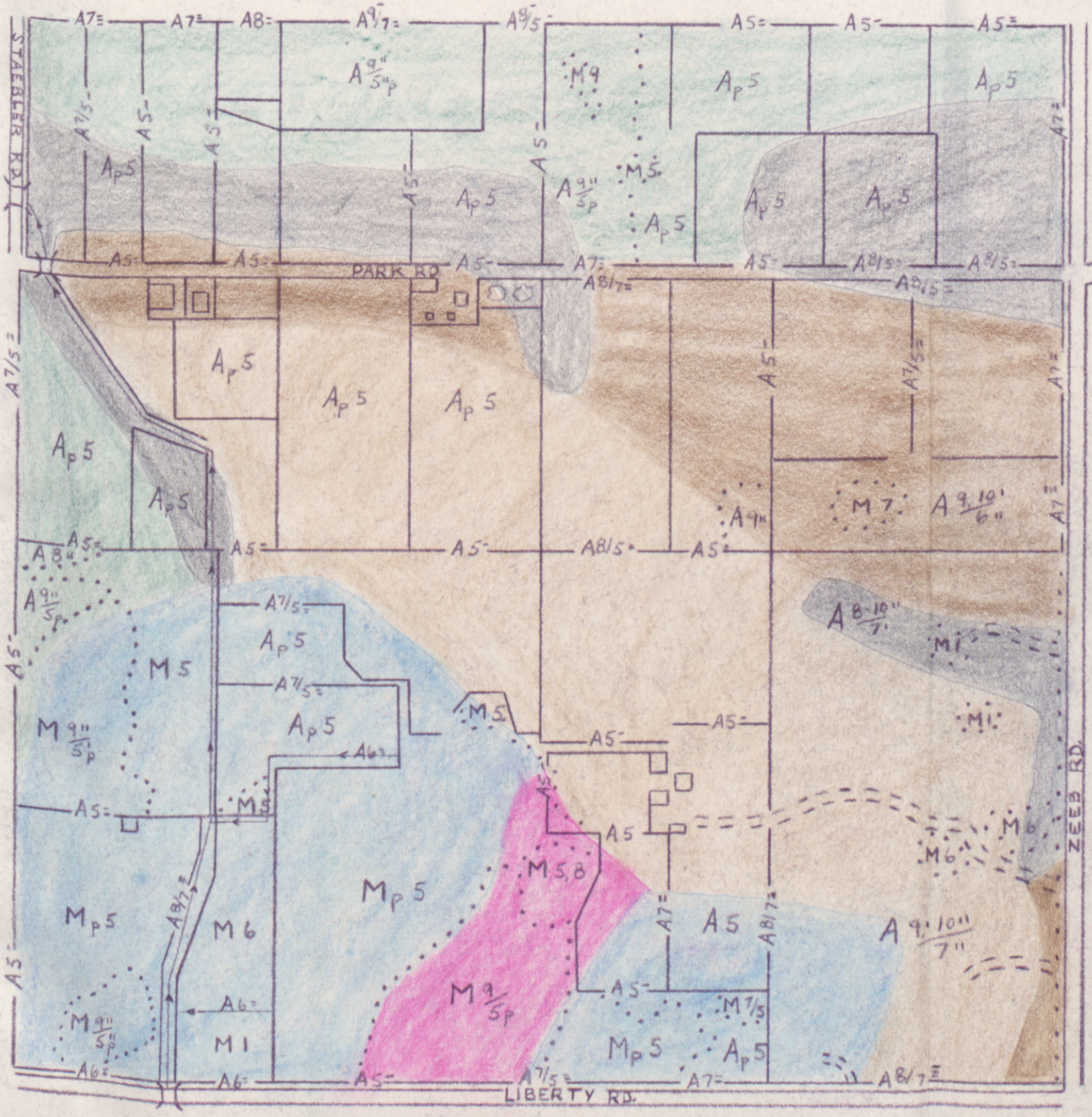
LEGEND

- BRONSON SANDY LOAM
- CARLISLE MUCK
- BRONSON LOAM
- MIAMI LOAM
- GILFORD LOAM

N

SEC. 29 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE



SOIL MAP

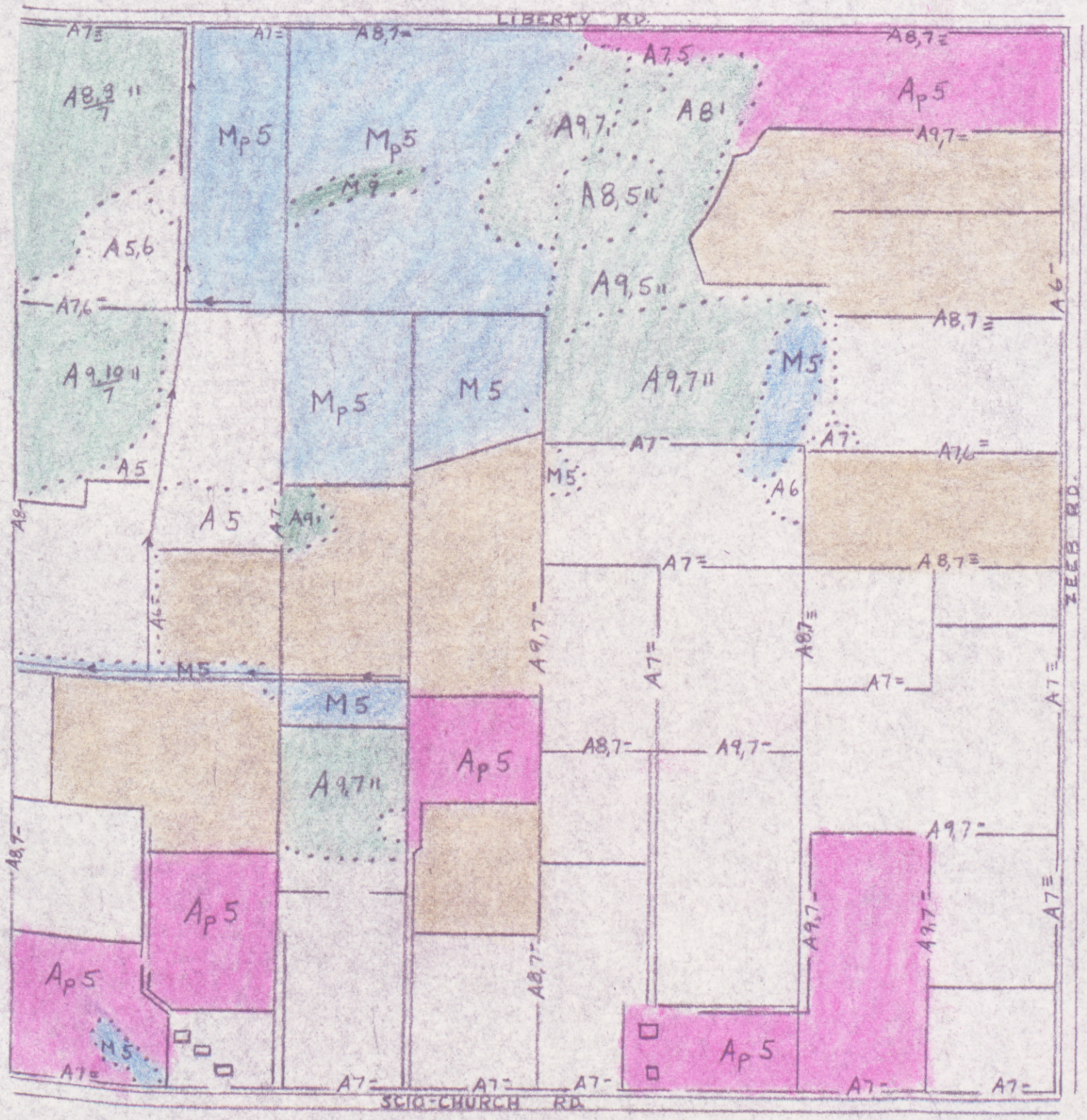
LEGEND

- BRONSON LOAM
- BRONSON SANDY LOAM
- MIAMI LOAM
- CARLISLE MUCK
- GILFORD LOAM
- BERRIEN SANDY LOAM

N

SEC. 28 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE



N

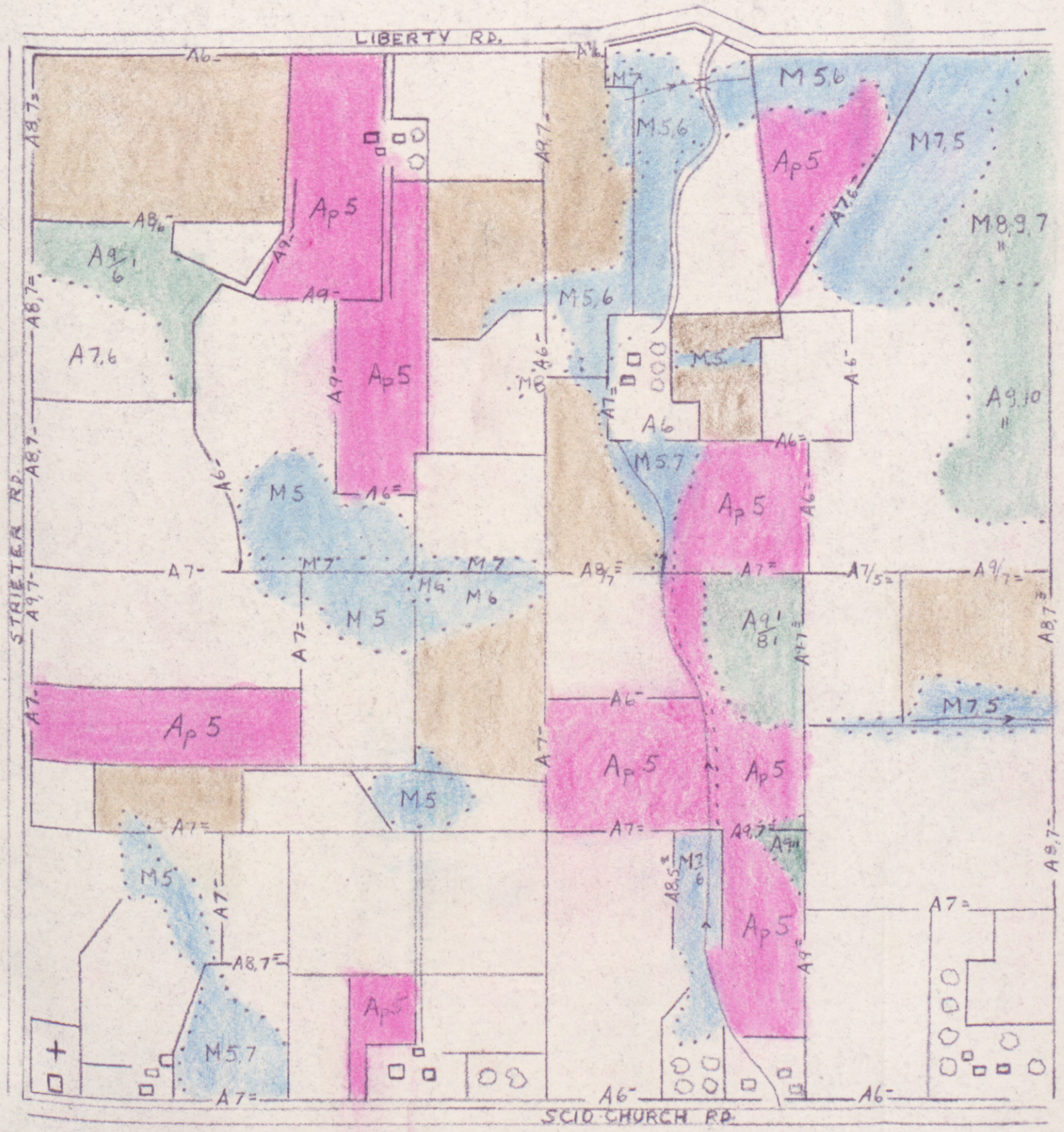
SEC. 33 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE

COVER TYPE MAP 1948

LEGEND

- WOODS
- MARSH
- CORN
- PASTURE
- OTHER CROPS



COVER TYPE MAP
1948

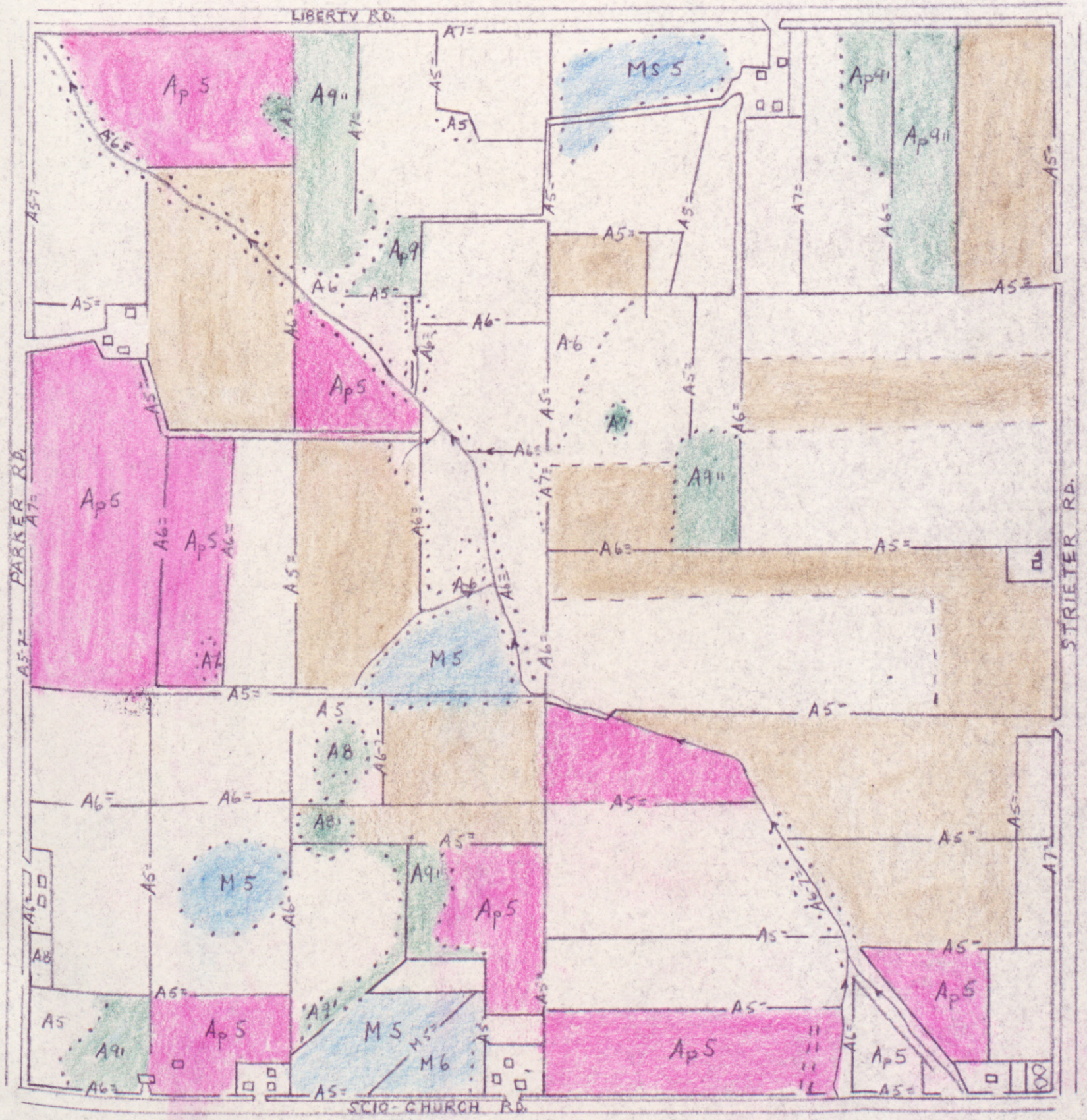
LEGEND

- WOODS
- MARSH
- CORN
- PASTURE
- OTHER CROPS

N

SEC. 32 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE



COVER TYPE MAP 1948

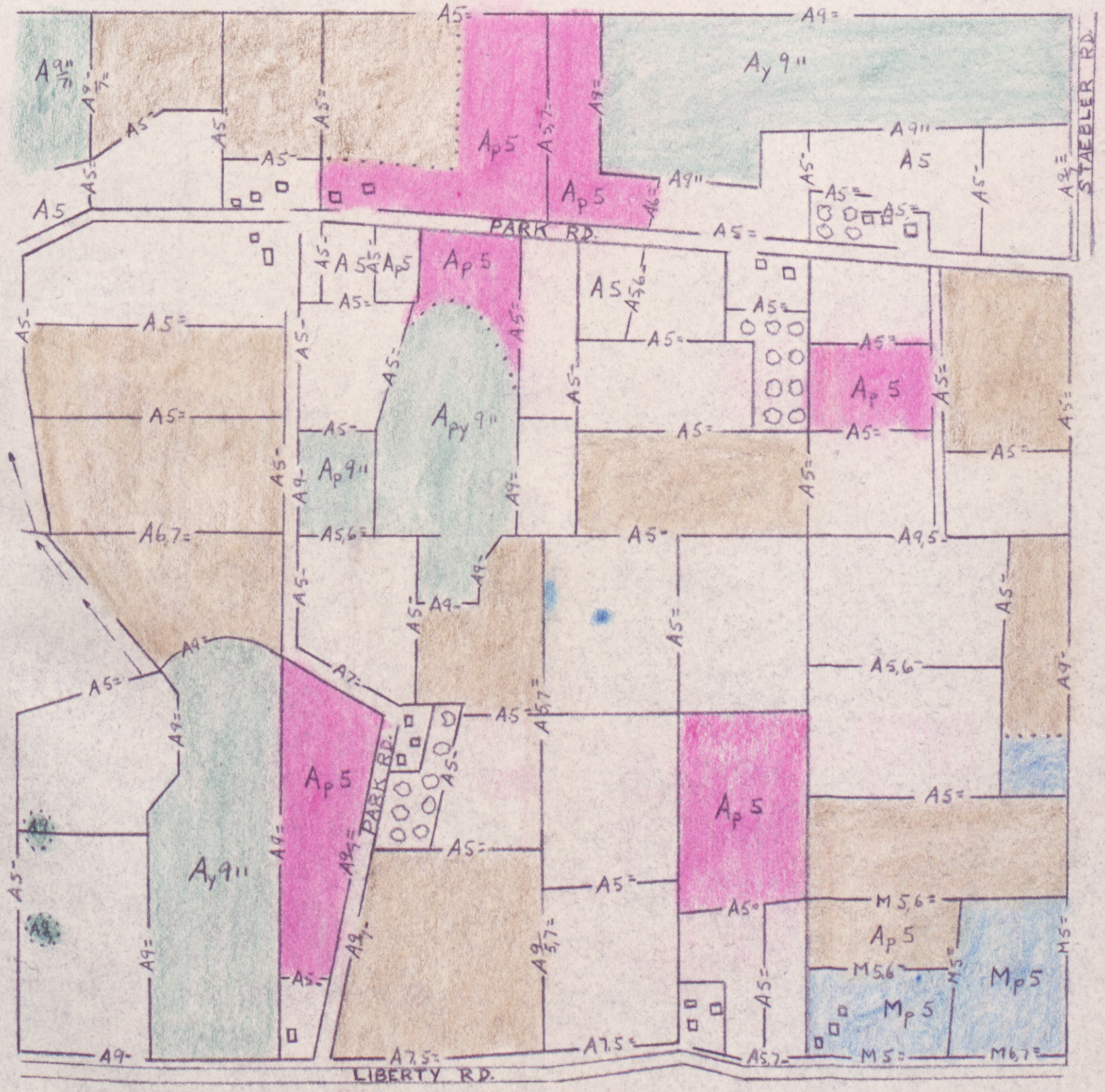
LEGEND

- WOODS
- MARSH
- CORN
- PASTURE
- OTHER CROPS

N

SEC. 31 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE



COVER TYPE MAP
1948

LEGEND

WOODS

MARSH

CORN

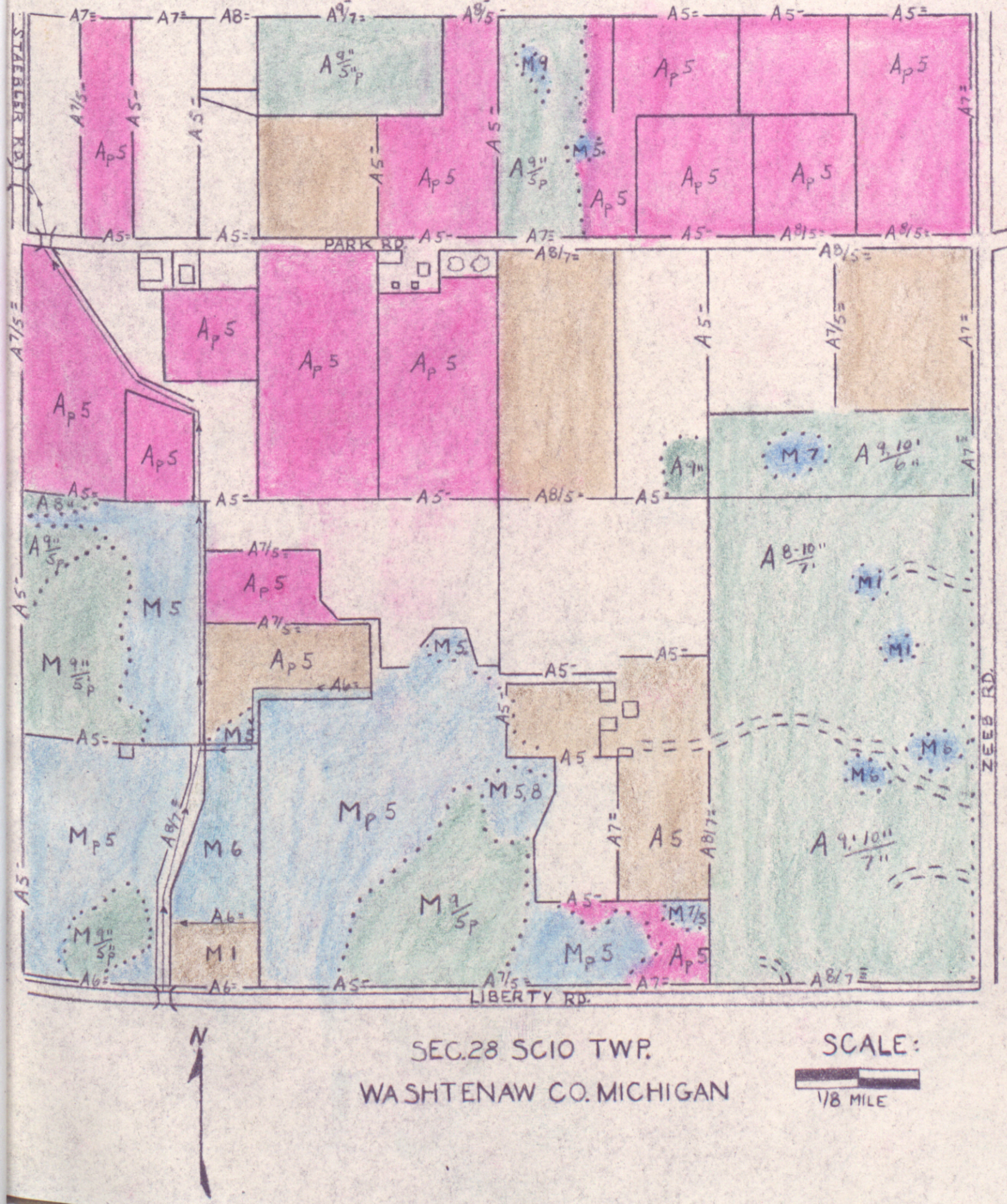
PASTURE

OTHER CROPS

N

SEC. 29 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE



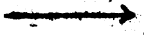
COVER TYPE MAP 1948

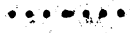
LEGEND

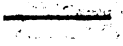
- WOODS
- MARSH
- CORN
- PASTURE
- OTHER CROPS

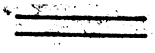
COVER MAP LEGEND

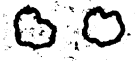
CULVERT 

STREAM 

TYPE LINE 

FENCE 

ROAD 

ORCHARD 

BUILDINGS 

SYMBOLS AFTER S. A GRAHAM

III

POPULATION STUDY

Methods

Census Methods

Since this work is concerned mainly with population data, most of the time spent in the field was concerned with gathering it. Other pertinent data was recorded whenever possible along with the census. The area is sparsely populated by pheasants so that a strip census would not show a true picture of the total population. A complete census was deemed feasible to use, and was conducted at all seasons from September until April. In the spring a crowing cock census was started. The author had the use of a five-year old female Irish Setter graciously donated by Mr. John Gwin, a University employee.

Pheasant distribution is not random on the area, but is dictated by the distribution of food and cover. In a majority of cases, the arrangement of the marsh cover was a predetermining factor in laying out a census route for fall and winter. Since the marshes constitute the major winter cover, and they are more or less consolidated or connected in most of the area, the route was laid out with this in mind, in

order to bisect all marshes. Other important cover types were not neglected at the expense of the marshes, but an attempt was made to cover the area as thoroughly as possible. During the spring when marshes were flooded and not heavily used for cover, less emphasis was placed on them and upland types were heavily worked in the census. The census was conducted by sections in a predetermined order, starting with section 33 and working numerically down to section 28, after which the sequence began again with 33. It usually took one morning or afternoon to census each section with a dog.

There is always the danger of double counting birds when they fly ahead of the observer or toward cover not censused. An attempt was made to control the dog's movements so that the birds would flush toward the periphery of the area. This was not always possible or successful, but was compensated for by accurately recording the number and sex of birds and location of cover types into which they escaped. Later when this escape cover was censused, all birds flushed, above the number previously seen to fly there, were recorded as original residents of that cover. This is not a completely accurate method, but population figures from successive censuses of the same section were fairly consistent for any one season. When an extremely dense marsh, such as the spirea-willow area was to be censused, the dog was allowed to run freely while the author watched from a vantage point that overlooked

the whole marsh. In this way, birds flushed or running ahead of the dog could be seen.

Many days were spent in the field at all hours and under all types of weather conditions, making and recording observations on prepared forms. The field work was done on 105 different days from September, 1948, until May 19, 1949. The dog was used on thirty-five different occasions. For ease in recording observations, each section was divided into sixteen equal subdivisions and given a number so that if an observation were made it would be recorded as (Section 33-10, north edge of sedge marsh).

Several attempts were made to shine birds on the roost during cold windy weather, but met with little success. The dense character of the roosting cover, usually a marsh, made quiet approach impossible and alerted the pheasants so they couldn't be approached.

Collection of Hunting Season Data

During the hunting season the author worked part time for the Michigan Department of Conservation on hunter bag check. Every morning and late afternoon, except the last two days of the season, was spent on the study area recording and aging pheasant kills. Each farmer on the area was instructed on how to distinguish adult pheasants from juveniles by using the bill and spur characters. He was asked to record all birds taken on his farm. Conservation department

cards explaining the aging procedure were left with each farmer and, at the end of the week, the data was collected. Most of the farmers forgot to save the bands from released birds killed, but noted them as such. The author believes that a majority of the kill was personally recorded and the farmers recorded some that the author missed.

Release of Game Farm Birds

The Game Division of the Department of Conservation made a release of 140 game farm pheasants, thirteen weeks of age in Scio Township, Washtenaw County, on September 28, 1948. Another forty birds were released in the adjacent township of Freedom. Fifty percent of the birds were cocks and the remaining fifty percent hens.

Only 100 of the birds were released on the study area, but twenty were stocked on a bordering section and could have dispersed onto the study area.

On September 27, 1948, the author went to the Mason Game Farm where the birds were raised to mark and band them. Bright yellow airplane dope, an acetate base paint, was brushed onto the tail coverts and tail feathers so that the banded birds could be distinguished from wild ones. As a check on the lasting qualities of the paint, several penned birds owned by Ralph Blouch, of Ann Arbor, were painted. The paint on the penned birds was plainly visible until early March,

1949. The experiment did not meet with a high degree of success, partly because an insufficient number of the marked birds were observed later than mid-fall. The yellow mark could be seen at a maximum distance of about 100 yards in bright sunlight with 7 x 50 m.m. binoculars. If a marked bird was flushed within fifty feet of the observer, the yellow was plainly visible to the naked eye. The greatest value of the yellow marking was in mortality identification.

Aging Methods

All birds handled during the hunting season were aged according to methods employed by the Game Division of the Michigan Department of Conservation (MacMullan, 1948). The method is not completely accurate and errors of as much as two weeks in aging may occur. Criteria used in aging were plumage characteristics, primary feather molt, length and appearance of spurs, presence or absence of bursa, and lower mandible test.

The mandible test was tried first, followed by a check of the spurs. If the lower mandible broke under stress of the bird's weight and the spur characters checked, the bird was classed as a juvenile. If the mandible stayed intact, then the bursa was probed for and, if missing, the bird was an adult. Juvenile birds were aged to the week, up to twenty-six weeks, by using the primary feather molt, tail length, and general plumage characteristics.

Crowing Cock Census Method

At the first signs of concerted crowing, a crowing cock census was started. Concerted crowing was established by conducting two minute crowing counts at picked stations beginning one-half hour before sunrise. When the total count on the route remained stable for a period of several days, this period was designated as the start of concerted crowing and the actual census began.

The ability to interpret crowing sounds in terms of direction and distance from the observer varies with individuals and experience. Mr. Ralph Blouch, a graduate wildlife student, graciously helped the author in his crowing census and was a competent and experienced worker.

Eighteen observation stations were set up approximately one-half mile apart along the roads fringing the area. These stations were consecutively numbered. Plane tables with a map of the area were used by each observer. One man was assigned the even numbered stations and the other the odd numbered ones, so that a "leap frogging" technique was used in getting to the assigned stations. The observers were never more than one-half mile apart. The census began one-half hour before sunrise and watches were synchronized at the start. A three minute listening interval was found to give best results with a five minute alloted travel time to get from one station to the next.

When a crowing call was heard, a line was drawn toward the source and the time recorded. It was found that if the observer put a mark indicating the approximate location of the cock, it was more easily located later. Faint calls were not recorded or, if so, were marked as such. At the end of the census, sight lines from the two maps were recorded on one. Where two or more lines intersected, a cock was presumed to be present. While crowing, some cocks move about considerably so that it appears as if there is more than one bird. Censuses were conducted on April 13, 20, and 27.

After the cocks were located by triangulation, their locations were checked by early morning field work. This consisted of walking toward the direction of crowing until the bird was located. The triangulation method was fairly accurate as substantiated by field work, but tended to show more cocks than were actually present because of their movements while crowing.

Population Data

Pre-Hunting Season Population

The area was censused twice before the hunting seasons, using a dog. The population at this time was determined to be 198 birds composed of ninety cocks and 108 hens. These figures include all banded birds that had stayed on the area

until the beginning of the hunting season. For the total population, this amounts to 6.28 birds per 100 acres or 2.85 cocks to 100 acres. In terms of acres per bird, it is 15.9 for the total population.

During pre-war years in Ohio Leedy and Dustman (1948) found that the population prior to the hunting season was composed of eighty-five cocks to 100 hens. This was determined by roadside census methods. It agrees very closely with the author's findings of eighty-three cocks per 100 hens based on the pre-season population of 198 birds. The sex ratio may be an indication that hen mortality during nesting was not especially high.

Hunting Season Mortality

The hunting season was twelve days long beginning at noon on October 15 and ending October 26. The total known kill was sixty-five birds, sixteen of which were released, leaving forty-eight wild birds shot. Of the sixty-five pheasants killed, fifty-five were cocks and twelve were hens. This is a total of 2.06 birds per 100 acres or 1.75 cocks per 100 acres. During and before the hunting season there were eight banded bird mortalities due to predation and road kills. The total known mortality due to accidents, predation, and hunting, amounted to sixty-five plus eight or seventy-three wild and banded pheasants.

Most of the hunting pressure was concentrated during the first three days and the tenth day of the twelve-day long season. This is readily explained by the fact that the starting day was a Friday and the tenth a Sunday. Legally there is no hunting in Washtenaw County on Sunday but the law is not enforced. It is usual to have a higher hunting pressure on the opening day and week-ends. Data for the last two days of the season is lacking.

Twenty-five percent of all birds were killed on the first day and 63.4 percent during the first three days. On the tenth day, a Sunday, 14.1 percent of the birds were shot. Leedy and Hicks (McAtee, 1945) found that during three hunting seasons, hunters took an average of 29.6 percent of all birds bagged on the first day and 57.5 percent on the first three days. Seventy-six percent of the released birds were shot during the first three days. This was expected as released birds are not as wary as birds raised in the wild. After the first three days, the total kill fell off. This was caused by decreased hunting pressure due to the start of the working week and increased wariness of the cocks. The kill started up again on the following week-end due to increased hunting pressure, but never reached the initial high attained the first three days. This could have been caused by increased cock wariness, spreading out of birds, and fewer available cocks.

The type of cover birds were in when shot, is not too significant, but does show that birds seek the heavier cover

of marshes and cornfield in preference to relatively penetrable fence rows. Forty-eight percent of all birds bagged were in marshes, followed by corn, 34.2 percent; herbaceous fields, and fence rows. In Wisconsin, 78 percent of all birds taken were in brush and grass marshes. (Gigstead, 1937) At the Rose Lake Wildlife Experiment Station (1942), pheasant kill in the major habitat types amounted to 29.5 percent of all birds bagged in idle land, 15.2 percent in crops, 50 percent in marshes, and 7 percent in woodlots.

When comparing the kill by sections with the highest sectional pre-season population, a direct relationship is seen except in the case of sections 28 and 29. In this case the section with the fifth highest population had the fourth highest kill. This may well be attributed to hunting pressure. Also section 29 has better cover conditions, giving the birds more security from hunters.

TABLE XII

SECTIONS WITH THE LARGEST KILL AND PRE-SEASON POPULATION SHOWN IN A DECREASING ORDER

Kill	Pre-Season Population
32	32
31	31
33	33
28	29
29	28

Post Hunting Season Population

If the total hunting season mortality of seventy-five is deducted from the pre-season population of 198 individuals the calculated post-season residual population amounts to 125 pheasants. This is a 36.8 percent decrease caused by known losses. The figure of 125 birds is the residual population that should have been left, providing that all losses were known during the hunting season. Since all losses attributed to hunting, predation, and egress from the area were not known, there was an unknown loss which can be calculated.

Before this unknown loss can be calculated, the actual post-season population must be obtained. This was accomplished by two complete censuses with a dog and resulted in a population of twenty-three cocks and fifty-five hens. This is a 60.6 percent decrease between the pre-season and post-season populations. The known loss during this period was 36.8 percent. Therefore, the unknown loss is 60.6-36.8 or 23.8 percent. This unknown decrease can be attributed to unknown hunting mortality, including crippling loss, predator mortality, and egress from the area.

The sex ratio of the post-season population, as determined by census, is forty-two cocks to one hundred hens. MacMullan (1948) found a post-season sex ratio of forty-three cocks per one hundred hens for 1947 as determined by roadside census over the state. The 1948 hunting season was on

a par with 1947, or slightly better according to conservation department releases.

Winter Population. At the start of flocking on December 12, there were seventy-three birds or 6.4 percent fewer than at the time of the post-season census. The decrease was due to a known mortality of five birds. The residual population at the end of flocking (March 17), was seventy-five pheasants. The net increase over this period amounted to two birds (75-73) or 2.7 percent.

The known mortality between the start and end of flocking (December 12 to March 17) amounted to ten birds. Thus, the known mortality of ten added to the net increase of two makes a total of twelve pheasants or a 16.4 percent gross increase during this period. The pheasants responsible for this increase may have been missed during the flocking census but most likely came in from adjacent areas. This latter assumption is made because there were twelve more birds recorded in the census at the height of flocking (January 27) than were tallied in the start of the flocking census. This would indicate that the additional birds had infiltrated the study area between December 12 and January 27, or were missed in the December 12 census.

The winter population did not start to decline until after the January 27 census. This indicates that all known mortality or egress occurred after this date. All known

winter mortalities were found between January 27 and March 17, the start of spring dispersal.

The sex ratio for the second week of December at the start of flocking was forty-three per one hundred hens. For the entire state, MacMullan (1948) found a sex ratio of forty-three cocks per one hundred hens during the first week of December 1947, before flocking began. This figure was obtained through road-side census by mail carriers and conservation officers. The fact that the two findings are similar, though for different years, may mean that the population between these two years was relatively stable.

Spring Dispersal. At the end of flocking on March 17, there was a calculated residual population of seventy-five individuals. By the middle of May the actual population was fifty-three pheasants, or a loss of twenty-two birds, eight of which were known mortalities. The remaining fourteen or 18.6 percent were unknown lossess attributed to egress, mortality, or census error.

Between the start and end of spring dispersal (March 17 to 25), the population was reduced by ten birds, five of which constituted 62.5 percent of the entire known loss. Five, or 35.7 percent of the unknown loss occurred during this period.

Spring Population 1949. The spring census disclosed a population of sixteen cocks and thirty-seven hens or a total

TABLE V

PHEASANT SEASONAL POPULATION
MORTALITY TABLE

	1			2		3		4		5		6			7	8			9
	Pre-hunting Season Population		Sex Ratio *	No. of Wild Birds Shot		No. of Banded Birds Shot		No. of Banded Birds Found Dead		Total Known Mortality (2+3+4)		Calculated Post-Season Residual Population (1-5)		Sex Ratio	Percent Decrease From Known Losses $\left(\frac{1-6}{1}\right)$	Post-Season Population		Sex Ratio	Percent Decrease Due to Unknown Loss $\left(\frac{6-8}{1}\right)$
Section	M	F		M	F	M	F	M	F	M	F	M	F			M	F		
33	15	23		4	1	1		1	4	6	5	9	18			6	10		
32	31	35		14	5	8				22	5	9	30			5	20		
31	21	21		11	5	3	1	1		15	6	6	15			4	9		
29	13	15		4					2	4	2	9	13			4	8		
28	10	14		4		4				8		2	14			4	8		
Total	90	108	83:100	37	11	16	1	2	6	55	18	35	90	39:100	36.8%	23	55	43:100	23.8%

*: Sex ratio in terms of cocks per 100 hens

M: Male

F: Female

TABLE VI

PHEASANT SEASONAL POPULATION
MORTALITY TABLE

	1			2		3			Percent Decrease Due to Known Loss $\left(\frac{1-3}{1}\right)$	4			5
	Post-Hunting Season Population		Sex Ratio	No. of Wild Birds Found Dead		Calculated Population At Start of Flocking (Dec. 12) (1-2)		Sex Ratio		Residual Population at end of Flocking		Sex Ratio	Percent net Increase Between No. at Start and End of Flocking $\left(\frac{4-3}{3}\right)$
Section	M	F		M	F	M	F			M	F		
33	6	10			1	6	9			4	11		
32	5	20		1	3	4	17			6	18		
31	4	9				4	9			3	9		
29	4	8				4	8			4	8		
28	4	8				4	8			4	8		
Total	23	55	42:100	1	4	22	51	43:100	6.4%	21	54	38:100	2.7%

TABLE VII

PHEASANT SEASONAL POPULATION - MORTALITY TABLE

	1			2		3		4		5			6	7			8
	Maximum Flocking Population (Jan.27)		Sex Ratio	Known Mortality of Banded Birds		Known Mortality of Wild Birds		Total Known Mortality		Calculated Residual Population At End of Flocking (March 17) (1-4)		Sex Ratio	Percent Decrease Between No. At Maximum And End of Flocking $\left(\frac{1-5}{1}\right)$	Spring Population (April-May)		Sex Ratio	Percent Decrease Between No. At End of Flocking And Spring Population $\left(\frac{5-1}{5}\right)$
Section	M	F		M	F	M	F	M	F	M	F			M	F		
33	8	11				4		4		4	11			2	5		
32	7	19				1	1	1	1	6	18			5	11		
31	4	12			1	1	2	1	3	3	9			2	6		
29	4	8								4	8			4	8		
28	4	8								4	8			3	7		
Totals	27	58	47:100		1	6	3	6	4	21	54	38:100	11.7%	16	37	43:100	29.3%

TABLE VIII

PHEASANT SEASONAL POPULATION - MORTALITY TABLE

1			2	3		4	5	6		7			8	9
Population At Height of Spring Dispersal		Sex Ratio	Known Mortality of Wild Birds	Calculated Residual Population At End of Spring Dispersal (March 25) (1-2)		Sex Ratio	Percent Decrease Between Height And End of Dispersal $\left(\frac{1-3}{1}\right)$	Known Loss Between End of Dispersal And May	Calculated Residual Spring Population (3-5)		Sex Ratio	Actual Spring Population (May)		Sex Ratio	Percent Decrease Between Cal. Residual Pop. at End of Dispersal & Actual Spring Pop. $\left(\frac{3-7}{3}\right)$	Percent Decrease Due to Unknown Loss $\left(\frac{6-7}{6}\right)$
Section	M	F		M	F	M	F			M	F	M	F		M	F			
33	4	9			2	4	7					4	7		2	5			
32	6	15			1	6	14				2	6	12		5	11			
31	3	9			1	3	8					3	8		2	6			
29	4	8				4	8					4	8		4	8			
28	4	8		1		3	8			1		2	8		3	7			
Totals	21	49	43:100	1	4	20	45	44:100	7.1%	1	2	19	43	44:100	16	37	43:100	18.5%	14.5%

TABLE IX

POPULATION TREND OF COCK PHEASANTS FROM SEPTEMBER, 1948 - MAY, 1949

Pre-hunting season census	90 M	108 F
Sex Ratio	83 M	100 F
Cocks per 100 acres	2.85	
Number of cocks shot during hunting season	55	
Cocks killed per 100 acres	1.75	
Calculated Residual	35 M	
Percent of cocks killed (known)	$\frac{90 - 35}{90} \times 100 = 61.1\%$	
Calculated percent of cocks that should survive	100 - 61.1 = 38.9%	
Calculated survival per 100 acres	1.1 M	
Post-hunting census	23 M	55 F
Cock survival per 100 acres	.73	
Sex Ratio	42 M	100 F
Percent of cocks actually lost	$\frac{90 - 23}{90} \times 100 = 74.4\%$	
Actual cock survival	100 - 74.4 = 25.6%	
Percent of unknown loss	74.4 - 61.1 = 13.3%	
Population at height of flocking	27 M	58 F
Sex Ratio	47 M	100 F
Percent increase over post-hunting season census	$\frac{27 - 23}{23} \times 100 = 17.4\%$	
Population at end of flocking	21 M	54 F
Sex Ratio	38 M	100 F
Percent decrease between post-hunting season population and number at end of flocking	$\frac{23 - 21}{23} \times 100 = 8.7\%$	

Spring population	16 M	37 F
Sex Ratio	43 M	100 F
Cocks per 100 acres	.50	
Percent decrease between population at end of flocking and spring	$\frac{21 - 16}{21}$	x 100 = 23.8%
Percent decrease between post-season population and spring	$\frac{23 - 16}{23}$	= 30.4 %

* M = Male
F = Female

TABLE X

NUMBER AND PERCENT OF TOTAL

NUMBER OF BIRD SHOT

Age in Weeks	DATE SHOT																				NOT DURING SEASON					
	10/15		10/16		10/17		10/18		10/19		10/20		10/21		10/22		10/23		10/24		11/4		1/1/49		1/23/49	
	No.	% of Total	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Wild Birds 19-24	11	15.5	8	11.3	8	11.3	5	7.0	2	2.8	1	1.4	1	1.4	1	1.4	3	4.2	7	9.9	2				1	
Banded 16	6	8.4	3	4.2	4	5.7	3	4.2											1	1.4						
ADults	1	1.4	2	2.8	2	2.8													2	2.8			2			
Total	18	25.3	13	18.3	14	19.8	8	11.2	2	2.8	1	1.4	1	1.4	1	1.4	3	4.2		14.1	2		2		1	

* Actual number of birds shot on Study Area was 65.

TABLE XI

COVER TYPES IN WHICH BIRDS WERE SHOT

Cover Type	Corn	Herbaceous Field	Marsh	Fence Row
No. of Wild Birds	21	10	28	0
No. of Banded Birds	5	1	9	2
Totals	26	11	37	2
Percent of Total	34.2	14.47	48.67	2.63

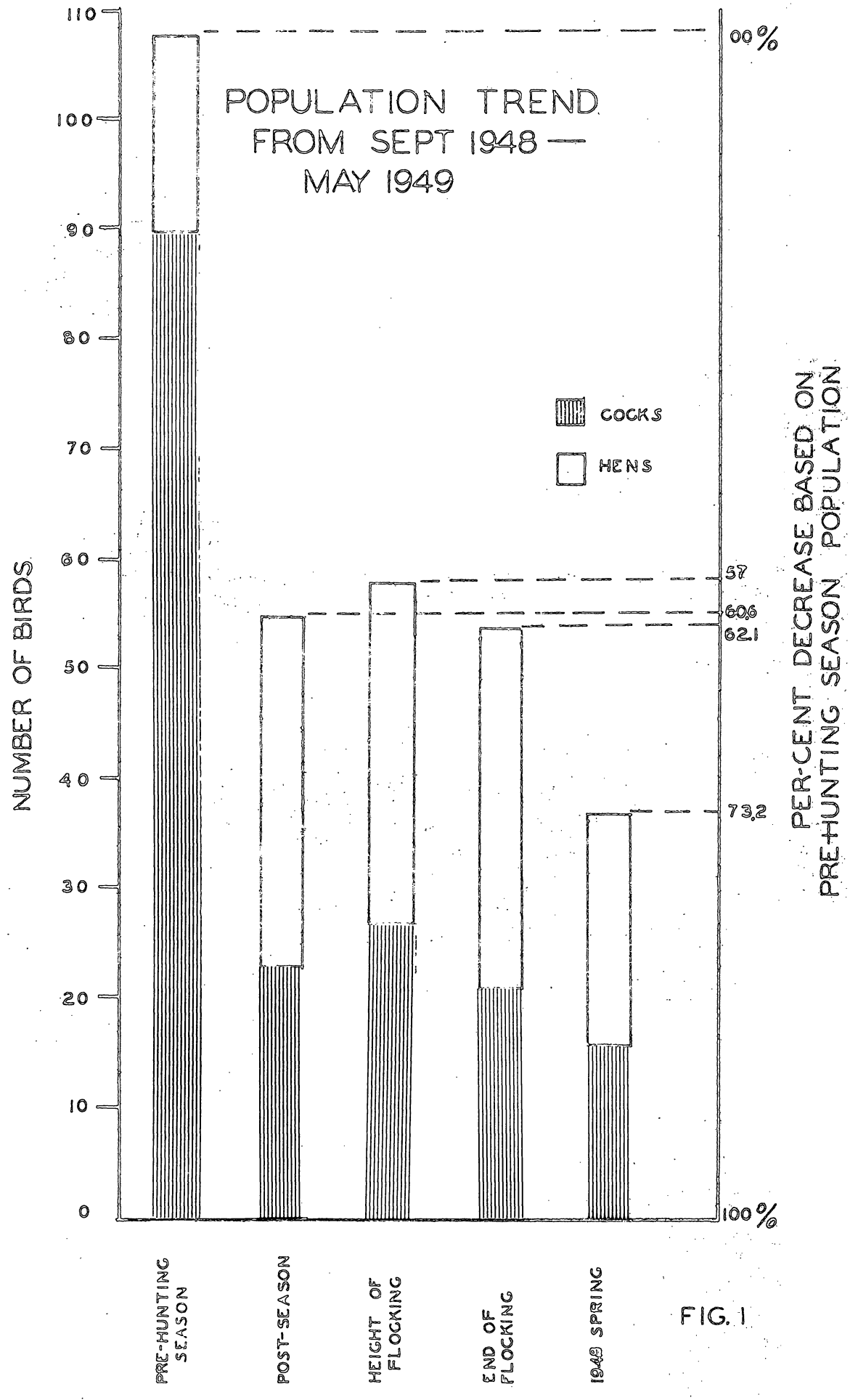

POPULATION TREND
FROM SEPT 1948 —
MAY 1949
NUMBER OF BIRDS
110
100
90
80
70
60
50
40
30
20
10
0
COCKS
HENS
00%
57
60.6
62.1
73.2
100%
PER-CENT DECREASE BASED ON
PRE-HUNTING SEASON POPULATION
PRE-HUNTING SEASON
POST-SEASON
HEIGHT OF FLOCKING
END OF FLOCKING
1948 SPRING

FIG. 1

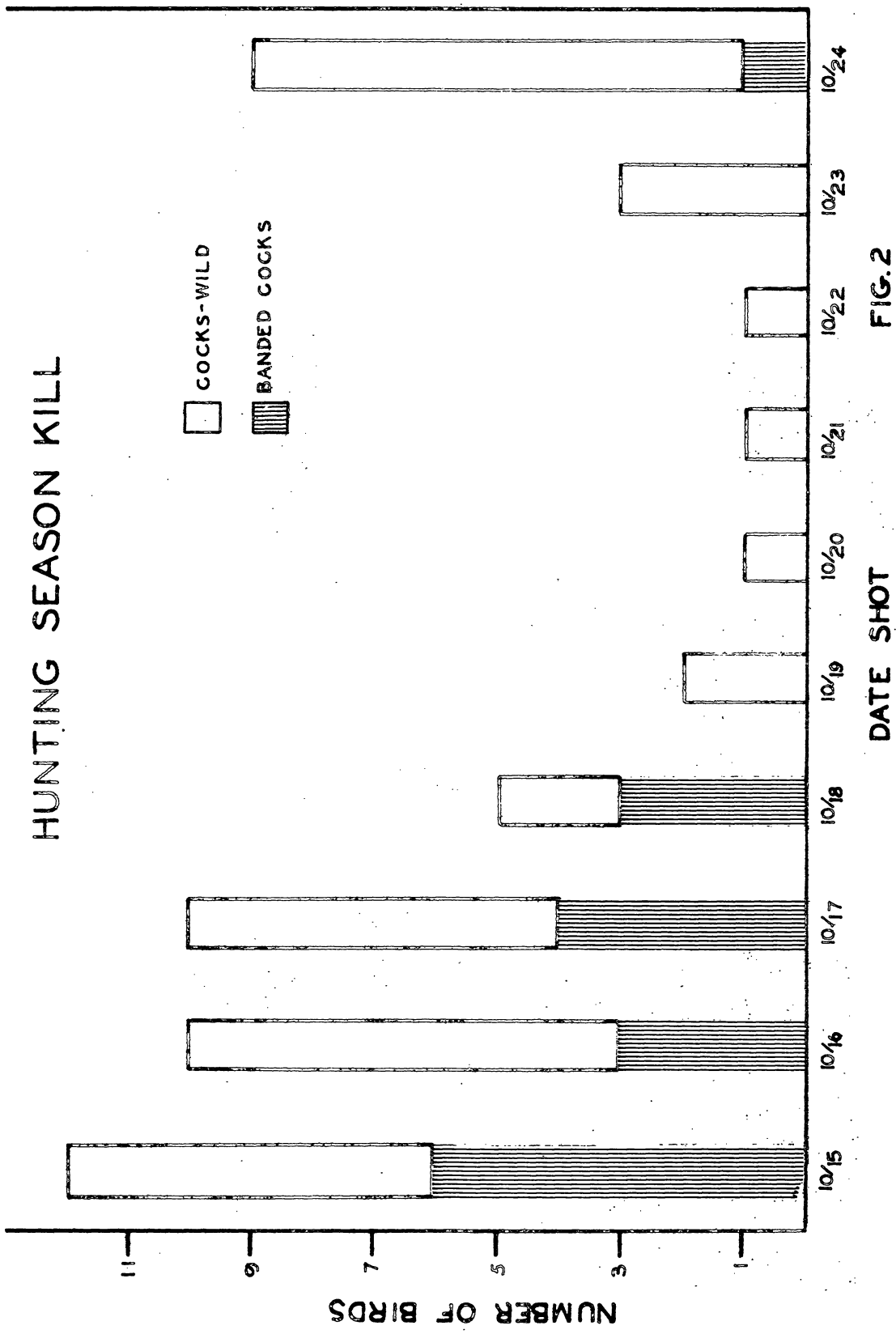

HUNTING SEASON KILL
COCKS-WILD
BANDED COCKS
NUMBER OF BIRDS
1
3
5
7
9
11
10/15
10/16
10/17
10/18
10/19
10/20
10/21
10/22
10/23
10/24
DATE SHOT

FIG. 2

of fifty-three pheasants. This is a density of 1.68 birds for every one hundred acres. The sex ratio is forty-three cocks for every one hundred hens, whereas, MacMullan (1949) found forty-one per one hundred for the same year using a road-side census.

The decline between the calculated residual spring population, which is the number of birds that should be left after known mortalities are deducted, and the actual breeding population was 14.5 percent. This loss was caused by withdrawal of birds from the area, unknown fatalities or both.

The total decrease from the post-hunting season population until the middle of May was 33 percent.

Moralities Due to Predation and Other Factors

Method of Study. During the time of this study, an effort was made to locate as many mortalities as possible by spending a considerable amount of time in the field. The method that produced the best results was to walk the area examining fence rows and cover that pheasants were known to frequent. On numerous occasions the dog was responsible for locating recently killed birds. If a bird of prey were flushed from ground cover, an examination of the cover usually disclosed a mortality. In this situation, if the pheasant was freshly killed, the fatality was attributed to the

avian predator.

The greatest difficulty in this phase of the study was encountered in attributing mortalities to specific causes and determining the length of time the bird had been dead. In the latter case, a freshly killed pheasant was found during fall and left so observations could be made on rate of decomposition and disturbance by carrion feeders and predators. The carcass was fed upon by skunks and opposums so that, within a week, it was wholly denuded of flesh. In most cases when a kill was found that could not be aged to the date of death, it was recorded under the season when it was found. This may cause a certain amount of error in calculating the percent of kill by seasons. A bird found in early winter could have been killed in late fall and was better preserved because of lower winter temperatures. If no positive evidence could be found indicating the type of predator responsible, then the mortality was recorded under the unknown category. Pheasant remains found at fox dens do not conclusively prove that that particular animal was the direct cause of death. However for the lack of better evidence these mortalities were attributed to foxes.

Released birds were identified in a majority of cases by the yellow paint on the tail or wing feathers.

Mortalities by Sex and Number. A total of thirty-one birds was found dead during the fall, winter, and spring.

Of this total, 64.5 percent were hens and 35.4 percent cocks, indicating that hens are more vulnerable. These figures show there was a differential sex mortality with 27 percent more hens than cocks killed. Cocks are stronger and more wary than hens except during the breeding season when they do not hesitate to expose themselves. Also, cocks are not as gregarious as hens and do not concentrate in mixed flocks to any great extent.

Released Birds. Of the one hundred birds of equal sex actually released on the area, seventeen were shot during the hunting season and nine were found later. This accounts for 26 percent of the stocked birds or 36 percent of the shootable population, as only eighteen were cocks.

The last of the banded birds, a hen, was seen in April in a group composed of one cock and three hens, one-half mile from the nearest point of release. Previous to this, the last observation was in December. The last banded bird mortality was found in March at a fox den. These observations seem to indicate that there are a few stragglers left on the area, but no accurate assumption can be made until after the 1949 hunting season. There were two cocks shot that were residuals from the 1947 stocking. A check with the conservation department revealed they had moved less than one mile from the point of release.

For a week after the birds were released (September 28), a majority of them could be seen along road-side cover within the release area. By October 15, the beginning of the hunting season, they were well dispersed but none were seen further than three-quarters of a mile from the release point. After the hunting season, observations on banded birds were scarce. This indicates that they couldn't be distinguished from wild ones, major dispersal had been over a mile in any one direction, or the mortality was high. Buss (1943), in Wisconsin, found that 2 to 6 percent of the released birds could be found dead by cruising less than one-quarter of the cover in which they were released. The author found that, except in the case of road kills, a majority of the fatalities were found from one-quarter to one-half mile from the point of release. Wright (unpublished) quoted Tubb's findings for Michigan as follows:

> In six years, 1935-1940, a total of 8,485 game, farm-reared cock birds were banded and released. Birds released in September showed a reported hunting mortality of 8.2 percent.

In returns from club-reared pheasants, Ginn, (1947) states that a total of 367 band returns received in 1942 to 1943 represented 4.4 percent of the total release. Cocks comprised 6.4 percent of returns.

No accurate statements can be made as to the contribution

of the stocked birds toward raising the total population as the time elapsed since stocking until this composition is only eight months. The only index figures available are the known crowing cock populations for 1948-1949. The crowing cock census showed an identical population of sixteen birds for the two-year period. This would indicate that the stocking had no effect on raising the cock population. In a paper given by H. D. Ruhl (1941) at a wildlife conference, he states,

> In the summer of 1933, 300 pheasants were liberated and, in spite of total protection from shooting, the pheasant population four years later was practically the same as it was the year following the stocking.

None of the birds shot or found dead were further than one mile from the release point. The maximum distance traveled cannot be determined, at least not until the next hunting season. Wight (unpublished) makes the statement that,

> Band returns to the conservation department from 192 birds released in 1932, showed that they did not move more than two miles from the point of liberation.

On the other hand, the average distance traveled by birds released in the fall of 1931 was 4.3 miles, while the maximum distance was twenty-two miles.

Mortalities by Season. The greatest mortality was found in fall when 41.9 percent of the total known kill

occurred. This was followed by winter with 32.2 percent and spring, 25.8 percent. The spring mortality figures are not complete since the study was terminated on May 19. Of the cocks, 27.2 percent were killed in fall, 54.5 percent in winter, and 18.1 percent in spring. The winter was relatively open and kills were not covered by deep snow. Part of the fall mortality of cocks and hens may be due to illegal kill and crippling loss. This would explain to some extent the higher percentage of mortalities found then.

Fifty percent of the hens were fall fatalities, 20 percent winter, and 30 percent spring mortalities. The previous statement concerning illegal kill comes to the fore again since 50 percent of all hens found were fall mortalities indicating a high illicit kill or a high summer mortality which wasn't found until fall.

The high percentage of cock mortalities found in winter, very possibly occurred in fall as crippling losses that were not found until winter. These are only speculative assumptions drawn from the data, but must be considered as possibilities.

The winter kill for both sexes was not excessive, possibly because of the mild winter. During the 1948-1949 winter, the pheasants did not flock as they would have during a cold one, but were scattered during the warm spells. This made them less vulnerable to predation since there were no

large concentrations for any one period of time. Many of the winter deaths occurred during March when the birds were moving about more and cocks were more visible because of the start of breeding activity. Randall (1940), of Pennsylvania, found that "Much of the winter and early spring predation occurred during late March and early April." This is in accord with the author's findings.

Twenty-five percent of all mortalities were found in spring. Eighteen percent of the cocks and thirty percent of the hens were killed during this season. Most of the spring mortality occurred during late March and early April, with hens in the majority. Scott (1947) found, "The proportion of hen remains appearing at dens (fox) increased in May and June."

The total effect on the population of known mortalities due to predation, crippling loss, unknown causes, illegal kill, and road kills is hard to evaluate as all mortalities could not possibly have been found. There is an unknown factor which may figure prominently in the final result. However, from the data collected, some conclusions can be drawn as to the drain that mortalities had on the existing population.

During the fall period, there was a 6.5 percent reduction of the population of 198 pheasants existing at that time. The pre-hunting season population was used in this

calculation rather than the post-season, because a majority of the losses incurred were found soon after the season. Some were undoubtedly due to illegal kill and crippling loss. Leedy's and Hicks' (McAtee, 1945) figures show that during the fall there was a 7.5 percent mortality of cocks and 8.5 percent mortality of hens.

The winter population of eighty-five was decreased by 11.76 percent or approximately one-half again as much as the fall population. Eighty-five individuals was the highest recorded winter population. Actually more dead birds were found during the fall period than at any other season, but the lower fall percentage figure was based on the highest population. Leedy and Hicks (McAtee, 1945) found approximately 6 percent of the cocks and 16 percent of the hens were taken out of the winter population. A 1935-1937 Michigan study indicated that winter mortality accounted for less than one-third of the pheasants (Ruhl, 1941).

The spring period population was decreased 12.3 percent due to known fatalities. Even though the study ended on May 19, this was the highest recorded percentage reduction of a seasonal population. Six percent of hens and eight percent of cocks were taken from a spring population (Leedy and Hicks, McAtee, 1945). The population was lowest during this period, but the predator and unknown pressures were greatest at this time. The pheasants were not taken

according to their density. This can partly be explained by the fact that during the start of breeding activity the cocks, and to some extent the hens, are more exposed, thus increasing their vulnerability to predation. Scott (1947) states,

> The increased vulnerability as suggested by behavior of cocks during courtship was evident at the dens (fox), for of the remains of eight adult pheasants found at dens in late March and April, five were cocks and three were hens.

The average population loss for the three seasons due to known and unknown causes was 10.2 percent. On Protection Island in Washington, Einarsen (1942) found the average annual pheasant loss due to predation was 9.09 percent.

Mortalities by Cover Type and Section. Table XIV shows the mortalities by cover type and Table XV by sections. There may be some error in the kills by cover type as a mortality found in a certain type doesn't necessarily mean that it was executed there. The highest mortality was sustained in herbaceous-woody fence rows with herbaceous fence rows and marshes next. In collecting the data, more time was spent in examining fence rows than any other type except marshes. Therefore, this figure may be exaggerated. As a rule, fence rows are used for travel lanes and roosting sites. An interesting fact is that fence rows with the heaviest cover produced a higher mortality than ones with herbaceous cover. There are too many unknown factors entering to make an accurate conclusion

concerning the last finding. Mortalities found in open fields most likely occurred during spring roosting or were killed elsewhere and carried to the fields. This assumption is made on the basis of pheasants' alertness while feeding in the open. They are extremely difficult to approach during daylight, but could possibly be caught while roosting at night.

TABLE XIII

SECTIONS WITH THE HIGHEST TOTAL MORTALITIES AND AVERAGE POPULATIONS SHOWN IN A DECREASING ORDER

Mortalities	Average Population For Three Seasons
33	32
32	33
31	31
29	29
28	28

Eighty percent of the road kills occurred in fall and were banded birds. The fall release of birds from the road would account for this. The heaviest cover sustained the highest mortality during the winter and early spring when it was heavily utilized by pheasants.

If the sectional mortality is compared with the sections having the highest average populations over the triseasonal period, there appears to be a direct correlation with the exception of sections 32 and 33. In this case the

TABLE XIV PERCENT OF MORTALITIES BY COVER TYPES

Cover Type	Number	Percent
Herbaceous Fencerow	6	17.64
Woody & Herbaceous Fencerow	12	35.29
Marsh	6	17.64
Stubby or Grassy Field	4	11.77
Road Kills	5	14.70
Under Owls Nest	1	2.95
Total*	34	99.99

* Included three birds from adjacent areas

TABLE XV SEASONAL MORTALITIES

	Wild Birds						Released Birds							
	Fall		Winter		Spring		Fall		Winter		Spring			
Sections	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	Total	Percent
33		1	4			2	1	4					12	38.72
32	1	3	1	1		3							9	29.03
31			1	2		1	1			1			6	19.35
29								2					2	6.45
28					2								2	6.45
Total	5		9		8		8		1		0		31	100%

section having the second highest average population placed first in the known mortalities. One contributing factor is probably that cover conditions and distribution are not as ideal on section 33 as on section 32. There are probably many other unknown factors contributing to this question.

Mortalities by Agents of Destruction. Table XVI shows mortalities by cause. Unknown mortalities lead the list because of difficulty in determining the cause of death. If a kill was not found within a few days from the time of death, identification of the cause was almost impossible.

Predatory Bird Population

The avian predator population was not specifically known, but observation records were kept during the entire study period. If hawks or owls were seen consistently in the same vicinity, it was assumed that that area was within their cruising radius. A majority of the species of hawks seen, except the Cooper's, do not make pheasants a part of their regular diet. The 1948 hawk and owl nesting population on the study area, was determined by F. and C. Craighead (unpublished). It consisted of three pairs each of red-shouldered and red-tailed hawks and one pair of great horned owls. During the late winter and early spring of 1949, the author consistently observed two great horned owls, four marsh, two Cooper's, four red-tailed, and four red-shouldered hawks on the area. Undoubtedly these birds were responsible for some of the predation but only five

mortalities could be positively attributed to avian predators.

Errington (1938) found pheasant remains in 27 percent of 371 great horned owl pellets collected in winter through summer. During 1933-1935, 4.3 percent of the marsh hawk diet was composed of pheasants (Errington and Breckenridge, 1936). At Michigan's Rose Lake Wildlife Experiment Station, Cooper's hawks and great horned owls were the chief predators responsible for twenty-four deaths during 1940-1941 (Rose Lake, 1940-1941). English (Wight, unpublished) found that one winter red-tailed hawk caught seven pheasants. This same author (1934), in writing on a study of a red-tailed hawk's nest, stated, "So far as could be determined by field observations, the area hunted by this pair of hawks was about 5,000 acres." McAtee (1935) examined thirty-nine red-shouldered stomachs and found only four with pheasant remains.

Fox

During the winter, two foxes were seen on the area and two occupied dens were found. On the first week of May 1948, one adult, with four kits, was observed on section 31, at a hillside den. According to farmers' reports, there were three individuals taken by hunters during the winter of 1948-1949. Known fox kills totaled only four pheasants, but some of the unknown kills may have been caused by this predator. The remains of two adult cocks were found at a fox den during the winter. Leedy and Hicks (McAtee, 1945) quoted an Ohio study which revealed that game birds (mostly pheasants)

made up less than 2 percent of the yearly food of the red fox on an area with an average of 1.5 foxes and thirteen pheasants per square mile. Tracking of twenty-seven miles of fox trails during January and February, 1942, revealed three cock and two hen mortalities. (Rose Lake, 1940-1941)

Dog and Cat Population

Cats were very plentiful on the area, but only one known fatality could be ascribed to this predator. They were frequently seen roaming one mile from the nearest dwelling. There is no doubt that cats will take an increasingly greater number of pheasants during the nesting season because they are so plentiful. Each farmer has at least two cats and one is known to possess eight. There are nineteen land owners so there would be approximately thirty-eight cats. In his study of the domestic cat, Forbush (1916) states,

> I have seen two full grown cocks that have been killed by cats and many more that had been reported. . . . They are taken from the time the chicks are hatched until they are full grown, although the young birds and females suffer most.

There are eighteen dogs owned by the various land owners. Of these, fifteen were allowed to roam freely and the remainder were enclosed or chained. Three of the dogs were frequently seen roaming the fields at all hours of the day and night. One trained pointer is known to have killed a pheasant caught on the roost. These animals can do considerable

TABLE XVI PERCENT OF MORTALITIES BY CAUSE

Cause of Mortality	Number of Birds	Percent
Unknown	14	45.16
Birds of prey	5	16.13
Road Kill	5	16.13
Fox	4	12.90
Dog	2	6.45
Cat	1	3.23
Total	31	100.00 %

damage during, and immediately following, the nesting season, but at other times they probably do not figure highly in pheasant mortality. Leedy and Hicks (McAtee, 1945) state, "In the chief pheasant territory of Ohio, one can frequently see cats and dogs carrying dead pheasants or pheasant eggs."

Hatching Peak. Age data obtained from birds killed during the hunting season made it possible to plot a hatching peak. (Graph III) The 1948 adult-juvenile age ratio for cocks was one adult to 5.7 juveniles and one to five for hens. The age data for hens was based on a very small sample so cannot be considered accurate. In a letter received from MacMullan of the Michigan Department of Conservation Game Division, dated May 16, 1949, he states,

> Our 1948 season adult-juvenile age ratio of cock pheasants killed in the fall was 5.5 on the basis of examination by biologist, 5.7 as turned in by hunter age cards.

Since the author used the same aging method as the Game Division biologists, the findings have a valid basis. Leedy and Hicks (McAtee, 1945) recorded the adult-juvenile ratio of 24,663 pheasants observed in northwestern Ohio from June to October 1, 1937-1940. By the end of the nesting season, about three-quarters of the population was made up of young birds. During this period, the population was relatively high. (Leedy and Dustman, 1948) During 1946, when the population was decreasing, Leedy and Dustman (1948) reported

adults composed 38 percent of the September population. This means that in years of high productivity, juveniles composed about 75 percent of the fall population, whereas, in years of lower productivity, they composed about 62 percent. "The adult-juvenile ratio of pheasants immediately following the nesting season is an excellent indicator of reproductive efficiency." (Leedy and Hicks in McAtee, 1945)

Based on the author's findings of 5.7 juveniles per adult cock, juveniles composed 82 percent of the pre-season population. The figures indicate that the 1948 nesting season was very favorable and brood survival was high. The other alternative would be that adult nesting or post-nesting mortality was high, but the first conclusion seems more probable.

The plotted hatching dates of individual birds show that the peak occurred during the last week in May and first week in June. At this time 71 percent of the pheasant broods come off. The earliest broods were hatched on the last week in April. The plotted hatching dates fail to show the possibility of a second hatch. Concerning this question Hiatt and Fisher (1947) say,

> Data showed opposition to the second brood theory. Since cocks with mature spermatazoa were not found in the population after the first week in August, impregnation of the female would necessarily have to occur on or before this time. No laying hens were found among birds autopsied after late July, but a small proportion had gravid ovaries through mid-August.

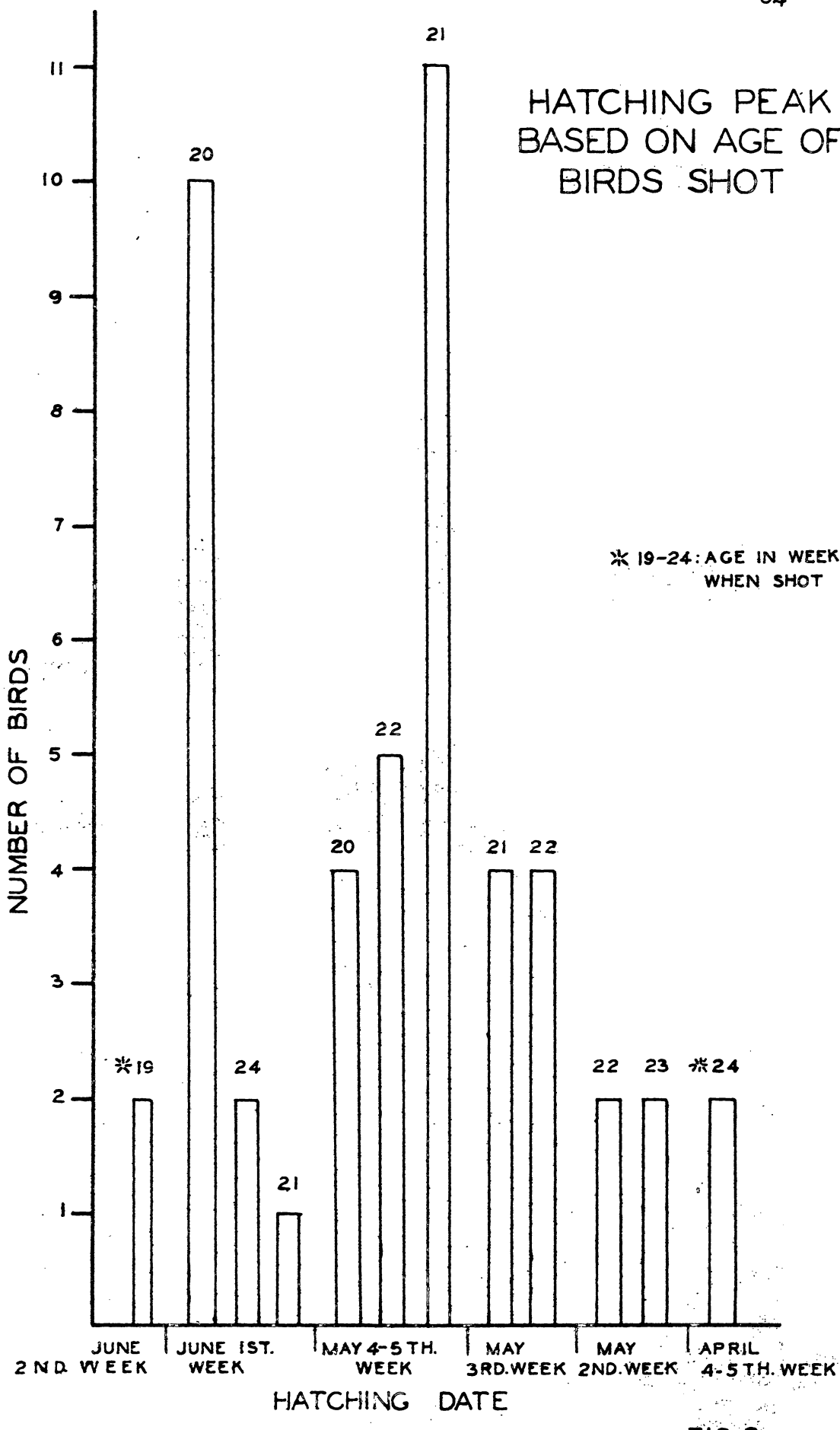
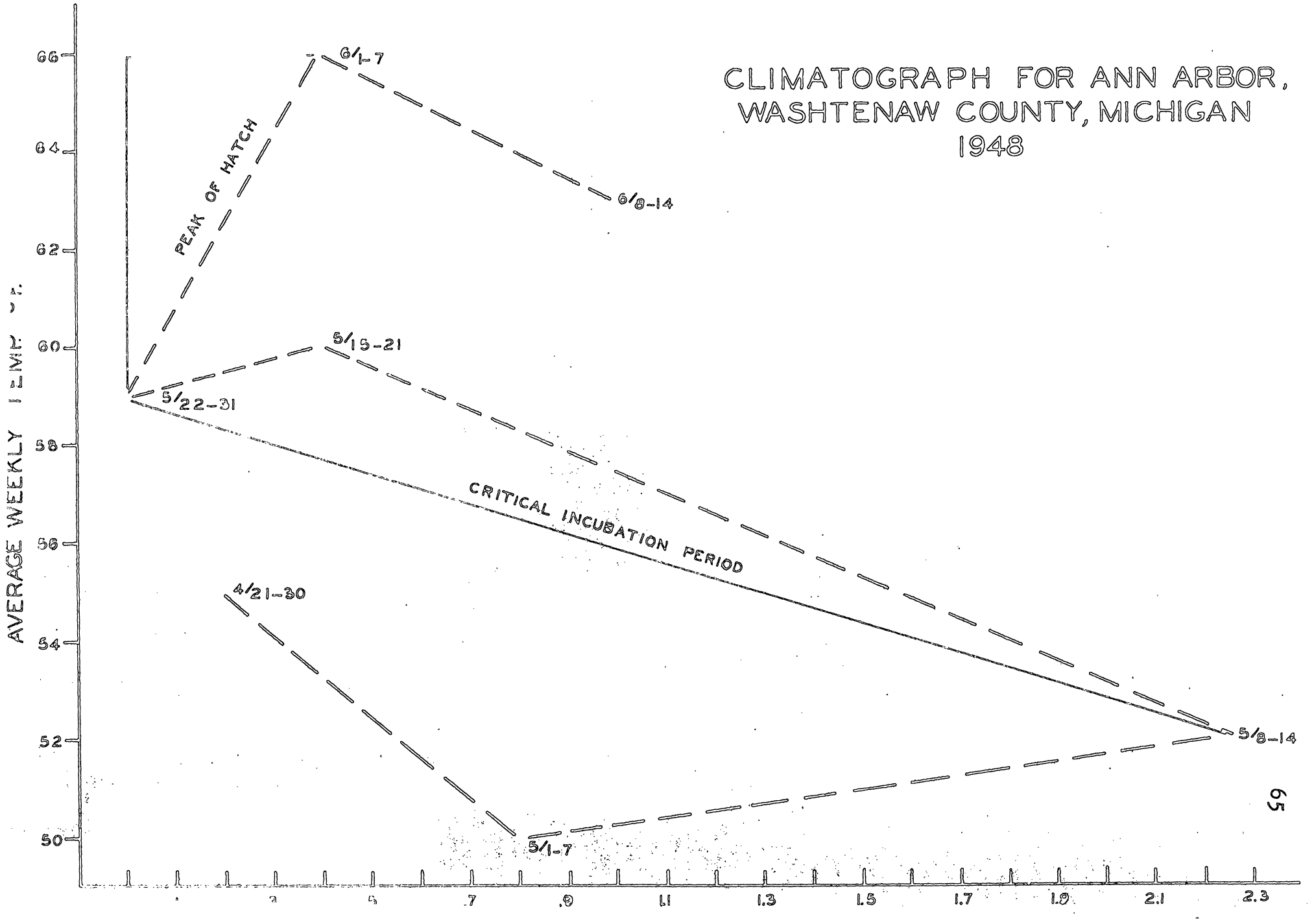

HATCHING PEAK BASED ON AGE OF BIRDS SHOT
* 19-24: AGE IN WEEKS WHEN SHOT
NUMBER OF BIRDS
1
2
3
4
5
6
7
8
9
10
11
*19
24
21
20
22
21
20
21
22
22
23
*24
JUNE 2ND WEEK
JUNE 1ST. WEEK
MAY 4-5TH. WEEK
MAY 3RD. WEEK
MAY 2ND. WEEK
APRIL 4-5TH. WEEK
HATCHING DATE

FIG. 3


CLIMATOGRAPH FOR ANN ARBOR,
WASHTENAW COUNTY, MICHIGAN
1948
AVERAGE WEEKLY TEMP °F.
66
64
62
60
58
56
54
52
50
PEAK OF HATCH
6/1-7
6/8-14
5/15-21
5/22-31
CRITICAL INCUBATION PERIOD
4/21-30
5/1-7
5/8-14
.7
.9
1.1
1.3
1.5
1.7
1.9
2.1
2.3

When the hatching peak is compared with the climatograph for that period, it is evident that the weather was very favorable. Rainfall was very low and temperatures did not average below 58° Fahrenheit. These are ideal conditions for young pheasant chicks, although they are able to withstand lower temperatures and higher rainfall.

Prior to incubation, pheasant eggs can stand below freezing weather (English in McAtee, 1945), but once incubation has started it must be maintained. This period is considered critical in relation to weather conditions. Therefore, it was plotted on the climatograph for the hatching peak. It shows that at the start of incubation rains started, (May 6) and in one week's time, over two inches had fallen. Undoubtedly, most of the lowland nests were destroyed by flooding, but heavy rains in March may have discouraged much of the lowland nesting. Some nesting loss due to weather conditions probably occurred, but the adult-juvenile ratio indicates this loss was negligible.

Productivity. The productivity of the population on the area is extremely difficult to ascertain with any degree of accuracy as all the pertinent data necessary is not available. In 1948, there were sixteen crowing cocks, but the actual number of hens present was not known as the author was hospitalized at that time. From actual observations and farmer's reports, it was determined that sixteen broods

were reared. The data is complete only up to the last week of July. There may have been more broods coming off after this date, but they were not seen by the author or reported by the farmers. This means there were sixteen cocks and at least a similar number of hens accounted for, plus an unaccounted number of unknown hens. Some calculations can be made with the known spring population of sixteen cocks and hens and a fall population of ninety cocks and one hundred eight hens.

The figures used in calculating the 1948 nesting and fall populations were derived as follows:

Sixteen adult cocks were present in June 1948. One hundred and eight adult and juvenile wild and released hens were present in the fall of 1948. Before this figure can be used, all known banded hens that were still on the area during the fall of 1948 must be deducted in order to get a figure that is as close as possible to the productivity of wild birds. Only eight banded hens were known mortalities. Therefore, 108-8 leaves 100 hens. From the 100 residual hens must be deducted x, the unknown spring population of adult hens. This would otherwise be carried over into the fall population, providing that no mortalities occurred. Therefore, 100-x equals the theoretical population of juvenile hens present in the fall of 1948. This figure will have an error due to the unknown number of banded birds

still remaining on the area. There were ninety adult and juvenile wild and banded cocks present in the fall of 1948. For the previously mentioned reasons, the known number of juvenile banded birds that were on the area in the fall must be deducted, also the known number of adult cocks present in the spring. The known cock banded bird mortalities amounted to eighteen and there were sixteen adult cocks present in spring. Therefore, 90 - (16 + 18) leaves a theoretical juvenile population of fifty-six cocks, in the fall. This figure may also include an unknown number of banded birds.

$$\frac{16}{x} : \frac{56}{100-x}$$

$$56x = 1600 - 16x$$

$$72x = 1600$$

$x = 22.2$ adult hens present in the spring of 1948.

$\frac{156 - 22}{22} = 6.1$ fall surviving juveniles per adult hen.

The calculations show that there were twenty-two adult hens and sixteen adult cocks in the spring of 1948. Each adult hen produced 6.1 fall surviving juveniles. This surviving brood size figure is high because it contains the error of the unknown number of banded birds included in the fall population from which it was calculated. In personal

correspondence with MacMullan of the Michigan Department of Conservation (1949) he states, "Estimated spring sex ratio was 100 cocks to 240 hens so productivity was about 4.5 juveniles per adult hen." Average brood size as reported by the rural mail carriers was 6.2 in 1948.

If the surviving brood size was 6.1 based on twenty-two hens and sixteen cocks, then the actual calculated population for the fall of 1948 would be 22 x 6.1 + (22 + 16) or 172 pheasants. The fall population before the hunting season was 198 pheasants, including banded birds, twenty-six of which were known to be on the area at that time. These calculations contain many unknown factors and no claim for extreme accuracy is made. They are intended to serve as an index to the possible productivity of the area and compare favorably with the known fall population.

IV

SEASONAL MOVEMENTS

Major Movements

There were several distinct seasonal movements observed on the area. In the fall there was a general reshuffling of the population before winter flocking started on December 12. Once flocking started, there was a movement and concentration of birds in the marshes. Due to the mild winter which caused alternate thawing and freezing of the marshes, the pheasant flocks were never concentrated for any long period of time. Individuals spread out to upland cover during the mild periods. Kimball (1949) states, "During milder weather cocks leave the concentration area and the count will run heavy to hens."

The winter concentrations consisted primarily of hens as the cocks are more solitary. By January 27, the concentrations had reached a maximum size and thereafter the trend was downward. On the third week in March the winter concentrations began to break up, and by the last of March dispersal was almost complete. Cocks were the first to leave winter cover, probably to seek crowing areas. After the cocks left the wintering areas and established territories, the hens followed. They seemed to wander about before mating.. By

the second week in May, all cocks were seen accompanied by at least one hen, with two the usual number. After this period, hens were rarely seen as they were probably on the nest.

Wight (1930) found that there were two major movements. The first occurred when mating and nesting activity was at its height and when the search for suitable nesting sites and territories leads birds away from winter cover. The second movement occurs during late summer and lasts throughout fall. Concerning spring dispersal, Baskett (1947) found that by March the cocks dispersed and hens gradually dispersed as small groups.

Seasonal Use of Cover

The use of cover types for roosting, shelter, and escape varied with the season. Table XVII shows the percent of cover types used by pheasants at different seasons of the year. Table XVIII is used for comparison with Wight's findings (McAtee, 1945).

During the fall, 46 percent of all pheasants were found in marshes with 21 percent in mixed herbaceous cover. Immediately after the hunting season a majority of the pheasants were found in the heavy marshes. They were probably driven there by hunting pressure. A majority of these were hens, with cocks, keeping more to the mixed herbaceous cover.

In winter when marsh cover is expected to receive the

TABLE XVII PERCENT OF COVER TYPES USED BY PHEASANTS AT DIFFERENT SEASONS OF THE YEAR

Season	Marsh	Mixed Herbaceous	Brush	Woods	Fields
Fall	46.5%	21.5%	6.0%	7.5%	18.5%
Winter	35.84	26.31	13.53	8.02	16.29
Spring	32.56	21.39	25.58	11.16	9.3
Average	38.3	23.06	15.03	8.89	14.69

TABLE XVIII PERCENT OF COVER TYPES USED BY PHEASANTS AT DIFFERENT SEASONS OF THE YEAR AS DETERMINED BY WIGHT (McATEE, 1945)

Season	Marsh	Mixed Herbaceous	Brush	Woods	Hay Fields	Corn Fields	Grain Fields
Winter	53.7%	13.8%	13.3%	.6%	4.9%	13	.9%
Spring	30.1	16.1	29.5	5.5	12.1	6.5	.2
Summer	5.1	19.3	16.4	8.5	34.1	6.6	10.0
Fall	14.7	21.0	19.2	5.1	7.4	32.1	.5
Average	15.9	17.6	19.6	4.9	14.6	14.5	2.9

highest use, only 35 percent of the birds were found utilizing it, as compared to 46 percent during the fall. This unusual result can be attributed to the mild winter which allowed pheasants to make heavier use of upland cover. It also shows up in the increased use made of herbaceous cover in winter over fall. A majority of the 16 percent of birds observed in fields during winter were feeding on waste corn. The area has ideal over-wintering cover and food. This is borne out by the winter population figures which show that there was an increase of twelve birds or 16.4 percent over the fall population. These additional birds probably come from adjacent lands because of the ideal winter cover on the study area. In Allen's study, on a 500 acre farm (1938), he states, "There has been frequent interchange of birds with surrounding areas that very materially altered the population numbers."

During spring there is a decrease in the use of marshes and an increase in use of brush, woods, and mixed herbaceous cover. At this time there is a movement out of the thawing marshes and the cocks are establishing crowing territories. These territories usually include herbaceous cover, brush, and woods. During this season, woods are utilized more than at any other time, largely by cocks, as this type is usually included as part of the territory.

Escape Cover

Records were kept of the cover type that birds flew to

upon being flushed. This was designated as escape cover and is shown by season in Table XIX. The escape cover varied with the weather, season, activity of birds when flushed, and somewhat with the time of day. If the birds were flushed in the vicinity of the roost early in the morning before feeding, they tended to fly toward the feeding grounds. In the evening or during the day, they tended to fly toward the roost. Individuals or small groups of pheasants were very consistent in their choice of escape cover for any one season. After a while, their line of flight and choice of cover could be predicted. This indicates that the birds had a pre-determined line of flight toward picked cover. The use of brush and woods increased steadly from fall to spring. This was due primarily to their inclusion in almost all crowing territories.

The average distance flown to escape cover also varied largely with the season. In the fall it was 13.1 chains; in winter, 8.4 chains; and 15 chains in spring (66' per chain). For several weeks after the hunting season birds were alert and the distance flown was quite far. During winter, the birds were more reluctant to fly any great distances and stayed fairly close to cover. One reason could be that they needed to conserve energy for producing body heat against the winter's cold. Also, wind velocities were greatest during this season and pheasants almost always flew with a strong wind. In spring, during the

breeding season, cocks seemed to be highly nervous and alert, flying long distances when flushed.

Roosting Cover

Winter

Here, also, it was found that there was a variation in choice of roosting sites with season. There seems to be a direct relationship between choice of winter roosting sites and distance to corn fields. There were some excellent marshes that went unused probably because of lack of any nearby corn or other food. Randall (1946) states, "The amount of standing corn apparently determines to a large extent the number of pheasants that an area in Southwestern Pennsylvania will winter."

About the affect of winter weather on movements, Dalke (Wight, unpublished) states,

> Strong winds, twenty-five to thirty-five miles per hour hamper pheasant movements. Temperature does not seem to affect feeding. Temperature does, however, seem to have a pronounced effect on movements.

During some of the coldest, windiest weather in late February, birds in the spirea-willow marsh were reluctant to leave and feed in their regular feeding grounds, 200 yards away. Out of twenty-six birds known to inhabit the marsh, only five-six went to feed in the corn field over a two-day cold spell. Some of the brome grass and sedge marshes were not utilized

late in winter because they lacked durability and were knocked down by snow.

As a rule, pheasants left the roosting areas to feed later in the winter than in fall and spring. More time was spent in roosting during the winter than at any other season. Marshes were used quite extensively for roosting, with herbaceous and ditchbank cover a close second. Cocks preferred to stay in the upland herbaceous cover while hens utilized marshes during the mild winter periods. A small spruce planting was used during the entire winter by approximately six hens and two cocks.

Spring

During the spring when low ground becomes flooded, pheasants must find suitable high spots for roosting.

> Unless they can find suitable roosting sites on the particular farm or unit being managed, they may be forced to leave. As a result they may rear their young on adjacent farms where they will probably remain during the fall hunting, returning to the original areas, only to spend the winter. (Wight in McAtee, 1945)

There was an unknown loss of three cocks and eleven hens between the end of spring dispersal and the time of the spring census. This unknown loss could be attributed to any number of factors, among them the lack of herbaceous and brushy cover for spring roosting and crowing sites. Two of the sections possess a fair amount of these types, but on the area as a whole, they are lacking.

TABLE XIX PERCENT OF COVER TYPES USED BY PHEASANTS FOR ESCAPE COVER AT DIFFERENT SEASONS OF THE YEAR

Season	Marsh	Mixed Herbaceous	Brush	Woods	Fields
Fall	57.14%	28.57%	2.38%	10.71%	1.19%
Winter	31.14	35.09	14.47	11.84	7.46
Spring	41.66	12.50	23.95	21.88	
Average	43.31	25.38	13.6	14.81	2.88

Practically all the brushy and herbaceous cover is present in the form of fence rows and ditchbanks. Two of the five sections have these poorly developed because of clean farming practices. On this question Wight (McAtee, 1945) says,

> In the census work it has become increasingly obvious that lands which have comparatively few brushy fence rows generally provide poor pheasant range and invariably have a comparatively thin pheasant population.

This could very well be the critical factor which causes loss of birds during the spring period.

Fall

The greatest variation in roosting sites for all three seasons was found in early fall. It seems there is a reshuffling of the population, and most cover types are still suitable for protection during roosting. The marshes are not yet flooded by fall rains, and the vegetation is not completely bare of leaves. Later in fall, there is a movement into the marshes. Since there is such a great variation in choice of fall roosting sites, this period cannot be considered a critical one in determining population density.

Crowing Season

Kimball (1949) states, "The crowing count is probably most useful in censusing low pheasant populations." According to the author's findings, the crowing count gives a very

reliable count on low to medium populated areas, but has its limitations. These limitations have been discussed previously under census methods.

The first crowing cock was heard on February 9, and sporadic crowing was heard from then on until the start of concerted crowing about the second week of April. Crowing can be heard infrequently, except during the breeding season, all year around. Wight (unpublished) found the average date of the first crowing in Southeastern Michigan was February 23.

The number of crows per two-minute interval was recorded at picked stations from the start of crowing to determine when concerted crowing began and when the period of maximum crowing was attained. The crowing count began one-half hour before sunrise and lasted for one hour or more. Graph 5 shows the relationship between time before and after sunrise and average number of calls heard per two-minute interval over a three-week census period. According to this graph, crowing intensity was greatest from ten minutes before until fifteen minutes after sunrise. This may vary with weather conditions and the time of the crowing season, but Kimball (1949) found it to be relatively constant. The earliest date (3/29-31) represents the start of the regular crowing period, and the latest one (5/6-9), the height of the crowing period. The end of the crowing season couldn't be determined

as the study was terminated before that time.

Audibility and Obstructions

On a good clear day crowing is audible for a distance of about eight-tenths of a mile. The country is fairly level with interspersed woodlots up to eighty acres in size, constituting the major physical obstructions to crowing audibility. The two man, plane table crowing census showed that, even with an obstructing woodlot of twenty-seven acres, cocks were heard for a distance of eight-tenths of a mile on a clear, still day. Tractor and car noises obliterated all but the very close crowing calls. Kimball's (1949) work in the middle west showed that normal calls can be heard roughly nine-tenths of a mile.

Affect of Weather on Crowing

Weather conditions, especially temperature and heavy rains, seem to have an affect on crowing intensity. On warm, clear, still days, the crowing was very regular, but several cool days (55^{o}F.) were encountered during which crowing was also regular. It is hard to say which weather element has the greatest affect on cock birds, but it is probably a combination and not any one single factor. Wind velocities over ten miles per hour, according to the Beaufort scale, cut down audibility considerably and distorted the directional sense of the observer. Kimball (1949) states, "Weather

factors with the exception of wind about eight miles per hour and heavy precipitation, apparently seldom affect crowing counts." Wight (unpublished) found that, "Crowing is conspicuous during warm periods and almost lacking during cold spells in February."

Crowing Interval

The two-minute listening interval was chosen partly because of time limitations and difficulty of concentration for a longer period. At the start of regular crowing in March, the crowing interval was about three minutes but declined until, during the last week of April, it was two to 2.5 minutes. Birds usually started crowing three-quarters of an hour before sunrise and stopped concerted crowing about one and three-quarters of an hour later.

Physiology of Maturity and Its Affect on Crowing

It was found that all the cocks did not start crowing at the same time. Additional cocks were heard and found as late as the first week in May. These cocks may have come from adjacent areas or they didn't begin crowing until after the start of concerted crowing. Hiatt and Fisher (1947) find, "Rapid development of the testis in early spring is not simultaneous for all males." This would indicate that all males would not come into breeding condition at the same time. If this is the case, it explains the late crowing cocks.

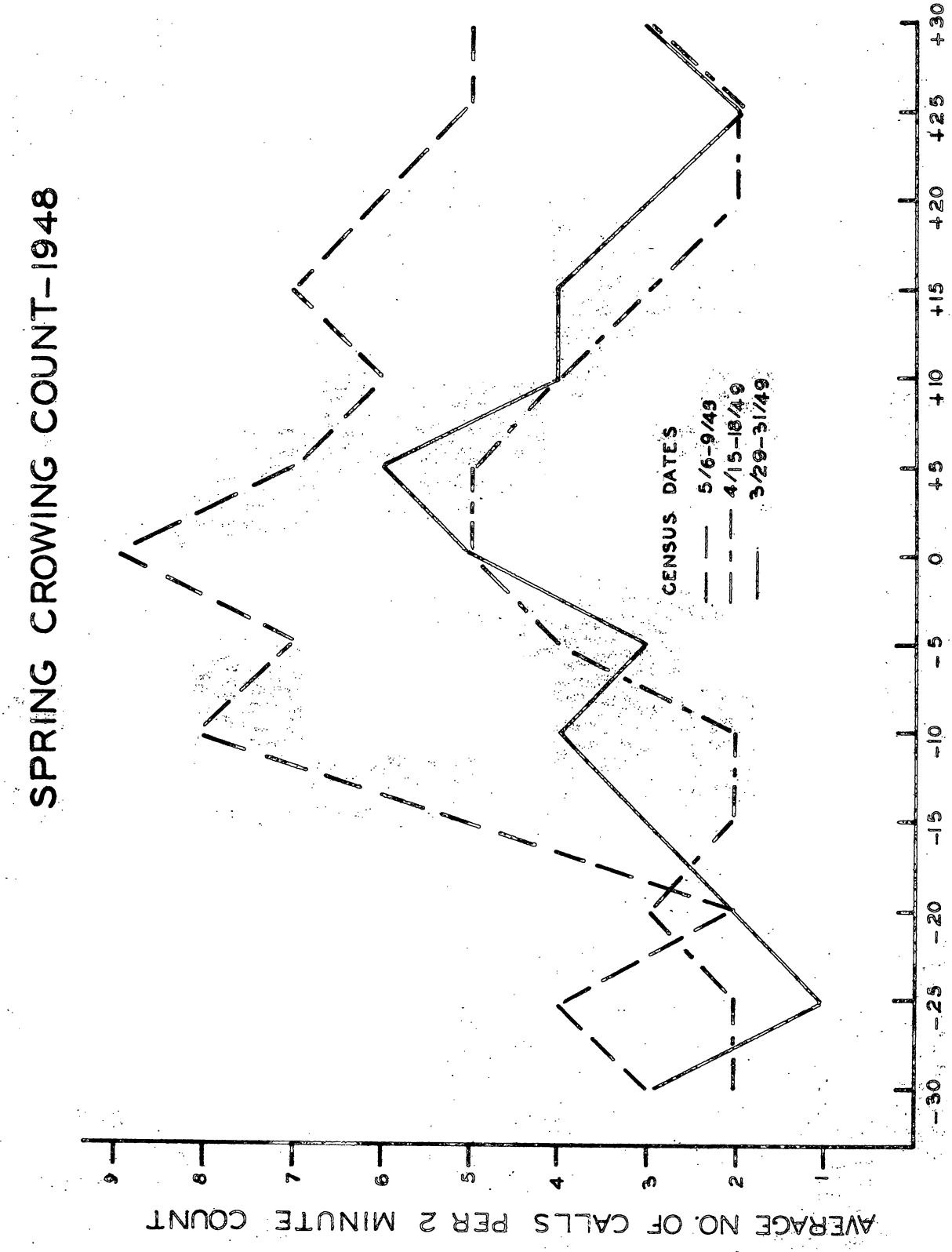

SPRING CROWING COUNT-1948
AVERAGE NO. OF CALLS PER 2 MINUTE COUNT
MINUTES BEFORE AND AFTER SUNRISE
CENSUS DATES
5/6-9/49
4/15-18/49
3/29-31/49
-30
-25
-20
-15
-10
-5
0
+5
+10
+15
+20
+25
+30
1
2
3
4
5
6
7
8
9

FIG. 5

Crowing Territories

The terms "crowing area" and "territory" are indistinguishable in the literature and, therefore, will be used synonomously. In writing about this, Wight (McAtee, 1945) states,

> Because these areas are distinguished, especially by the call of the cocks, they have become designated as "crowing areas", and this term is used here synonomously with "territory" in the technical sense.

What determines and constitutes a territory is one of the most difficult questions confronting pheasant research workers. According to Wight (McAtee, 1945), the extent and shape of crowing areas are determined by composition, arrangement, and density of cover. In his unpublished manuscript, Wight further states,

> Any area of cover, large or small, that will permit the cock to follow a normal routine unobserved, will be sufficient to warrant its being recorded as a crowing area.

This is a very encompassing statement and warrants broad interpretations.

On two different areas known to the author, crowing cover is scarce on one and apparently plentiful on the other. It may be the determining factor of population density on one area but doesn't seem to affect density on the other. In Lenawee County, Michigan, where there is very little cover

except cornfields and a few fence rows, crowing cock counts by the Conservation Department (MacMullan, 1949) are one point above the state average (3.6) for pheasant range. Near the author's study area, departmental two-minute crowing counts are 2.7 or below the state average. If the two areas are compared on the basis of crowing cover and food, it would undoubtedly show that crowing cover conditions are more ideal on the study area, but there is more corn present in Lenawee County. In the Lenawee County situation, the corn seems to retain the birds that make the best use of what little cover is available. One explanation could be that the land adjacent to the study area contains good crowing cover, so some of the birds are drawn there. In Lenawee County, practically all the land is lacking ideal crowing cover so that the birds have nowhere else to go within reasonable flying distance. This is on ly one of the more feasible assumptions, and many others could undoubtedly be postulated. This illustration was given to show the extremes in crowing cover as it might affect population density.

Number of Crowing Cocks in 1948 and 1949

The number of crowing cocks was sixteen during each of these years. This would signify that the population of cocks was stable and the stocking of released birds did not seem to bolster the numbers. It could also mean that there are a set number of crowing areas which would limit the number of

TABLE XX

OCCURENCE OF COVER TYPES ON CROWING AREAS

Size of Study Area	Number of Crowing Territories	Marsh		Herbaceous		Woods		Brush		Corn Fields		Hay Fields	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
3150 acres	16	11	68.7	9	56.2	12	75	15	93.7	11	68.7	7	43.7

TABLE XXI

HAREM SIZE

No. of Hens With Cock	Cock Occurence
1	1
2	9
3	6

cocks the area could maintain. Of the sixteen territories occupied in 1948, fourteen were used again in 1949 and only two new ones were established. One established cock was killed by predators during the crowing season and another left his ditchside crowing area because the farmer brushed out the cover. If these birds had remained on the area there would be eighteen crowing cocks in 1949.

Wight's unpublished manuscript contains the following statement, "The population on any piece of land is therefore limited by the number of such combinations that can be utilized for crowing areas." His term "such combinations" means the number of places containing brush, nesting cover, and woods adjacent to each other in one compact parcel. If the exact cover types required to constitute a crowing area were definitely known, it would be a relatively easy matter to determine the number on the area. There is such a wide variation in the cocks' choice of types that this is not possible. According to Wight (unpublished), "The number of crowing areas required to produce a good fall population is, according to best information, about forty per square mile."

Composition of Provisional Crowing Territories

The occurrence of cover types in the crowing territories is shown in Table XX. It appears that brush and woods are the two most important types as they appear 93 and 75 percent

respectively on the crowing areas. In regard to composition of territories, Wight (McAtee, 1943) says, "Thus the crowing area is a unit of land bearing dense, woody vegetation combined with open herbaceous cover suitable for nesting." Herbaceous cover probably was present on more than the indicated 56 percent of the territories as fence rows usually contained this type. The occurrence of hayfields in the territories will probably rise later in the season when hay has grown some. If the occurrence of woods and brush is any index to the important part it plays in selection of territories, it would be justifiable to conclude that this type is scarce on the area as a whole. This factor may tend to limit the number of available crowing areas. Woods are not especially scarce on the area but they are not ideally scattered in small parcels. On the whole area only five woodlots were excluded from crowing territories. Brushy cover is relatively scarce, and all available parcels, except some fence rows, were utilized by cocks.

Size of Provisional Territories

The territories are designated as provisional because they are subject to change and it was difficult to set any definite boundaries. Boundaries were determined by observation and, in some cases of adjacent territories, fighting was seen which indicated one common border of the crowing area. The provisional boundaries include the limits of the

territory the cock was seen to frequent during crowing, fighting, or feeding. While feeding and moving to feeding areas, cocks crow sporadically. The sizes of territories ranged from twenty-four to seventy acres, and was regulated by the density, composition, and arrangement of cover. Territories in fence rows were narrow and elongated, while others were irregularly shaped. Wight (unpublished) came to this same conclusion.

Fighting

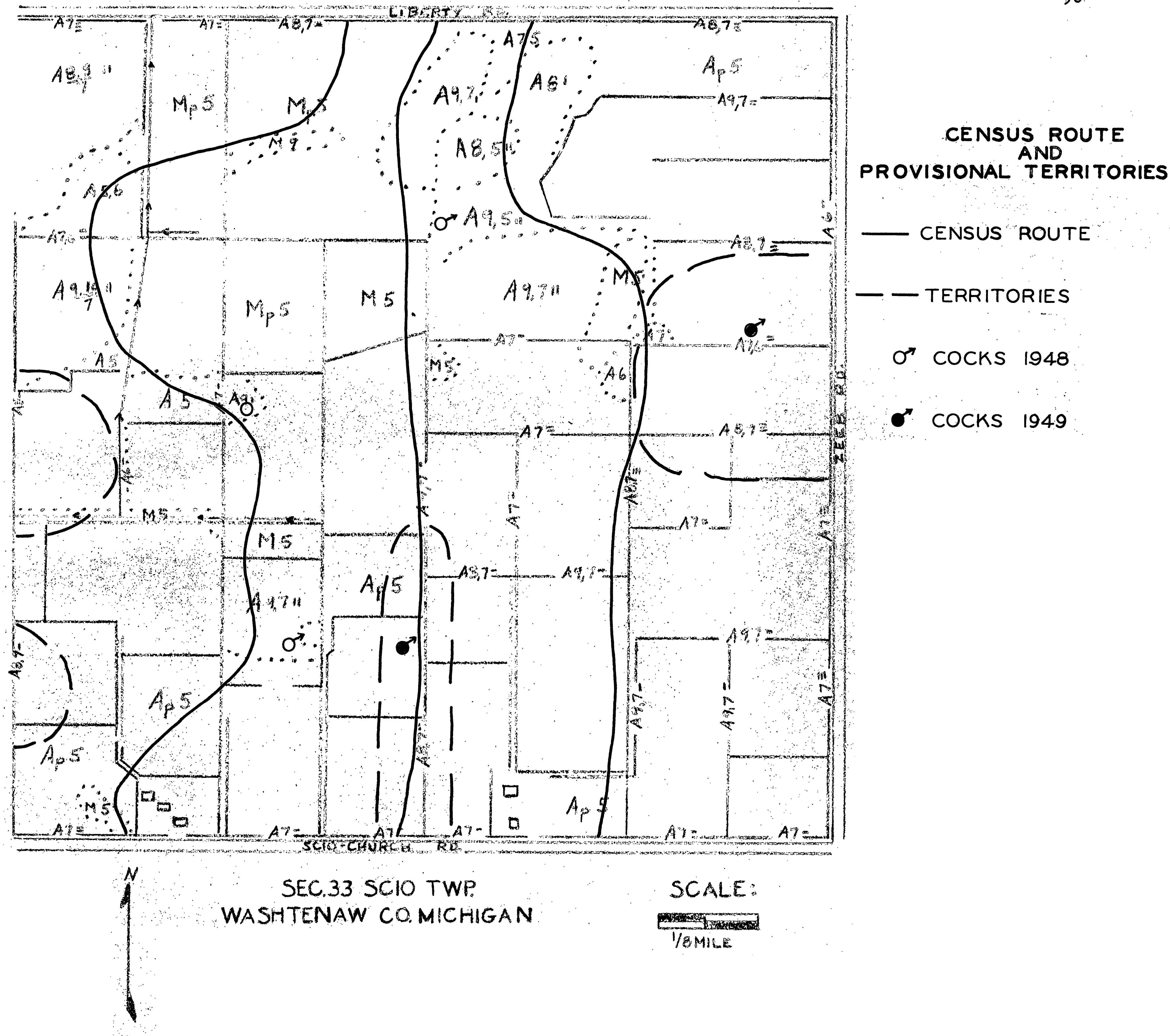
Fighting was observed in three instances where territories bordered each other, but hens were seen present in only one case. Baskett (1947) seems to think that most fighting is not over hens, but the presence of females may perpetuate conflict. In one instance, two cocks were observed feeding together in a pig-pen adjacent to a woodlot which one cock had appropriated as his crowing area. Two hens were seen in the woodlot at the time the cocks were feeding. Apparently the feeding grounds were neutral territory. Later, the same cocks were seen engaged in battle in the middle of a gravel road bordering the woods. One cock was eventually driven across the road into section 31 where he set up a territory. The victor returned to his woods where the two hens were waiting. The second case involved a fight in the center of a hayfield with three hens as onlookers. Both groups were feeding peaceably on opposite sides of the field

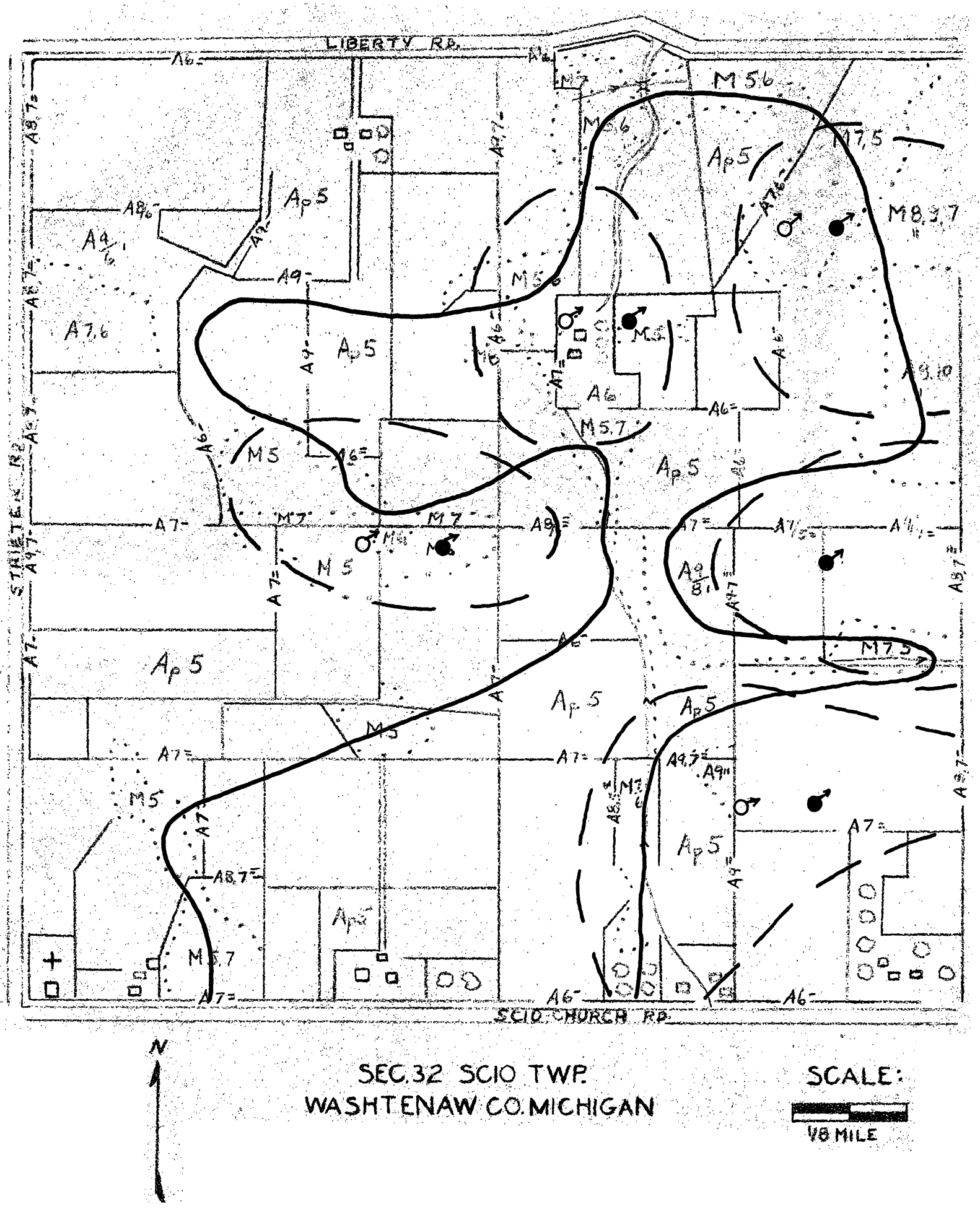
until one cock apparently crossed an imaginary line. The other cock rushed over and a fight ensued. This imaginary line evidently was the boundary common to both territories. The hens were never seen to cross the line.

In the last instance of observed fighting, the boundary instituted a fence row separating a woodlot and marsh. In all of these instances, the conflict seemed to be over invasion of territory by cocks, although the presence of hens in the one case could have been an influencing factor. Hens could have been present in the other instances but were not visible.

Harem Size

The range and occurrence of harem size is shown in Table XXI. Two hens composed the usual harem with three hens per cock the largest. Wight (McAtee, 1945) contends that the size of the pheasant harem depends more upon the number of hens in the neighborhood at the time spring mating occurs, than upon pronounced polygamous tendencies on the part of the cocks. If all hens were included in harems and three was the largest harem size, then the eleven hens that left or were killed on the area during spring dispersal could easily have been serviced by the remaining cocks. In order to increase productivity on the area, some way should be found to retain any hens that would otherwise wander off the area during spring dispersal.


CENSUS ROUTE
AND
PROVISIONAL TERRITORIES
CENSUS ROUTE
TERRITORIES
COCKS 1948
COCKS 1949
LIBERTY RD.
SCIO-CHURCH RD.
ZEEB RD.
N
SEC. 33 SCIO TWP.
WASHTENAW CO. MICHIGAN
SCALE:
1/8 MILE



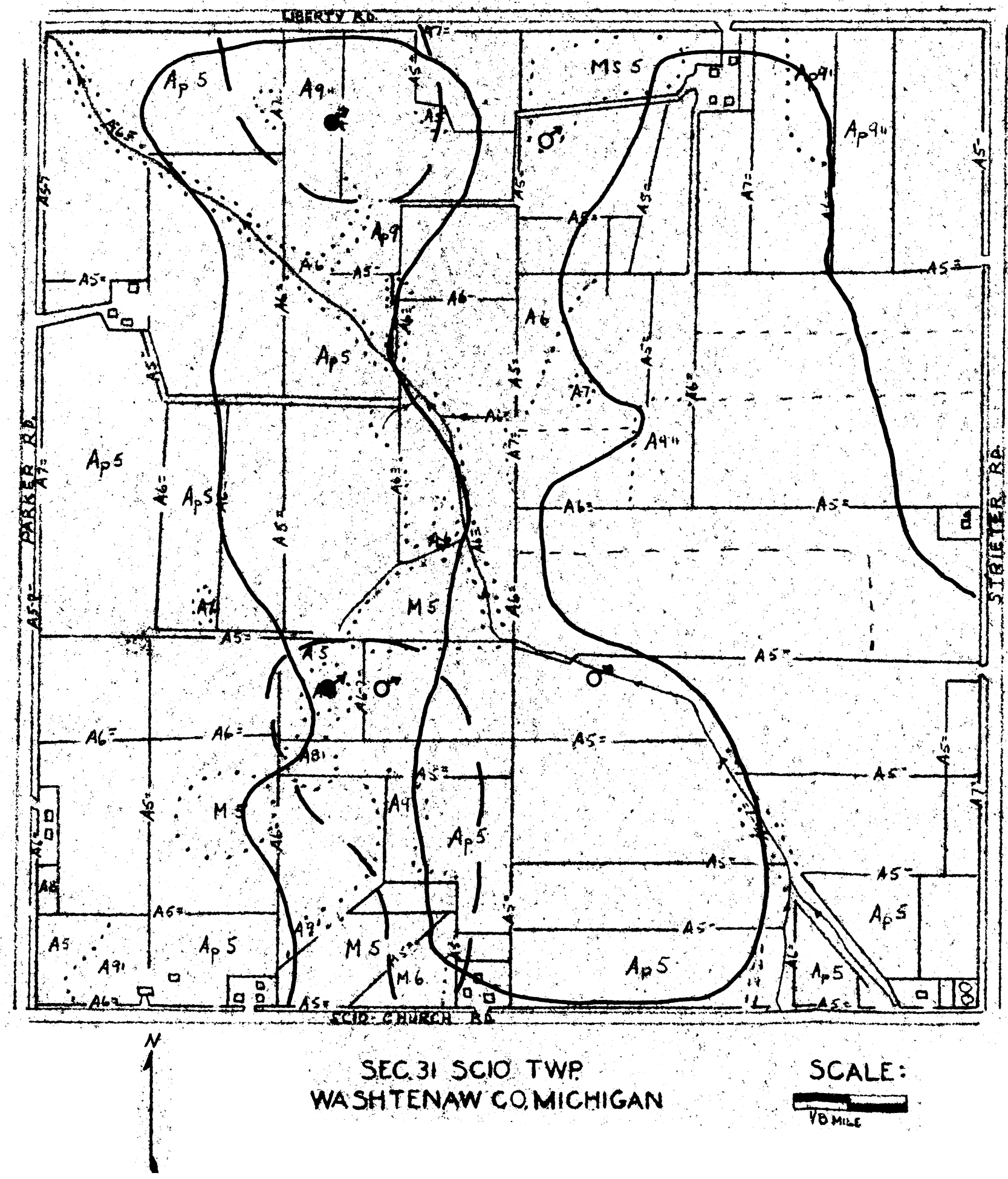
CENSUS ROUTE AND PROVISIONAL TERRITORIES

— CENSUS ROUTE

— — TERRITORIES

♂ COCKS 1948

♂ COCKS 1949



CENSUS ROUTE
AND
PROVISIONAL TERRITORIES

— CENSUS ROUTE

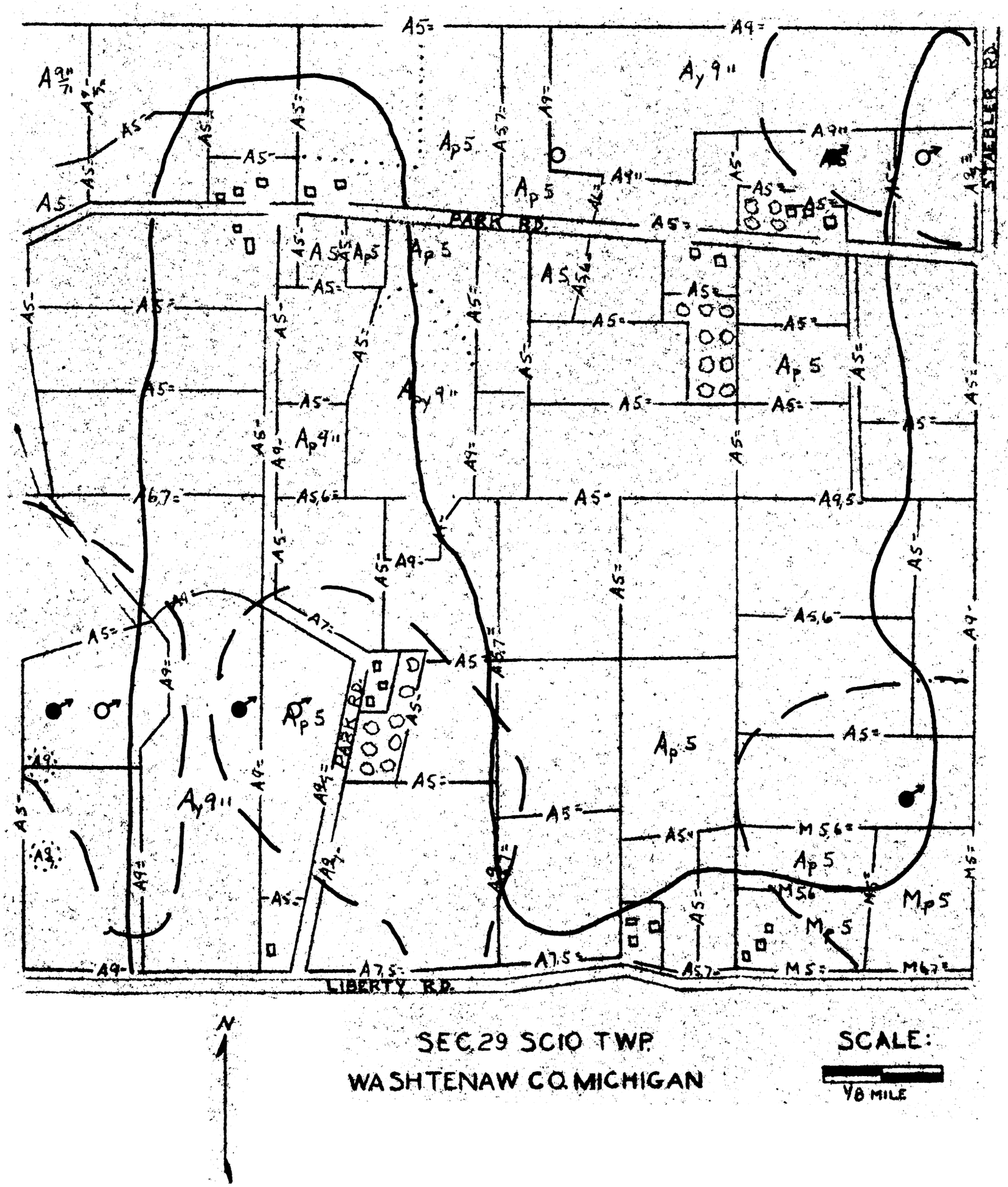
— — TERRITORIES

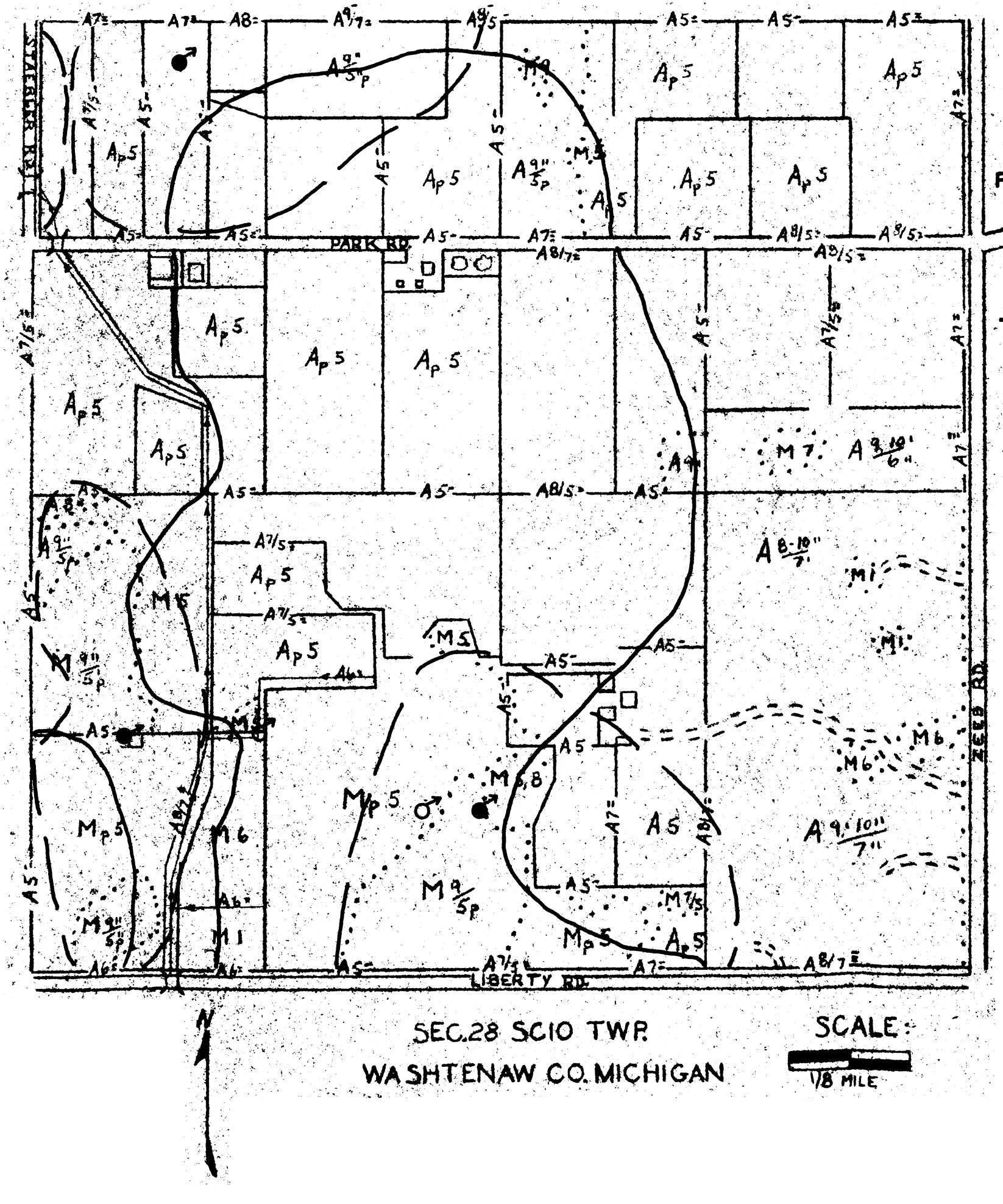
♂ COCKS 1948

♂ COCKS 1949

SEC. 31 SCIO TWP.
WASHTENAW CO. MICHIGAN

SCALE:
1/8 MILE


PARK RD.
STAEBLER RD.
LIBERTY RD.
PARK RD.
CENSUS ROUTE AND PROVISIONAL TERRITORIES
CENSUS ROUTE
TERRITORIES
COCKS 1948
COCKS 1949
N
SEC. 29 SCIO TWP.
WASHTENAW CO. MICHIGAN
SCALE:
1/8 MILE


STAEBLER RD.
PARK RD.
LIBERTY RD.
ZEEB RD.
CENSUS ROUTE AND PROVISIONAL TERRITORIES
CENSUS ROUTE
TERRITORIES
COCKS 1948
COCKS 1949
SEC. 28 SCIO TWP.
WASHTENAW CO. MICHIGAN
SCALE:
1/8 MILE
N

V

SUMMARY AND CONCLUSIONS

Area productivity was not high, partly because of lack of hens, but the nesting season was very good. The cocks on the area could have serviced many more hens than were available.

Hunting pressure and take was relatively high, considering that the area is not heavily populated. Sixty percent of the available cocks were shot during the season. The number bagged could safely be raised to 75 percent without endangering productivity. Illegal kill, although unknown, seems to be high because of the unknown loss of hens found after the season.

Known losses, due to predation, were under 10 percent for fall, winter, and spring, so predators are not a limiting factor in determining population density. The area offers excellent wintering ground for pheasants as evidenced by the increase in the overwintering population, but 14 percent of the pheasants between the end of spring dispersal and the start of concerted crowing were lost. As far as can be determined, this loss was partly due to a lack of spring roosting and crowing cover on part of the area.

If the birds, especially hens, could be retained during

this critical period, the area productivity would undoubtedly be raised. This could be accomplished by manipulation of food and cover and improved farm practices. This would be difficult to do because of the indifferent attitude of the land owners.

Areas of this type are important in the Ann Arbor region because of their ideal location in respect to centers of potential hunter populations. They receive a large share of the week-day or "business man's" type of hunting because they are accessible and serve to take some of the pressure off the heavily hunted excellent pheasant range. They should not be neglected as these rural areas have an excellent future in the hunting picture.

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