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The effect of topography and  
land use on ruffed grouse in  
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Master's thesis

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**THE EFFECT OF TOPOGRAPHY AND LAND USE ON  
RUFFED GROUSE IN SOUTHERN MICHIGAN**

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## INTRODUCTION

It is the purpose of this study to determine the effect of topography and land use on the ruffed grouse, Bonasa umbellus umbellus, in its southern Michigan habitat. It is also the purpose, here, to develop a management plan under which a shootable population of grouse may be built up. The study covers the period of February 1947 to January 1948.

There is a unique relationship between the ruffed grouse and topography. Topography influences vegetation - the food and cover which it offers in season, the selection of nesting sites, brood cover, escape routes, and daily movements. Topography has a marked effect upon the actions of grouse predators.

Slope is an aspect of topography and is important in the action of wind, water, and sunlight. Slope has determined the location of woodlots and the nature and extent of their use. Cultivation has limited grouse habitat, but on the other hand, it has provided additional food and dusting spots. Drainage has lowered the water level so that more land might be brought into cultivation; it has also in cases increased the water supply in the basins around which grouse habitat is in large part centered. These and other agricultural practices now in use in southern Michigan will be discussed from the standpoint of their value to this game bird.

In order that the study areas and the management plan might be viewed in the proper relationship, a brief summation of glaciation is important. Furthermore, glaciation is the basic cause of that topography, the effects of which will be discussed. The terrain of outwash plains, kettle holes, and moraines is the result of a definite ice movement, the main pressure of which was exerted from the northeast and east. The general area in which the study was carried on includes Washtenaw County, the eastern edge

of Jackson County, and the southern edge of Livingston County. The northwestern portion of the area is occupied by rough, interlobate moraine of loose textured soil. This is known as the Interlobate Lake District, which extends from Lenawee County on the south to Oakland County on the north. Thousands of acres of swamp and marsh land occur in the basins of this district. Grouse habitat is centered in the wooded basins. The central portion of the area is included in the Clay Morainic Belt. High and rolling, this area reaches from just below Portage Lake to Ypsilanti (27).

Drainage and erosion play a large part in the determination of the vegetation in grouse habitat. In the Interlobate Lake District a string of over forty lakes swings from southeast Livingston County, across the northwest corner of Washtenaw County, and south along the east side of Jackson County. Interior drainage is predominate here. The most important stream in the study is the Huron River, which rises near Wolverine Lake in Oakland County, flows southeast through the area under discussion, and empties into Lake Erie below Dearborn. The Huron River and the small streams of the Interlobate Lake District are important in the development of the management plan.

The Gladwin State Game Refuge and a portion of adjacent Clare County are more northern grouse habitats which were observed for comparison in the study. The topography of these areas will be discussed later, as will the respective drainage systems.

The grouse is a bird of subclimax situations where a mixed habitat of brush and trees is available (31). In consideration of a management plan it is important that the former vegetation be known, as this will indicate the suitability of the area for grouse. Upland forest on the more sandy soils were composed of red, black, and white oak with smooth



bark hickory, sugar maple, and a few shag-bark hickories. Creeping juniper and yew were in the second story. On the flood plains grew soft maple, black ash, white elm, and swamp oak. Along the river banks was a growth of red bud and red cedar.

Tamarack bogs are scattered in both the sandy and clay morainic areas. The upland forests in moraines with noticeable clay content consisted of oak, white ash, shag-bark hickories, with some elm, sugar maple, black walnut, butternut, and aspen. Stand density was so pronounced that there was little underbrush.

A small stand of black spruce grew at the edge of Independence Lake. Along the Huron River there were cotton-woods, sycamores, and willows. Red cedar and juniper grew along the bluffs overlooking the river. There were some oak openings of white and bur oak with a lower story of hazel brush. Remnants of this timber still occur (38). The spruce is gone at Independence Lake but there is a great deal of shag-bark hickory on the sandy moraines. Ground juniper and yew are still to be found and have increased in overgrazed areas. The stands are reduced to the status of woodlots, cut and grazed, and have varying amounts of brush.

Ten to twenty years ago there were more grouse in the region of Whitmore Lake and Chelsea. Some stands below the forty acres of which Fisher (20) speaks once held grouse. The birds are no longer found in these stands. The population has decreased because of cutting, grazing, and drainage. There may have been some effect from the closing of crown canopies and brush areas in ungrazed, lightly cut woods.

Mention should be made of those who gave information concerning former grouse populations. These men may be of value to later workers. Joe Warren of 42 Barker Street, Whitmore Lake, states that fifteen years ago

there were a few grouse in the region around the four small lakes just east of Whitmore Lake. Warren mentioned a Charles Golf, living somewhere near the west side of Whitmore Lake, as being a man who might be of service. Golf has long been familiar with this territory. Merkel of Sylvan Road, near Chelsea, referred the writer to the Chelsea Game Refuge. He said that there were twelve to fourteen grouse there twenty years ago. The Mason brothers used to flush twenty or more grouse in their woodlots and thirty or more at Mud Lake. Clutier, who owns half of the Chelsea Game Refuge, states that there were eight grouse in the cedar swamp from 1937 to the present time. Much of the grouse habitat is now closed to hunting. Few hunters in this region know that grouse still exist here.

## TECHNIQUES IN THE COLLECTION OF DATA

### Mapping:

K. C. Leebrick has some excellent maps in his thesis (25), some of which he did and some which were prepared by others. These maps were used as an already prepared and convenient source of material and were carefully checked in the field. Any changes appearing in the field since his work will be found recorded on the maps. One new map was prepared. Regarding the Waterloo Recreation Area, in view of its extent and the meagerness of the data collected, it was deemed a waste of time to type map.

In order to place the data in relation to the geological setting, maps have been included showing the location of the study areas in reference to the glacial formation of the areas under discussion. These maps are a further aid in the direction of glacial movement and in the understanding of the agricultural status of the land.

### Population:

As the types covered present only small acreages in comparison with those on which Fisher did his work, it was not thought advisable to use his modification of King's census method.

The study areas were thoroughly worked, sometimes alone when it was thought necessary. For the most part, however, a dog was used. These areas were worked with the same intensity in this and in all other phases of the work, as perhaps even areas of lesser potential value may give useful information. Each grouse flushed or observed was recorded on the map (pp. 87 to 94). Later these data were analyzed in order that per acre population, movements, and increase, might be determined (pp. 21, 22, 23).

### Cover:

Careful attention was paid to cover in order that composition and

value might be noted. Timber, shrubs, herbaceous vegetation, and topography were considered in relation to concealment, mechanical properties, and plant species. Negative information enters here as there are conditions where certain seasonally used types are of no value.

#### Food Habits:

Field observations, collection of droppings, and laboratory analysis constitute this phase. Droppings were looked for regardless of flushes; this is especially important during summer as birds are often hard to find and droppings equally so. Consequently, increased searching was necessary. Both adults and young were observed feeding, and trails were followed from beginning to end in the collection of information (fig. 1, p. 7). Winter and summer droppings were collected and analysed (p. 43). Six foot quadrats were thrown around those places in which summer grouse were flushed; the plants were carefully observed for signs of browsing, and the information recorded on forms. Some observations of actual feeding were obtained.

#### Predation:

All evidence of predation was recorded and carefully checked with the findings of Darrow (12). A study was made of the game-predator ratio (26), historical information, previous findings, and the effect of habitat. The tracks and droppings of predators were especially looked for during the winter.

#### Hunting and Former Populations:

People living close to the study areas were questioned as to former populations and hunting conditions. This information was recorded and then compared with existing conditions in an attempt to find the reason for the present low grouse population. The various woodlots which they mentioned were observed.



Fig. 1. Habits may be read through tracking.



Fig. 2. Dropping analysis gives information on food habits. Note the cecal dropping. This is an exposed form in open hardwoods.

## Topography and Land Use;

The correlations of topography and existing vegetation were studied. This information was then viewed from the standpoint of its influence upon grouse. As much of this was concerned with plant ecology, the inferences drawn were checked with a standard work (37). Glacial action and the associated soil conditions were compared with the vegetation. Inferences were later checked with Leverett and Taylor (27). Observed grouse movements were studied in both direct and indirect relationships to topography.

Land use data was drawn from field observation and from conversation with people on the land. The fall land status and other environmental changes were recorded on the maps. Land use operations were observed and their effects upon grouse were noted. Leverett and Taylor provide very useful information, which contributes to the broad picture of land use in the northern and southern areas of this study. The Agricultural Census (36) and a publication of the W. P. A. (29) provided invaluable information. Coupled with observation and the information given in Leverett and Taylor, a clear picture of land use effects for both the northern and southern areas were obtained.

## Area Descriptions

### Mud Lake:

The more rugged topography surrounding Mud Lake (p. 88) lies along the northern edge of this swamp which has a fourteen-acre bog lake. The sharpest rise along the immediate border includes the hardwood stand on the northeast end where the slope is about 40%. Progressing towards the west end of the northern border the slope drops to about 30%. The western half of the northern border of the swamp varies from about 15 - 20%; this includes the upland hardwood on the west. On the west, the terrain slopes more or less evenly towards the swamp from the junction of Barker and South Hamburg Roads. The sharper slopes border the swamp on the eastern half. For the most part, the terrain to the south is not as sharp. This fits in rather well with the fact that Mud Lake lies on the edge of the Fort Wayne moraine, which is gently undulating, rises from 30 - 50 feet above the till plain, and is composed of clayey drift with few boulders (p. 87).

A hundred-acre mixture of yellow birch, elm, maple, and aspen with some hickory, ironwood, and oak covers the north side of the swamp. Tamarack and black spruce is in two areas with leather leaf, spruce, and tamarack reproduction to the south. Dense yellow birch-aspen reproduction is on the north. Extending out to the east and west, cattails border a belt of tamarack.

Through the center of the swamp hardwood extends a strip of poison sumac grading into chokeberry on the east and west. Being poorly drained, there is water in the swamp hardwoods during spring and fall. The black spruce is bordered on the west by swamp hardwoods which are rather dry.

This has high bush blueberry as a shrub understory. Out to the west the marsh extends with an island here and there. Pasture and woodlot flank the swamp on the east, while pastured and cultivated fields bound it on the north and south.

Other shrubs throughout the hardwood, especially around openings and along the ecotones, are dogwood, Michigan holly, and elderberry. In the areas of the swamp hardwood and conifers holding a good deal of water there occurs a growth of skunk cabbage. Plants typical of the swamp hardwoods in general are at least three species of fern, violet, stinging nettle, dwarf Solomon's seal, jewelweed, marsh marigold, sedge, star flower, jack-in-the-pulpit, bedstraw, and true Solomon's seal. In the conifers, orchids and some marsh marigold occur, while along the edge of the tamarack and out into the leather leaf and cranberry grow pitcher plant and sundew. Nightshade and grape are also found in the swamp hardwood, while occasional asters and goldenrod are sometimes to be seen.

When not of pure cattail, the marsh also has meadowsweet, aster, fern, shrubby cinquefoil, dogwood, willow, goldenrod, and an occasional group of white birch. Upland hardwood varies from the lowland hardwood in that it has bracken, asters, bloodroot, anemone and other plants more distinctive of drier habitats. Hazelnut is a distinctive shrub. The discussion of food habits contains more information pertaining to Mud Lake.

Stinchfield Woods:

It will be seen that this study area is located on the Mississinawa moraine which has 20 - 75 foot relief above the outer till plains, and is composed of clay till (p. 89). The moraine shows a steep front, averaging 50% in the region of Stinchfield, which might be imagined as a small



area with undulating rises and pockets on the north end of the moraine (p. 87). The steep slopes are especially apparent from the Dexter-Pinckney and Stinchfield Woods Roads. In the hardwood stands there are some small areas which are comparatively level.

There are about one hundred acres of hardwoods composed of red and black oaks, white oak, hickory, ash, and maple. There are over three hundred and twenty acres of conifers and a little maple set out in plantations. Dogwood, sumac, ash, hickory, and hazelnut make up the shrub cover. Bracken, grass, and the usual upland herbaceous plants are present, many of the herbaceous plants finding suitable habitat in the leaf mould of small, leaf-filled pockets, while the hardier asters and golden-rods appear in more open areas. Here and there ground juniper is found in the hardwood. Occasional openings in the conifers support growths of Jersey tea, a little aspen, and some sumac and dogwood. Vetch is also found scattered in these openings and along the roads. There is a small amount of Japanese barberry. Some berries, wild apple, and cherry are also to be found.

#### The George Reserve:

Placed as it is in the Kalamazoo morainic system, it is to be expected that this area (p. 90) shows a rugged topography. Knobs 75 - 100 feet are common along the south border of this part of the moraine, which displays the most prominent relief in the system (p. 87). On the northeast and southwest the land falls sharply to extensive marsh and swamp land. The topography is not as rugged on the east towards Pinckney. The outstanding feature of the George Reserve is Big Tamarack Swamp, which is about one half the area contained in the eastern portion of the reserve. The general trend of the swamp is on a line running

southwesterly. There is a series of lowlands along the west side beginning with Fish Hook Marsh and ending with the Big Cassandra just a little east of the northwest corner. A marked ridge runs northeasterly through the reserve; the remainder of the terrain breaks up into a strong moraine roughly paralleling the ridge. Some outstanding hills are situated on the northwest. These features stand out sharply on the topographic map included (p. 91). The only study area comparable to this interesting topography is that in the region of the Chelsea Game Refuge.

Upland hardwoods on this area are composed of red, black, and white oak with some maple. There is also some hickory, ash, aspen, basswood, and ironwood. There is but little shrub cover in the woods, this consisting of sassafras, huckleberry, and hazelnuts with some blueberry and gray dogwood along the swamp margins. The swamp timber is of rather open nature, and is largely tamarack with high bush blueberry, Michigan holly, dogwood, poison sumac, sedge, and fern as shrub and herbaceous cover. Big Tamarack, as its name implies, has the most dense cover of tamarack, with a great many fallen trees. To the east of Big Tamarack Swamp there is a small, low area with a growth of yellow birch.

There is a marked difference among the herbaceous plants of the north and south slopes. Bracken, grass, and asters are typical of the dry south slopes, while violet, anemone, hepatica, and bloodroot are found on the north slopes. This does not seem to hold true for the herbaceous plants growing under and near the shrub cover along the swamp edges. The herbaceous plants in such situations vary from pure sedge in the damper places to mixed herbaceous plants such as violet, fern, sedge, and stinging nettle. There are many areas of open grassland in the reserve.

### The Mason Farm:

As the Mason farm (p. 92) is situated on the till plain adjacent to the Fort Wayne moraine (p. 87), this study area displays the most level terrain of all those observed. The ground is broken only by gentle rises and depressions in which lowlands and small bodies of water occur.

There are some fifty acres centered around a six-acre bog lake. The bog succession series is typified in the aquatics, leather leaf, shrubs, tamarack, swamp hardwood and upland hardwood. On the north are two plots of upland hardwood eight acres in area composed of oak, maple, elm, and cherry, while on the south a strip of hardwood borders a field. Swamp hardwood of elm and maple runs along the edge of the tamarack and is mixed on the east with tamarack and brush. The tamarack averages about twenty feet in width and fans out on the north and south to cover stands of eight acres.

The upland hardwood has shrub cover of reproduction, dogwood, and hazelnut. Swamp hardwood has poison sumac, hazelnut, and dogwood. High bush blueberry, Michigan holly, red osier dogwood, yellow birch, and rose compose the understory in the tamarack, Down trees and grapevine growths are abundant.

### The Chelsea Game Refuge:

The Chelsea Game Refuge (p. 93) is situated near the northeast end of the Mississinawa moraine. The refuge faces the steep front of the moraine. The slope here is comparable to that of many of the hills on the George Reserve, though it is not as steep as the sides of Buck Hollow. Steep hills slope quickly down into the seventy acres making up the swamp. The west side is flanked by the hills and the remainder of the swamp

opens onto relatively level land. Grazed and cultivated fields surround the swamp.

Almost one half of the swamp is cedar. The remainder is composed of tamarack-swamp hardwood (fig. 3, p. 15). There are two small ponds, one of which has been improved for fishing. A scattering of aspen, birch, and tamarack occurs throughout the swamp, and in small openings grow Michigan holly, poison sumac, elderberry, high bush blueberry, and red osier. Growths of red osier and gray dogwood vary from dense to scattered around the outer margins of the conifers and hardwoods. A scattering of Michigan holly and nannyberry as well as poison sumac is also to be found along the edge of the timber. Between the shrub border and the hills, a strip of sedge and cattails rings the swamp. Marsh marigold, nightshade, jack-in-the-pulpit, dwarf Solomon's seal, skunk cabbage, violet, moss, and sedge are among the plants composing the ground cover. Sedges occupy the immediate border of the ponds where they are not overshadowed by timber.

#### The Waterloo Recreation Area:

This is a large recreation area (p. 87) between Jackson and Ann Arbor, lying between North Territorial Road and U. S. 12 (Jackson Road). The Kalamazoo moraine (p. 87) runs through the area giving it a distinctly rugged terrain rolling down to the Portage marshes. In many places boulders are seen. The topography is that of sharp hills and basins with many lakes and marshes. There does not seem to be an abundant growth of shrubs in the upland hardwoods, but the islands which sometimes occur in the marshes have a dense shrub cover. Stands of tamarack, varying in size and density, occur here and there in the lowlands. There is also some cedar. The stands of upland hardwood are interspersed between fields. Timber, shrubs, and ground cover are much the same as in areas previously described.



Fig. 3. Cedar, tamarack, and swamp hardwood provide fine grouse habitat.



Fig. 4. Seven feeding grouse were flushed from this hardwood opening on the Chelsea Game Refuge.



Fig. 5. Cedar-tamarack cover on the Chelsea Game Refuge.



**Fig. 6. Cover value is increased by tangled windfalls in cedar and tamarack stands.**



## Populations

### Mud Lake:

The late winter census at the time this problem was begun showed there to be 20 grouse on the area. This seems to be somewhat in balance with the spring drumming count of 9 male birds, excepting the three birds killed. Let us study some figures using Edminster's percentages of loss (18). He finds that over a twelve year period of observation, 40% of the young are lost and 60% of the adults are lost over the year, with September being used as the time when young birds reach adulthood. The calculations follow:

$$\begin{array}{r} 17 \text{ adults} = 8 \text{ pair plus one single} \\ \quad \quad \quad \times 12 \text{ eggs} \\ \quad \quad \quad \hline \quad \quad \quad 96 \text{ young} \\ \text{plus } \quad \quad \quad 17 \text{ adults} \\ \quad \quad \quad \hline \quad \quad \quad 113 \text{ birds} \end{array}$$

$$\begin{array}{r} 60\% \text{ of } 96 = 57.60 \text{ young birds lost} \\ 40\% \text{ of } 17 = \quad 6.80 \text{ adults lost} \\ \quad \quad \quad \hline \quad \quad \quad 64.40 \text{ lost per year} \end{array}$$

$$\begin{array}{r} 113 \text{ birds} \\ \text{minus } \quad 64.40 \text{ lost per year} \\ \quad \quad \quad \hline \quad \quad \quad 48.60 \text{ birds remaining} \end{array}$$

Of course these figures were obtained from a more ideal area. These figures are carried out on the assumption that an even sex ratio exists between the birds. On September 29th, a brood of seven young were flushed with the mother bird. Two adult birds were flushed also on this day; thus, by the end of September, there were only 10 grouse, out of a possible 48 surviving, to be found on the area. On the census of December 31st, there were 18 grouse, thus indicating that at least eight birds had moved into the area following the September census or a covey was perhaps missed.

It is particularly difficult to determine the fate of these birds not showing up on the area. A survey of the immediate surrounding cover shows it to be almost without exception too open for adequate protection.

Whether these birds hang on outside and later find their way in to replace those cut down, has not been definitely determined. It is not inconceivable that some of these birds may reach the Mason farm during the fall shuffle; this is practically the only adequate cover close to Mud Lake. There have been reports of birds flushed in late November from small patches of wet land cover.

Stinchfield:

Drumming census showed two male birds, and late winter and spring flushes showed a total of four. It was extremely difficult to locate grouse during the summer at Stinchfield. Only one bird was flushed during July. Four grouse have been present on the area from September 6th.

The George Reserve:

As a drumming census was not possible, particular attention was paid to flushing and twelve birds were found on the area most of the time. One brood of twelve was observed on July 12th. Because of thin ice on the swamps, a winter census was not possible. It is conceivable that those birds not succumbing find their way to suitable habitat such as that around Fox Hill or the University Health Camp.

The Mason Farm:

The spring drumming census yielded nothing on the two attempts made from the same stations used by Leebrick. The entire spring seems to have been too wet for the grouse to remain in the vicinity. Flushing yielded no data either. The Masons were equally unsuccessful in hearing grouse, however, they reported seeing a brood of 12 grouse around August 3rd, so it is definitely known that at least one brood came off. The census of December 22nd showed 10 grouse on the area.



#### The Waterloo Recreation Area:

No birds were personally observed during the summer or early fall on the area. It was not possible to work all the area and likely looking cover worked yielded no birds. Three grouse had been seen up to the opening of the duck season.

#### The Chelsea Game Refuge:

As the Chelsea Refuge was not found until early September, there are no data on spring population. A single track was all that rewarded a search on September 2nd. Upon a subsequent return, 8 grouse were flushed. This left the area, at this date, with a population of 8 birds for seventy acres. A census of December 13th showed a winter population of 7 grouse.

#### Density:

Edminster found, at maximum density or saturation point, a figure of one bird per four acres (18). Fisher (20) found a figure of one bird per five acres for Michigan. K. C. Leebrick (25) arrived at a population figure of one bird per six to seven acres, with figures based on the two best areas and a number of sample areas picked at random. The density figure set down for this study is the density per acre for the total area in which these birds have been found; this includes winter habitat only as it is the most reliable. It is felt that if this figure is confined to those areas in which birds are definitely known to be, it will be closer to actual conditions than otherwise. Grouse in southern Michigan are not creatures of extensive habitat; they are rather of individual, isolated habitats for which a density figure of birds per acre of used habitat seems to be fitting. On this basis, there is one bird per 8 - 9 acres (p. 23). This is a conservative estimate based on two sets of winter figures for Mud Lake and Stinchfield; one set of winter figures for the Chelsea Game

Refuge and the Mason farm; and Leebrick's figure for the George Reserve. His figure seems logical and is used because thin ice delayed a winter census until it was too late.

Consecutive Flushing Records for Stinchfield Woods

Date of Trip	When Flushed	Upland Hardwood	Spruce	Pine	Brush
Apr. 17	x	1(1)		2(1)*	
Jun. 20	x				3(1)
Jun. 22	x				4(1)
Jul. 23	x				5(1)
Jul. 29	x				6(1)
Aug. 16					
Sep. 20					
Oct. 6	x	7-8(2)			
Oct. 10	x	9-10(2)			
Nov. 5	x	11(1)	12(1)		

\* Type total

Consecutive Flushing Records for the George Reserve

Date of Trip	When Flushed	Upland Hardwood	Tamarack	Marsh	Brush
Jun. 27	x				1(1)*
Jun. 28	x	2-3(2)			
Jun. 29	x				4(1)
Jul. 11	x				5-7(3)
Jul. 12	x	8-19(12)			
Jul. 18	x				20-22(3)
Jul. 19					
Jul. 31	x		23-24(2)		25(1)
Aug. 1					
Aug. 5	x				26-29(4)
Oct. 25	x				30(1)

\* Type total

Consecutive Flushing Records for the Chelsea Game Refuge

Date of Trip	When Flushed	Swamp Hardwood	Tamarack	Cedar	Marsh	Brush
Sep. 1						
Nov. 2	x					1-8(8)
Nov. 23	x	9-15(7)*				
Dec. 13	x	16-20(5)		21-22(2)		

\* Type total

Consecutive Flushing Records for Mud Lake

Date of Trip	When Flushed	Swamp Hardwood	Tamarack	Upland Hardwood	Spruce
Mar. 9	x	5-10(6)	1(1)		2-4(3)*
Mar. 14	x	11-19(9)	28-30(3)		20-27(8)
Mar. 21	x	31-32(2)	33-34(2)		
Apr. 20	x	35-39(5)			
Apr. 26					
Jun. 8	x			40(1)	
Jun. 9	x			41(1)	
Jun. 18	x			42(1)	
Jul. 7	x			43(1)	
Jul. 22	x			44(1)	
Jul. 27	x	51-52(2)		45-50(6)	
Aug. 10	x			53-60(8)	
Sep. 10	x	61-68(8)			
Sep. 29	x	69-76(8)			

\* Type total

Consecutive Flushing Records for the Mason Farm

Date of Trip	When Flushed	Swamp Hardwood	Aspen	Tamarack	Brush
Aug. 3**	x				1-12(12)*
Dec. 22	x	13-19(7)	20(1)	21(1)	22(1)

\* Type total

\*\*Seen by the Masons

The Estimated Density  
of  
Grouse on the Study Areas

<u>Area</u>	<u>Acres of Used Habitat</u>	<u>Average Population</u>	<u>Acres per Bird</u>
Mud Lake	100	19	5.2
Mason's	50	10	5.0
Chelsea Game Refuge	70	8	8.7
Stinchfield Woods	100	4	25.0
The George Reserve	200	14	14.2
	<u>520</u>	<u>55</u>	

Density:  $\frac{520}{55} = 8 \text{ to } 9 \text{ acres per bird}$

Birds Moved per Hour:

$\frac{162 \text{ flushes}}{287 \text{ field hours}} = .56 \text{ birds moved}$

## Cover

### Roosting Cover:

Winter. Winter cover might be placed in three categories: coniferous; swamp hardwood in which the form is protected; and swamp hardwood in which the form is exposed. In the conifers, grouse roost either in the trees or beneath the roots of trees which have fallen. The dense foliage of the spruce offers excellent concealment. Oftentimes, roosts may be located in the trees from droppings which fall upon the ground below and also lodge in the branches. Those forms beneath the roots of fallen trees vary in the degree of protection but all are protected at least from the rear. The degree to which the forms are protected from above varies with the amount of overhang and the number and size of the natural crannies offered. Those forms beneath the roots offer an open avenue of escape when the bird is flushed. They face open spaces of varying size and natural avenues between or beneath the surrounding foliage.

Those forms which are protected in the hardwood take advantage of vegetation including trees and shrubs. Fallen trees may also figure in this cover. Oftentimes, the grouse form will be under the dense cover of sumac or in a tangle of grapevines. At other times the form may be placed close to the base of a tree or beneath the roots of a down tree. In such locations the upperstory gives a high canopy with plenty of open space in which the grouse may take rapid flight. The cover of shrub and grape tangles open upon clear avenues of escape as noted above. Overhanging branches of shrubs, grape tangles and roots are important in that they offer concealment and the chance for safe escape from predators. The upperstory may offer concealment from some hunting hawks but this is of little concern to owls which hunt inside the woods.

Those forms situated in the open among the hardwoods have no immediate, overhanging cover but have, within quick flight, ample cover of timber and shrubs (fig. 2, p. 7). The bird probably depends upon silence for safety. Two special cases observed at Stinchfield Woods should be mentioned. They clear up a previously unanswered question.

The value of plantation conifers to grouse has not been definitely determined. On April 17th, a grouse was flushed west down a road between the hardwood and conifers; it cut sharply to the right into the pines and a short while later, what was thought to be the same bird was flushed from the southwest edge of this particular stand. It was, however, determined to be another bird from the pile of droppings, which could not possibly have accumulated in the short space of time between the two flushings. The other case occurred on November 5th, when a grouse was flushed from the shelter of a spruce along the road just southwest of the cabin. This bird had been eating ceanothus leaves previously and had evidently settled for the night beneath the cover of the spruce. Howard Hammond, wildlife student, has frequently observed grouse and grouse tracks in coniferous openings.

Spring. The birds remain in the swamps if conditions are such that certain portions of it are dry and offer the necessities which they require. Otherwise, they move out to adjacent uplands. Adults make the most use of cover in the ecotone between swamp or marsh and upland hardwood. The best cover offers trees, shrubs, and herbaceous vegetation for protection. This may be further strengthened by topography. Cover of dogwood with sedge, or pure sedge alone was never used.

One of the best examples of spring cover was that used by a grouse on the edge of Big Island in the George Reserve. The bird used this

cover all day. It was backed by a steep slope and was overhung by a leaning cherry. The cherry branches arch over to within one half or three feet of the ground and dogwood grows up into its overhanging branches. Beneath the dogwood was a dense cover of fern with some bedstraw and violet. Out in the swamp, a stand of tamarack with various shrubs contribute additional protection in that some hawks would be forced to fly high. The sedge surrounding this shrub growth also contributes to concealment. Hardwoods at the top of the slope complete the cover (fig. 7 and 8, p. 27).

Brood cover is situated in the upland hardwoods and, in the cases observed, consisted of saplings of open density near swamp-upland ecotone. The two places observed had an upperstory of aspen and hickory, respectively, with scattered mature trees. The aspen under observation had diameters averaging about four inches; the predominant ground cover in this case was bracken fern with grass and some asters. That brood cover observed in the second case was of hickory with trees averaging about three inches; this upperstory was rather dense except where broken by small openings. The ground cover was composed of ferns and species varying from those found in more shaded upland hardwood to the plants of more open areas such as asters and other composites. While the aspen, because of its density could offer roosting cover, it seems more likely that the ecotone along the swamp is used.

Summer. Usually the summer cover remains the same for the adult birds as that used in spring. An exception arises in that the grouse make use of berries; this sometimes causes them to shift their locations to places a little more open than usual. Only in one case was grouse observed feeding on berries. This took place at Stinchfield,





Fig. 7. Excellent cover formed by a cherry overhanging dogwood, fern, stinging nettle, sedge, and violet.



Fig. 8. Cover is enhanced when backed by wooded slopes and fronted by swamp timber. This is a picture of fig. 7. taken from above.

and constitutes the only summer observation for that study area. Berries were ample in the study areas. Summer birds are supplied with much more abundant and easily available food and they remain for longer periods in such shelter. Either they remain hidden from observation or else they are more difficult to flush during summer. Moulting may have some effect.

Autumn. Roosting cover during this season is a transition from summer to winter cover, with the main difference being ascribed to weather effects. On cold, wet days there is a noticeable shift towards coniferous cover in the lowlands. In the case of upland plantations, grouse make use of coniferous shelter during wet, fall weather.

Hardwood roosting cover is situated beneath maple with some birch and aspen. The understory is usually composed of sumac and dogwood with grape, Michigan holly, and elderberry. Ground cover, for the most part, is made up of two or three ferns, jewelweed, nettle, sedge, marsh marigold, and violet. The exact abundance and composition of the understory and ground cover depends upon how close to the edge the roosting cover happens to be. The brood observed at Mud Lake was found much closer to the edge of the cattail marsh on warm days. Two lone adults observed there this summer were consistently flushed from beneath poison sumac bushes in an opening towards the northeast end of the swamp.

#### Feeding Cover:

Winter. Feeding cover is at its lowest from the point of view of protection. The grouse wander about from one place to the other and are frequently exposed to view, if the tracks are read at all correctly. The majority of those tracks show that the grouse, when feeding in this manner, rarely leave the ground. Ample cover is available around or

near the trees in which the grouse browse. Shrub and canopy cover have been discussed.

Spring and Summer. Cover, during this season, is situated in relatively heavy growths of shrubs and herbaceous vegetation, sometimes strengthened by timber and topography. In the majority of cases there was always fern present in the cover. At no time was a grouse found to have been feeding in pure sedge, as in most cases pure sedge was growing in locations either very damp or with water covering the surface. Dogwood and pure sedge, when existing together, were always passed by; no grouse were to be found there. At no time was a grouse flushed from shrub cover lacking herbaceous ground cover beneath it. Food is in most cases required to be a part of the cover. There are exceptions; a grouse was observed quite fully exposed feeding on berries. Brood feeding cover is situated in open stands with sheltering ground cover of fern or other herbaceous <sup>plants</sup> cover.

Autumn. It should be noted that roosting and feeding cover are hardly distinguishable in spring, summer and early autumn as the cover is entirely adequate for both. With the advent of the autumn berries, there is sufficient sign showing that the birds have made use of the fruit on the shrubs. It is the opposite in winter; most of the tracks followed show the grouse to be dependent in great degree upon fallen fruits. A few fruiting shrubs or vines were always found in those places in which the grouse were flushed. During periods of inclement weather, the grouse made use of feeding cover closer to the conifers. In such locations, the feeding cover has shrub growth as a component if there are openings.

The brood observed at Mud Lake presented a striking example of



Fig. 9. Aspen saplings over bracken, aster, and grass formed this brood cover on the George Reserve.



Fig. 10. Autumn brood cover is more dense. Mud Lake.  
A late brood of 8 flushed here.

seasonal movement. Enough flushes were obtained so that the pattern of movement became clear. The brood had moved from the upland hardwood, crossed the marginal ditch, and then progressed towards the conifers (fig. 10, p. 30). There was evidently little wide scattering of the brood.

#### Drumming and Nesting Cover:

From examination of previous data, the drumming locations of this year correspond with those previously used. This, as may be seen in the data of Dr. S. A. Graham, has been a strikingly consistent use to the exclusion of other favorable locations. His studies also show an almost consistent count of twenty birds present in the spring. The grouse preferred hardwood locations for drumming spots.

Those birds using drumming cover more scant than other positions begin the drumming a little earlier. Some birds in the better cover drum later in the morning. One bird was noted to have moved its station from time to time. The cover varied from poison sumac, giving scant mechanical shelter, to swamp hardwood with some dogwood cover, or to a very adequate shelter of high bush blueberry and dogwood. All drumming cover takes on increased value with the appearance of foliage in the spring.

No definite information concerning nesting cover has been found during this study, though evidence points towards conditions similar to those which Leebrick observed. On July 22nd, a decoying female was flushed from the edge of the hardwood stand on the northwest side of Mud Lake. On the 27th of July, a brood of six young birds was flushed in almost the same location. It is inferred that the female nested in this locality, which is composed of hickory reproduction and larger

maples and hickories with small openings. The brood observed on the George Reserve, was in all likelihood, brought off in cover adjacent to the lowland areas. The outstanding point is that, just as Leebrick found, the birds resorted to the edge of upland hardwoods for their nesting. One of the interesting things in the Mud Lake observations is that the hickory reproduction offered an unusually dense canopy, while dense shrub and ground cover were noticeably lacking. This sort of cover is probably adequate for the young birds. The brambles and herbaceous vegetation of the openings were equally effective.

#### Food Habits

##### Seasonal Feeding Locations:

During the spring, the grouse move to the edge of uplands. Females, of course, lead the broods a little further from the ecotone into those areas having the necessary sapling growth. Feeding places of male grouse are located in mixtures of trees and shrubs with the trees usually backing the shrub strip. The shrubs face upon sedge or cattail. The feeding locations, then, fall along an ecotonal strip providing required food. This holds true for the George Reserve, Mud Lake, and probably the Chelsea Game Refuge, as this presents a situation very similar to the former areas. There are exceptions. On several occasions, a grouse was flushed from an island in the marginal ditch at Mud Lake.

The data indicate that a brood came off in the upland hardwoods bordering the northwest edge of Mud Lake. This area is composed of upland hardwood saplings averaging about three inches and of rather dense composition. Openings occur here and there. The west edge of the woods opens upon a field; this provides shrubs differing from those along the southern swamp edge. Food plants were more varied than those used by the

brood on the George Reserve. This brood was located in an almost pure aspen type which was relatively open.

Summer feeding locations bring the males into areas having berry food (fig. 13, p. 38). The situation varies little from that of spring, except that the birds are brought into closer contact with the more open edge - that is, on the side having the lesser cover such as grass or crops. Late summer and fall bring the grouse down out of upland hardwood, through the ecotone and into the swamp hardwood. Fall rains find the birds feeding in locations closer to winter cover. Feeding locations vary from areas with timber of diameters up to fourteen inches with a shrub understory to areas which are more open in nature and surrounded with shrubs.

Stinchfield Woods constitutes an exception, in that the grouse remain on the upland throughout the winter. This use of upland cover presents an interesting parallel to the condition which Fisher(20) describes when speaking of Houghton Lake. The grouse there made the greatest use of upland deciduous and coniferous timber which occurs in a nice interspersion attractive to the birds. That these game birds prefer feeding spots in an upland coniferous-deciduous mixture, rather than the lowlands in winter as exemplified at Houghton Lake and Stinchfield Woods, seems to be valid. Dr. O'Roke has occasionally observed grouse in Saginaw Forest.

With few exceptions, those grouse flushed made use of locations in which fern constituted the larger part of the ground cover. During the spring no grouse or grouse sign were observed under swamp shrub cover which was surrounded by water or was in a very damp location. In a few cases, grouse were flushed from ground cover predominately sedge with a

little fern. Feeding grouse on the Chelsea Game Refuge during winter are found most frequently in cedar openings.

#### Cover and Food:

In general, the majority of spring and summer grouse were flushed from positions backed by steep slopes giving considerable protection. A striking example of cover in relation to topography was observed on the George Reserve. A narrow tongue of land on Big Island is cleft by a pass reaching to swamp level. A short distance from this pass, a grouse made consistent use of adequate cover. Regardless of the direction of approach, the bird made use of this convenient and sheltered escape route each time it was flushed (fig. 7, p. 27).

Spring and summer cover bordering swamps consisted of mixed or pure hardwoods; overhanging sumac, dogwood, with a little cherry, grape, and elderberry; fern, star flower, violet, jewelweed, stinging nettle, nightshade, true and false Solomon's seal, marsh marigold, and some sedge. These are representative of all the ecotones bordering swamp land. All of these species were used for food. It appears that grouse make the heaviest use of those positions in which there is sufficient fern to conceal them. Sedge would offer sufficient cover, but food plants are generally lacking except for a scattering of fern. Those areas in which sedge is predominant are perhaps too wet for the use of grouse. Several examples on the George Reserve support this viewpoint. Tamarack, sumac, blueberry, and other shrubs offered cover to flushed grouse. This cover was dense, but the birds made no use of such locations.

Fall cover is composed of swamp hardwoods; poison sumac (fig. 11, p. 35), blueberry, elderberry, chokeberry, Michigan holly, nannyberry, high bush cranberry, dogwood, nightshade, and some rose and grape. Ground cover





Fig. 11 and 12. Two winter grouse foods of high value.  
Birch stands offer budding in winter.



includes violet, false Solomon's seal, jack-in-the-pulpit, marsh marigold, sedge, nettle, watercress, jewelweed, and some orchids. Most of the above species of plants and shrubs offer food. Aspen and birch offer food in late fall.

Winter cover consists of conifers and hardwoods mixed or relatively pure and offering many of the same food plants. The coniferous types offer dense cover in the evergreen species and perhaps some ground cover food in pitcher plant, the tips of skunk cabbage, and a few ferns and marsh marigold. Food is an edge consideration either of the type perimeter or of openings within the type.

Broods were observed in swamp hardwood types mentioned above, but spring and summer food, in relation to cover, varied considerably from that of adult males. Open upland hardwood or pure aspen (fig. 9, p. 30) has an understory of hazelnut and witch-hazel and a ground cover of briars, fern, violet, anemone, bloodroot, geranium, grass, aster, and other plants. Either fern or other herbaceous species provide cover. Food plants and insects are present.

#### Special Observations:

A grouse brood was flushed July 12th on the George Reserve. One youngster was singled out and watched from a distance of about twenty-five feet until he disappeared from view in the bracken fern, cheeping occasionally as he returned to the mother bird. This took place in a small stand of almost pure aspen with bracken, grass, aster, and some nettle as ground cover. The young, seven weeks old bird was observed to snap up some insects on the bracken and to pick at an anthill. He had eaten beetles and grasshoppers. While displaying perhaps a little anxiety, the chick progressed in the general direction of the mother,

stopping occasionally to take food.

On July 29th, a grouse was observed feeding in a patch of berries at Stinchfield. Almost no information on actual feeding was obtained here, as this bird saw the observer almost at the same time that the observer saw him, upon which he took flight. Indications are that the bird hopped from the ground to take an occasional berry out of reach even though there were plenty within reaching distance. Fresh pedicel ends were present showing that the berries had recently been taken.

November 5th was a day of mist and intermittent rain; a grouse was flushed from an opening in red pine and spruce just northwest of the cabin at Stinchfield. Two or three small aspen saplings, sumac, dogwood, ceanothus, grass, and some strawberry and vetch composed the vegetation in the opening. The grouse had left a clear and easily followed trail of droppings beside the ceanothus, strawberry, and vetch of which it had partaken.

This gives some indication of actual feeding during the seasons; it remains but to cite examples of winter feeding. K. C. Leebrick (25) has done some admirable work on this phase of grouse habits. On March 14th, a faint grouse trail in the swamp hardwood was pieced together in the snow, and the bird was found to have eaten nightshade berries (fig. 14, p. 38), sedge, poison sumac berries, and some green fern and marsh marigold.

Phenology:

Species known to constitute grouse foods were searched for during the field investigations and the dates upon which they were first definitely distinguished were recorded (p. 39). Similar recordings were made of flowering, fruiting, and of budding. This does not follow phenology in the strict sense of the word, that is, first dates are not recorded as they



Fig. 13 and 14. Brambles and nightshade provide a late summer and fall food.



The Major Phenology of Some Trees, Shrubs, and Plants  
Known as Grouse Foods - 1947\*

Species	Vegetation	Flower	Fruit	Bud
<b>(Plants):</b>				
Hepatica	Mar. 17	Apr. 27	Jul. 29	
Bloodroot	Mar. 17	Apr. 27	Jun. 21	
Canada violet	Mar. 17	Jun. 8	Jul. 29	
Anemone	Mar. 17	Apr. 27	not noted	
Strawberry	Mar. 17	Jun. 8	Jul. 29	
True Solomon's seal	Apr. 17	Apr. 27	Sep. 20	
Lady's slipper	Apr. 15	Jun. 18	Sep. 20	
Trillium	Apr. 17	May 30	Jun. 20	
False Solomon's seal	Apr. 17	Jun. 8	Oct. 5	
Bedstraw	Apr. 15	Jun. 8	Sep. 20	
Marsh marigold	Apr. 20	Jun. 8	Jul. 29	
Ceanothus	May 15	Jul. 27	Nov. 5	
<b>(Shrubs):</b>				
Rubus	May 15	Jun. 20	Jul. 27	
Elderberry	May 15	Jul. 27	Sep. 20	
Rose	May 15	Jun. 20	Sep. 20	
Nightshade	May 15	Jul. 27	Sep. 10	
Blueberry	May 15	Jun. 8	Jul. 19	
Honeysuckle	May 15	Jul. 27	Sep. 4	
Grape	May 15	Aug. 15	Sep. 27	
Bittersweet	May 15	Aug. 10	Oct. 12	
Staghorn sumac	May 15	Aug. 10	Sep. 15	
Poison sumac	May 15	Aug. 10	Sep. 15	
Nannyberry	May 15	Jul. 29	Oct. 2	
Hazelnut	May 15		Oct. 5	
<b>(Trees):</b>				
Birch	May 15			Oct. 2
Aspen	May 15			Oct. 2
Maple	May 15			Oct. 2
Willow	May 15			Oct. 2

\* Only dates of appearance are recorded for those vegetative parts used for food. Flowering dates are recorded as they determine fruiting.

would have been had daily field trips been possible. These data do give some information on when the food becomes available and particularly, in the case of fruits, how long it persists.

Hepatica, bloodroot, violet, and marsh marigold appear early in spring, the latter persisting as evergreen throughout the year, and does not appear to be succulent during winter. Bloodroot dies back in June. The lady slipper blooms fairly early and stays in leaf into September. The anemone appears early with the first flowers and vanishes early. Fern, while persisting in some species throughout winter, is well up and fruiting in June. Mayapple flowers in mid-May and is in fruit by mid-June. Many of these species stay in leaf until September. Strawberry, hepatica, marsh marigold, and fern remain evergreen the year long. Ceanothus has been selected as a plant appearing later during the spring and holding the leaves up into November. These plants offer herbage until the season of fall fruits. Such species as the true and false Solomon's seal hold the fruit until well into September. The berries of the dwarf Solomon's seal and the false Solomon's seal continue into winter.

Nightshade, elderberry, dogwood, Michigan holly (fig. 15, p. 41), apple, grape, and bittersweet are well in fruit by mid-September. By the middle of October, grape, dogwood, and apples are declining. The cultivated species of apples are less persistent than the wild types. Michigan holly continues as far as January but in decreased numbers. Nannyberry (fig. 16, p. 41) will continue through until March and is used by both birds and mammals. The blueberries come into full fruit during July and only a few of them persist beyond September. Elderberry has practically lost all its fruit, except for a few persistent berries in late September. Fruit of the staghorn sumac appears in late



**Fig. 15. and 16. Michigan holly and nannyberry provide late fall and early winter foods.**



August and September persisting, as do the fruits of the poison sumac, throughout the year.

With the vanishing and decrease in amount of the various fall shrubs, the hardwoods, especially birch and aspen, offer buds as food.

#### Food Preferences:

There seems to be a seasonal difference in the operation of preference, especially with regard to winter and summer. The bird followed during March 14th showed no definite preference having eaten here and there of nightshade berries, sedge seed, poison sumac berries, marsh marigold, pitcher plant and skunk cabbage, the ends and tips of which were visible in places where the snow had melted. Preference does not seem to operate here. However, it should be pointed out that since poison sumac and birch hold a high place in the analyses - 15% and 21% respectively in Leebrick's work (25) - a preference does operate to a marked degree. It is not clear why the grouse should take so much poison sumac. Perhaps it serves as a grit substitute (1).

On September 10th, eight grouse were flushed in a brood at Mud Lake. Foods known to have been taken by these birds were: jewelweed, fern, elderberry, daisy, nightshade, and dwarf Solomon's seal; the first three had definitely been taken as preferred foods and in that order of abundance. The jewelweed showed particularly heavy use.

On November 2nd, the eight grouse flushed at the Chelsea Game Refuge were found to have been feasting upon Michigan holly with dwarf Solomon's seal and marigold as second and third in abundance among the plants used. Some poison sumac, nightshade, and elderberry - still persistent - had been taken as well. The grouse flushed on November 5th from spruce cover in Stinchfield constitutes a marked example of preference for ceanothus leaves.



An Analysis  
of  
Twenty-five Groups of Droppings Showing Seasonal Foods

<u>Common Name</u>	<u>Parts</u>	<u>% of Total Vol.</u>	<u>Frequency</u>
Mealy material	?	31.0	25
Aspen and y. birch	Buds & catkins	20.0	19
Poison sumac	Seeds	10.0	19
Green material	?	9.0	15
Michigan holly	Seeds	8.0	13
Nannyberry	Seeds	5.0	9
Nightshade	Seeds	3.4	14
Common greenbrier	Seeds	2.0	12
Virginia creeper	Seeds	2.0	9
Common elder	Seeds	2.0	11
Clover sp.	Seeds	2.4	8
Staghorn sumac	Seeds	1.0	7
Common barberry	Seeds	T	2
Common vetch	Seeds	T	1
Grape	Seeds	T	3
Sedge	Seeds	T	1
Dogwood	Seeds	T	1
Rose	Seeds	T	5
Insects	Hard parts	T	1

Rather than to discuss the food preferences of the grouse brood observed on the George Reserve, one of the Gladwin broods has been selected. This brood was feeding on sedge seed in a patch of almost pure sedge ground cover. The mother bird feeding upon a frog constitutes an exception to the general rule. Other observations made at different locations within the same areas and during the same months show similar foods for specific areas in general, but the preferred species varies. This places preference on a basis of availability. That food present in greatest amount was always the one most used. The examples in which jewelweed, Jersey tea, and Michigan holly were cited support this contention.

#### Weather

##### Cover Selection:

During periods of wet weather, as previously mentioned, the grouse move into or near the conifers. The brood observed at Mud Lake on September 29th was close to the border of the spruce. There was slight rain most of the day and these birds were much closer to the conifers than on the preceding and following days of clear weather (4). The grouse observed feeding on Jersey tea leaves at Stinchfield Woods was definitely making use of coniferous cover during wet weather.

There could possibly be a desire for cool spots which sends the grouse into cover along the swamps and marshes in summer. Though the best cover is also found here, coolness is not necessarily excluded. Though food and cover seem to be the factors in the winter use of lowlands, there is decidedly less wind action in the basins. It is certainly not as cold as where the winter winds whip up windward sides and hill tops. Summer brood cover is noticeably dry and warm.

### Food Selection:

Winter observations indicate that the grouse remain close or even in the form during snowfall. This limits food selection to their immediate surrounding. Weather determines what winter foods are available. It would seem that in the case of the trail of droppings left by the Stinchfield grouse, weather may have had an influence on what was eaten. This bird was moving in a very limited area.

Broods are not active to any great extent in feeding when the weather is damp. Those observed at Mud Lake had been feeding under protection of brush and had been there for some time. The jewelweed in the vicinity was pulled down and well worked over by the young birds. During the wet weather following observation of the George Reserve brood, these birds were not again located.

### Nesting:

Weather appears to be decidedly important in nesting. Mud Lake was so wet this spring that no nests were found in the swamp hardwood. The location of broods, if found early enough, is an indication of where nesting has taken place. Flushing of a decoying female may also be taken as either indication of a nearby nest or of a very young brood. Observations of both were taken and it is fairly certain that one brood came off in the hardwood stand on the northwest side of Mud Lake. The grouse brood at the George Reserve was brought off either along the swamp edge or in the young hardwood which is of sufficient density and ground cover to afford some degree of cover. The brood on the Chelsea Game Refuge, was from all indications, brought off within the swamp. There are several dry knolls within the swamp.

## Mortality

It is generally held that predators are not the most important critical factor in reduced numbers but rather that the number of predaceous animals is controlled by the abundance of species upon which they live. This probably holds true for those habitats which have not been adversely affected by man. The grouse of southern Michigan occupy small, isolated habitats surrounded by fields. This is not the normal thing for grouse; it is possible that factor influences are not the same under such conditions.

The Mud Lake data show that in September, according to Edminster (18), there should have been almost fifty birds. There were not, nor could there have been according to the density figures previously held. Weather has not been definitely determined to be the limiting factor. Unless further work is done, preferably by more than one person, there is great possibility of error in any conclusive statement made concerning factors.

Leopold defines cover - also a factor - as being "a geographic unit of game cover." The cover on the study areas is limited. One hundred acres of swamp hardwood constitute a very important winter type to the grouse in that the majority of the feeding is done here. To attempt to place 48 grouse in this type during winter would be to have a saturation figure far above that of Edminster (18). The birds are not there. Could predation cut them down?

### Predation:

Mud Lake presents the greater share of the predation figures and almost all the grouse kills. During every winter day in which tracks could be read in the snow, fox were active on all the areas. Several

times during the year fox were actually seen at Mud Lake. One was observed on the south side as it went up the hill to enter the old building overlooking the swamp. Sign was abundant there during the spring. Grouse feathers were found at the entrance of a den not far from this former location.

There are definite trails, worn by animals, which cross and re-cross the swamp. Coon sign has been picked up along some of the trails. Fox were often tracked along these runways. During spring and summer there is a definite trail following the north edge of the Mud Lake marginal ditch, from the hardwood on the west to the southeast corner. From time to time fox scats were picked up on this trail. A young opossum, song bird, and an unidentified hawk are some of the species known to have been killed in the vicinity of this trail. No comparable trails were found in any of the other areas. A fox is known to have taken a fox squirrel at Mud Lake and on the George Reserve. Two fox dens on the George Reserve had rabbit bones scattered around the entrances. The young grouse found during the summer at Mud Lake is ascribed to a weasel. Only the wings and a few feathers remained, the wings being located about a quarter of a mile distant where crows had carried them to eat.

Barred owls were observed several times, both on the George Reserve and at Mud Lake. Two grouse kills are ascribed to owls at Mud Lake, as in each case the feathers were found beneath owl feeding places continually used throughout the winter. Examination of owl pellets from the various areas showed mice to be the dominant food. Rabbit fur and bones were found in one pellet, and the sternum of a small bird in another. No large bones such as those of a grouse were found.

A barred owl was flushed from daytime feeding on the George Reserve. It had taken a chickadee. This bird had been consistently feeding on a low stump adjacent to a kettle hole.

Predation may be more important than is ordinarily believed. During the fall and spring of 1946-47, the writer set up a wildlife management plan for sections 11 and 12 in Freedom Township, Washtenaw County. Pheasants in some cases selected for their feeding areas small, isolated patches of weeds and shrubs situated along fence rows. Fox regularly visited these islands and in them the only known cases of pheasant kills occurred. There were three cases during the spring. All of them are ascribed to foxes. The grouse is a similar creature of island cover. Comparison of kills with the findings of Darrow (12) have facilitated identification of the above mentioned predators. A dead calf was fed upon during the winter at Mud Lake. The animal had died near a clump of bushes on the northeast side of the swamp, and the fox and opossum left tracks and scats.

The history of Washtenaw County definitely shows that wildlife makes use of the only available cover left to them when man has used the rest for agriculture. In 1870 Henry Wilson of Dexter saw a bobcat Lynx ruffus ruffus near Independence Lake. In 1862 Henry Wilson killed a fisher in the same locality. There are other records. It is natural to assume that fox and other predators have made and still make use of this cover because the game is found there. When rabbits are low in number as they were last year, the fox increases its hunting range, thus coming into contact with more grouse (16). This means that island habitat is covered more thoroughly. In 1946 Johnson, a wildlife student, found six pairs of foxes between Mud Lake and the Mason farm; this shows a predator-game

ratio (26) of almost one to one. This at least indicates that more work should be done. The rate of predation must be more accurately determined. A single worker is hindered by the following; 1) limited time, 2) the possibility of not seeing grouse remains, 3) failure of the dog to catch the scent of dead grouse, and 4) snow covering grouse remains thus making detection by man or dog more difficult. It will be necessary to trap and mark the grouse for accurate results (15).

## Biotic Relationships

### Cutting:

All the study areas have been cut in varying degree. Mud Lake, Stinchfield Woods, and the Chelsea Game Refuge present the most compact areas of timber. Those stands on the George Reserve are now so open in character that windfalls are taking place.

Through the opening of stands in the lowlands, brush has become established. The Mason farm shows the greatest spread of this type. The effect varies in accord with the degree of cutting. The presence of poison sumac - a plant of more open situations - in the hardwood stand of Mud Lake is extremely valuable to grouse both as a source of food and cover. Much of the brush on the Mason farm is far too dense to be of value. A heavy growth of jewelweed grows beneath dense dogwood in parts of the Mason farm. This herbaceous plant is a grouse food but this was not used because of the dense shrubs. Valuable food plants are often to be found in openings which are the results of cutting.

The cutting at the Chelsea Game Refuge has been, in some instances, favorable to the grouse. With removal of the cedar, brush and aspen - offering food and cover - have come into the area. Light cutting of the yellow birch has resulted in some windfalls with a subsequent growth of shrubs. One of the very interesting things about the refuge is that cutting has made conditions suitable for the establishment of a small group of beech on a mound which rises about eight feet above the level of the swamp, and beech is a grouse food. Incidentally, there is a fox den in this mound.

Last winter, cutting was going on in the northeast end of Mud Lake. This could have a detrimental effect upon the grouse if a heavy growth



of brush comes in.

**Fire:**

The most outstanding result is seen in the two stands of spruce which were formerly one stand along with tamarack in the central portion of Mud Lake, until fire burned through the conifers. Dense aspen and yellow birch cover the northern portion of the burn while spruce-tamarack reproduction with leather leaf ground cover is found on the side towards the lake. This represents an increase in available winter food and a reduction in a valuable cover type.

**Grazing:**

Without exception, portions of land bordering all of the study areas have been grazed. Some of them have been grazed within and many of them have been overgrazed. The George Reserve has been heavily overgrazed through a deer population too high for reproduction of timber and shrubs (fig. 17, p. 52). There are many high, bald hills standing out sharply at Stinchfield. The Chelsea Game Refuge has noticeable erosion with exposed sand on one of the high slopes bordering the north side of the swamp. Sheep and cattle are responsible. Stands along the southeast corner of Mud Lake have been overgrazed by sheep. Through grazing, grouse habitat is reduced to swamp lands and swamp ecotone.

**Planting:**

Coniferous and hardwood stands are something similar to an interpersions of types. The three cases observed in which grouse used the coniferous cover at Stinchfield lend additional weight to this. Density comparable to that of the coniferous stands at Stinchfield will offer shelter to birds from the very fact of that density. Grouse also make use of coniferous openings for feeding.



Fig. 17. Contrast the overbrowsed ground cover along this George Reserve Road with that of the Gladwin Refuge (fig. 21).

## Wildlife:

Game. Species of game are most abundant in the ecotones and extend their range in accordance with the season. During the winter, pheasants range the hardwood stands at Mud Lake occasionally penetrating as far as the conifers. The pheasant makes use of the marginal ditch both as feeding and roosting cover. There is no pronounced competition between the pheasant and the grouse for food. Seven pheasants (one cock and six hens) make use of the marsh, brush, and adjacent corn fields at the Chelsea Game Refuge.

Rabbits make use of the marsh cover. They also range freely through the hardwoods. One case indicates the possibility of competition with grouse. The grouse observed feeding on ceanothus leaves happened to be doing its feeding in a patch at least three quarters of which had been browsed by rabbits. In a year in which rabbits are plentiful in such an area as Stinchfield Woods where available grouse foods are scarce, there could be competition.

Squirrels range into lowland and upland. The red squirrel is consistently found during the winter and often during the summer in spruce or cedar stands. The fox squirrel makes use of the swamp hardwood during winter. No competition for food has been noted.

The George Reserve deer herd has ranged as high as 188 but in the last few years has been maintained at about 100. With the exception of Big Tamarack Swamp, the whole reserve is in an overbrowsed condition. These hardwoods have the most inferior grouse cover in the study areas. The tamarack has been noticeably browsed.

Predators. The red fox, raccoon, weasel, mink (fig. 19, p. 54), opossum, and skunk are on the areas. The kills have been described



Fig. 18. A grouse kill at Mud Lake



Fig. 19. The tracks of mink, one of the predators on the study area.

elsewhere and are indicated in the chart (p. 56). The remains of rabbit bones were found at several fox dens. Kill remains were not found near dens during the winter; all those kills ascribed to foxes were found in the fields or woods. They do, however, appear near the dens during spring. Grouse feathers were found at a den entrance on the south side of Mud Lake. Comparatively recent fox scats among the small pile of stones under which the den had been dug clearly indicated that this was an actively used burrow.

During the winter, the fox was the only animal which ranged widely through the various types. The sign of rabbit, weasel, and mink was present in and about the marginal ditches or along the ecotones of both lowland and upland hardwoods. The skunk and raccoon are not confined to lowland areas. Owls and foxes preyed most frequently upon the grouse during the winter. Owls, foxes, and weasels were definitely known to have been predators during the summer. There are diagnostic characters of the kill remains which definitely pin down the observed grouse kills(12).

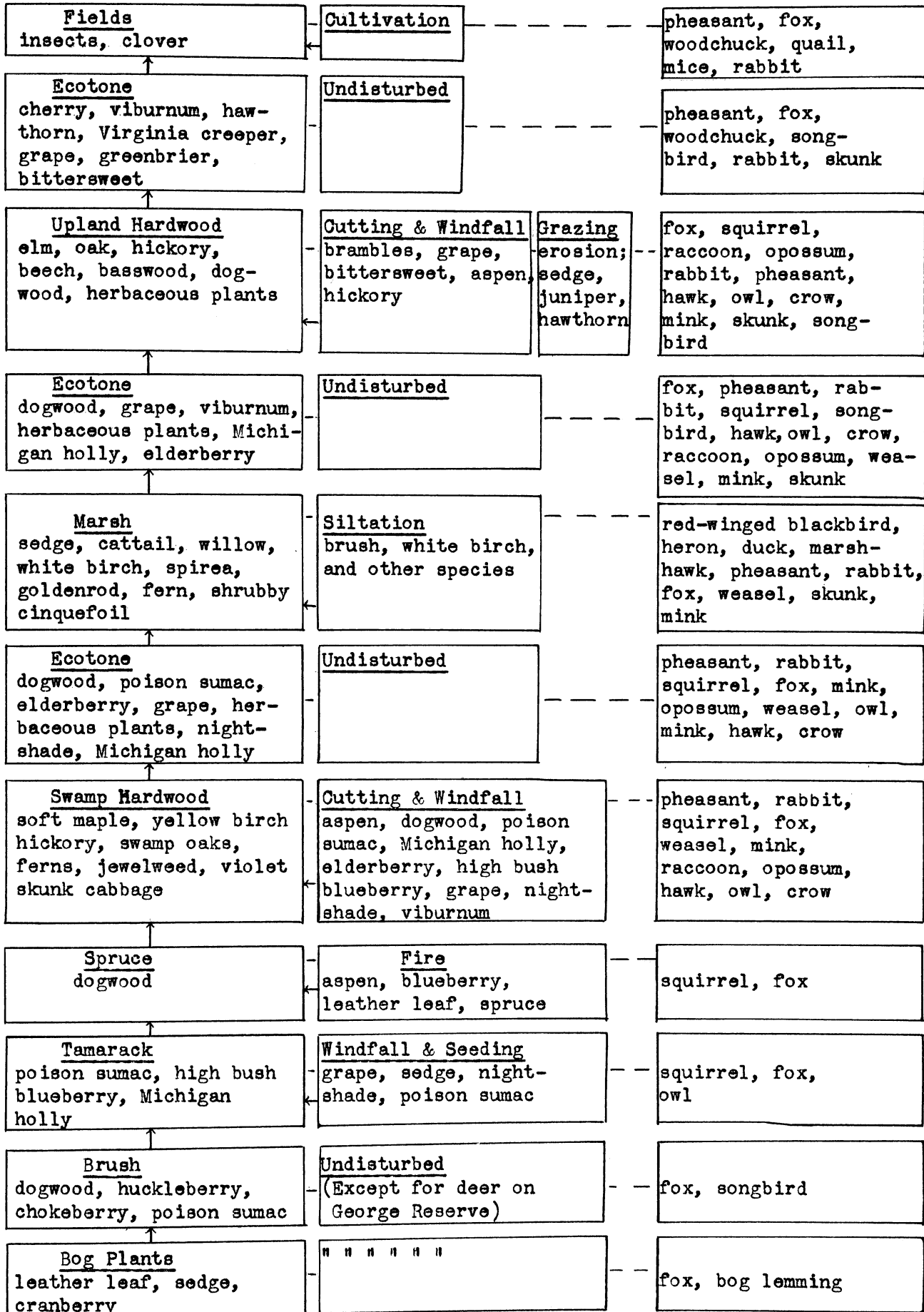
#### Song Birds.

The usual winter and summer species were seen on the areas. There is no competition with the grouse as there is abundant food during summer. The diets of those remaining during winter vary from the grouse in the staple foods taken. The red-winged blackbird may be a buffer species as far as owls and grouse are concerned.

Table of Predation

Species	Predator	Date	Location	Type
Chicken	Fox	Apr. 18, '47	Mason's	Field
Fox squirrel	Fox	Mar. 3, '47	Mud Lake	Swamp hardwood
	Owl	Apr. 18, '47	Mason's	Upland hardwood
Grouse	Owl	Mar. 14, '47	Mud Lake	Spruce
	Owl	Mar. 17, '47	Mud Lake	Spruce
	Fox	Apr. 20, '47	Mud Lake	Edge of marginal ditch
	Weasel	Jun. 7, '47	Mud Lake	Upland hardwood
	Fox	Nov. 23, '47	Chelsea	Cedar
Hawk	Fox	Apr. 20, '47	Mud Lake	Marsh edge
Opossum	Fox	Mar. 21, '47	Mud Lake	Edge of marginal ditch
Pheasant	Fox	Jun. 18, '47	Mud Lake	Edge of marginal ditch
Rabbit	Owl	Mar. 3, '47	Mud Lake	Swamp hardwood
	Fox	Jul. 31, '47	George R.	Upland hardwood

The Ruffed Grouse in the Bog and Upland of Southern Michigan  
 (Showing Cover, Food, Disturbance Effects and Related Wildlife)



## THE GROUSE OF THE GLADWIN AREA

### Purpose

Desiring to contrast a more northern grouse habitat with that to be found in the southern part of the state, September 12th and 13th were spent in observing the Gladwin Refuge and portions of Clare County in the company of William Laycock, District Game Manager. Gladwin is located about twenty-five miles southeast of Houghton Lake at the junction of state highways 61 and 18.

### Topography

#### Moraines:

The refuge (p. 87) is situated on a southwest branch of the West Branch morainic system. This branch forks into two lobes over the area in question. Sand and gravel plains lie between the moraines.

#### Character and Relief:

The topography presents relatively inconspicuous knolls. The lakes and basins of the Gladwin refuge are typical of the swell and sag topography exemplified in the Gladwin ridge. The outer face of the West Branch morainic system rises 100 feet and may reach 200 feet in northern Clare County.

#### Drainage:

The Gladwin State Game Refuge, located in T. 20 N., R. 2 W., has the Clare County and Roscommon County lines as the west and north boundaries respectively (p. 94). The refuge covers 5,120 acres and drains east and southeast through a series of small lakes into the North Branch of the Cedar River. The Clare County area drains to the southwest into the Muskegon River.



## Vegetation

### Gladwin State Game Refuge:

The northwest corner of the refuge was originally part of the pine plains with its mixture of white pine, Norway or red, and jack pines. Mixed hardwoods and conifers covered the remainder of the refuge, except for the coniferous vegetation of the small swamps which occur there.

The area now presents an interspersion of aspen, cedar, and oak, with some tamarack. Among the shrubs composing the understory are: nannyberry, mapleleaf viburnum, wild raisin, blueberry, and high-bush cranberry. There are also staghorn sumac, cherry, leatherwood, Michigan holly, and plants of bog vegetation. Vegetation of the forest floor includes such plants as: bracken fern, sweet fern, dwarf Solomon's seal, *Aralia* sp., dwarf dogwood, clover, and dwarf raspberry.

### Clare County:

Aspen stands are more open than those on the refuge. Consequently, there is a greater growth of grasses and bracken. The demarcation of the ecotones bordering the cedar swamps is more pronounced. In general, it may be said that there is a less even gradation from upland summer cover into the fall and winter cover of the swamps. This, in conjunction with the fact that more intensive management measures are lacking, may be the reason why the Gladwin refuge offers more suitable grouse habitat. Aspen stands more open in nature and fewer food plants are not conducive to the best grouse habitat.

### Grouse Habitat

There is an ample spread of the necessary upland and lowland habitats tied in by an even transition. Aspen stands are of low diameters, with an even crown closure; they serve well for broods.

Those uplands used by the grouse show no pronounced slope. This is particularly true of those broods observed. Oak, as stated by Mr. Laycock, serves as valuable mast during the better fruiting years. There is a variety of food plants. Mountain ash and dogwood are also included among the food plants cited above. Bracken, sweet fern, and other herbaceous plants provide summer browse.

Sedges, poison sumac, high blueberry, and Michigan holly grade into the tamarack cover of winter. Dogwoods occur along the bog edges. The cedar swamps offer excellent cover of an evergreen vegetation. Fallen trees provide protecting roots for safe cover. An outstanding thing, true of both the Gladwin and the Clare County areas, is that the cedar swamps are within easy reach of the aspen-browse so necessary in winter. Here is one of the important facts pertaining to grouse during the winter season; that they have food in sufficient abundance and that that food be within easy reach of cover.

#### Grouse Management

Field trials at Gladwin require that there be a sufficient supply of grouse on hand for the competing dogs. They further require that the grouse be reasonably close to the courses on which the dogs are run and judged. A planting program has been set up in order that the birds might be held in the vicinity of the courses.

#### The Planting Program:

The plantings are a combination of fruiting shrubs placed around spruce and red pine cover. Fruiting shrubs include nannyberry, mountain ash, and crategus. There has been no success with plantings of Michigan holly. The plants were set out and marked by stakes so that a survival count might be made; almost 100% survival has been attained.

Some of these plants have begun to produce fruit in their second year of growth.

A system of protection for the young plants was found to be necessary as the deer on the refuge constitute a browsing problem. After planting the food and cover patches, the aspen has been lopped over forming a protective "jam pile" (fig. 20, p. 63). When the shrubs have attained sufficient height to over-top the pile, there is no longer danger of destructive browsing. The cuttings offer an effective source of light to the shrubs and conifers. The second method consists of cutting poles and building exclosures about eight feet high and fifteen feet long. Sportsmen entering the field trials have taken keen interest in the plantings and have themselves begun a planting program which has already seen the planting of crategus, white, and alsike clover. It has been suggested that snow fencing might prove a cheaper means of protection than those previously employed.

#### Plant and Animal Relationships:

Deer have increased to such an extent that a browse line is beginning to appear in the cedar stands. Indication of the severity of the condition may be seen in that there is only 1 fawn for every 2.06 does. Over-browsing constitutes a danger to grouse populations (34).

The refuge is dotted with beaver dams (fig. 21, p. 63) and the resultant impoundment of water has killed a great deal of cedar. This is a threat both to deer and to grouse. The beaver are being trapped and removed to other places. The deer present an additional problem in that if cedar is cut for browse, aspen or spruce may replace the cedar. Such a chance is not particularly desirable for grouse or deer.

#### Experimental Feeding:

Mr. Laycock tried feeding the grouse unsuccessfully on the refuge, finally concluding that he had not begun it early enough in the winter for the birds to become adapted to the new food supply. The birds would come near the food but passed around it. Deer, rabbit, and squirrel made use of the grain, however.

#### Mortality:

No losses have been observed on the refuge. It was thought that, because one trapper found a dead grouse last winter during the ice snap, many grouse had perished. Laycock, however, observed that the grouse shook the ice from the aspen buds and browsed easily.

Fox were on the refuge and trapping yielded three; to date no fox sign has been observed. One coon was taken this spring. On the whole, the effect of predation would seem to be little.

#### Grouse Observations:

Four grouse of a brood of seven were observed on the refuge. The birds were in staghorn sumac and sedge along a swamp edge (fig. 22, p. 63). The mother was picking at a dead frog. On another occasion 12 grouse were flushed. All the juveniles were late broods due perhaps to the wet spring. One grouse was flushed in Clare County, along the edge of a cedar swamp. Laycock stated that from 1941 to 1946 there were 2.52 grouse moved per hour. The figures were compiled from field trial results and personal observations. There were .55 birds moved per hour during the southern area field work (p. 23).



Fig. 20. Jam piles protect food plantings from browsing deer.



Fig. 21. Beaver flood out cedar stands valuable to grouse as cover.



Fig. 22. A brood of four was flushed from this cover at Gladwin Refuge.

## TOPOGRAPHICAL EFFECTS

### Drainage:

Drainage furnishes a supply of water to those lowland areas and basins in which the best grouse habitat is centered. This means the maintenance of conditions necessary to the swamp hardwoods and conifers upon which the grouse depends. A supply of fresh water is important to the growth of cedar cover. Streams are important to grouse as they delay the complete spread of a single type and insure the presence of valuable ecotones.

Basins hold a place of considerable importance to grouse. The hydrogen ion content which influences marginal ditch vegetation is the direct result of basin drainage. Basins are at once reservoirs and a source of water for areas on the same or lower levels. The existence of basin vegetation, in particular those with lakes in various stages, is insured by drainage.

### Topography Delineates Upland from Lowland:

This is extremely important in the interspersions of types necessary to grouse. River, flood plain, and basin extend distinct vegetational types into the upland areas. Subclimax types with attendant ecotones exist here and may be held indefinitely by natural or artificial factors. Thousands of acres of basin and lowland are used for winter cover and in them grows much of the winter food of the grouse.

The slow build up of lowland soil will bring about establishment of valued food and cover species (32). Again, ecotones become important for along the edge between upland and lowland there is such valued food and cover as the viburnums, dogwoods, and climbing vines.

### Topography Influences Slope Vegetation:

On the uplands there is a vegetational difference between the north and south slopes. South slopes have a preponderance of hickory and oak which provide food. Less food-bearing shrubs are found on the south slopes. *Crataegus*, juniper, and blueberries are some of the plants found on the south slopes of basins.

North slopes, when on better soils, have a greater mixture of hardwoods. Maple, beech, ash, and some black walnut will be found with the hickory and oak. On both north and south slopes, when the soil is of poorer quality, there is a great deal of oak. Shrubs and small trees of north slopes include viburnums, pawpaw, smilax, ironwood, and witch-hazel. Where small seepage areas occur, growths of elm, ash, and dogwoods are found. Potzger (32) has termed this topographic control. It is probably indirect, the major influences being the action of sunlight and soil depth upon soil moisture. In the lowlands water excesses exert controlling influences (32). Topography is concerned in that both drainage and retention of water enters the picture. Subclimax forests of the lowland are invaded by beech as soon as the soil is elevated some ten to twelve inches above the water table (32). Beech is a grouse food.

### Topography and Wind:

Leeward slopes always afford protection against the wind. It has been noted that during driving wind, snow, or rain, entrance down into a basin shows a great difference. The wind is as quiet as the interior of a pine stand and it is appreciably warmer. The side protected from wind holds the snow for a longer time and this affords an effective insulation which is probably one of the factors contributing to the early appearance of the spring flowers which are found on north slopes (37).

These early herbaceous plants provide food for the grouse. Those shrubs offering cover in the lowlands - in particular the dogwoods - kept their leaves and fruit a little longer in the year than the upland shrubs; this was equally true of those trees having their crowns below the tops of the basin or ridge. During seasons in which there is less snow, insect populations are often higher on the dry, protected slopes (33). Protection from wind offers more comfortable shelter, longer lasting deciduous cover and food, and the early appearance of animal and plant food.

#### Topography and Cover Value:

Inasmuch as cultivation does not usually include the steeper slopes of basins and lowland, the most valuable summer cover is to be found along the lower portions of these slopes, adjacent to the marsh or swamp. Topography holds this cover against the encroachment of man. The value of cover is appreciably increased when backed by a slope which necessitates high flight or cautious stalking. A grouse in such cover has an added advantage in that danger from the rear is lessened. Such positions are further strengthened by timber topping the ridge and/or facing the cover. Such positions are usually within easy flight of escape cover.

#### Topography and Escape:

On the north side of Big Island in the George Reserve, a grouse consistently, no matter what the direction of approach, made use of an escape avenue through a small pass and into cover on the far side of a small cove. This bird could have flown over the ridge, but was obviously taking the easiest way to escape cover.

The mother grouse of the brood observed on the George Reserve



dropped quickly down the adjacent slope into cover along the kettle hole. The seven weeks old brood flushed wildly in all directions across the small flat on which they were feeding and up the slope to the edge of the stand, where they perched on low branches and shrubs or settled to the ground. Do young birds learn the value of fast downhill flight, or is brood escape something which finds its greatest value for young birds in the sudden manner with which it is accomplished?

#### Grouse and Slope:

No grouse were observed on such steep slopes as those to be found in Buck Hollow on the George Reserve, nor was this the case at Gladwin. While slope affords a fast downhill flight, it operates against the grouse in that feeding would be limited either to a downhill walk or a walk parallel to the ridge. Also, uphill flight would tax the strength of a bird of such low endurance as the grouse. At no time were grouse flushed off a slope over 20%; this may indicate that topography has something to do with that particular habitat in which the grouse centers its daily movement. Edminster believes topography may have such an influence (18).

#### Mammalian Predators and Topography:

It has been noted that much of the remaining cover is to be found along the base of ridge and basin. Animal trails follow the basin edge and are used by both herbivore and carnivore as well as those mammals of omnivorous diet. This offers two advantages, 1) detection is lessened as the animal does not stand out against the sky, and 2) the growths of shrubs and herbaceous vegetation offer effective concealment. Such trails afford easy progress and at the same time bring the predator into contact with prey along the ecotone.

### Cultivation:

Inasmuch as topography distinguishes between moraine and swamp it determines, in a broad sense, the effect of agriculture upon grouse habitat. Where soil types and slope permit, cultivation extends directly to the edge of those muck soils which are too difficult or expensive to work.

Cultivation is also limited by the dry sandy soils or ridges. This determines the location of woodlots, which in turn effects the summer movements of the grouse. Where slopes have been cleared of woodlots, grazing has been the general use and the influence of this, in its worst form, may be seen in the blow-out on the Chelsea Game Refuge. Were it not for the presence of the sheep themselves, some of the effects of overgrazing might prove valuable to grouse in that small patches of hawthorn often become established. There are other values of cultivation which will be discussed later.

### Topography and Logging:

The more expensive equipment is out of reach for the average farmer and he is forced to use sleds for logging the lowland. Even during winter some sort of road construction would be necessary in order to truck logs out of such places. The farmer faces added wear and tear on his truck if forced to haul over adverse grades. Using a sled on slopes over 10% requires the use of hay, straw, or dirt for greater traction when hauling heavy loads (3). Sleds are almost necessitated when there is no wind-break preventing high drifts over lanes. Saw logs are taken out by the average farmer only where topography offers the least resistance.

## LAND USE

### Correlation of Moraines and Agriculture:

The outer rims of the moraines usually contain sand and gravel of no value to agriculture. On logged over areas there is now a growth of brush and aspen where there was formerly pine. At best, this land offers only scanty grazing for stock. The inner borders of the morainic systems carry a clay till which is productively farmed. Moraine and outwash soils offer the better agricultural chances. Basins, being low and wet, usually present difficult problems in agriculture. Those farms on the more inferior soils show heavy overgrazing; in places sand has been exposed and blow-outs have developed.

### The W. P. A. Survey and the Michigan Agricultural Census:

The W. P. A. survey (p. 72) shows the northern counties to be poorer than the southern counties. There are more low income farms, lower percentages of farm tenancy, and less farm wage workers. The land value per capita of the northern rural farm population was \$434 as compared to \$998 for the southern counties. There are less people in the northern counties.

Examination of the census tables bears out the findings of the W. P. A. survey (pp. 73-75). Gladwin County has a higher percentage of woodland, and a lower percentage of pastured woodlots. This is entirely natural in view of the scanty forage offered by the sand soil. Except for a few tender-leaved shrubs, the ground cover is composed of bracken and plants of "leather-leaved" foliage. This is not good forage. More woodlots and less pasture means a better grouse habitat. The opposite is true of Washtenaw County.

There are more crop failures and less crop land in Gladwin County. Washtenaw County has more successful farming, more agricultural land, and farm equipment higher in value than those of Gladwin County. The situation is the same regarding livestock. Crop failures discourage farming, and less crop land means more grouse habitat. Agricultural operations are not as great in the north as in the south. This means less clover, dusting spots, insects, and other foods for grouse. These are increased in southern Michigan. In an effort to keep the land productive, northern farmers on poor land have gone into grazing. The situation becomes worse for the farmer and worse for the grouse.

Gladwin County has less people than Washtenaw County. This means less hunters; however, these people sustain themselves with more home products. The meaning is clear. Many of the northern people are poor. Anyone who has a gun is going to hunt in order to increase the food supply. Undoubtedly, those hunting put considerable effort into it. However, the total hunting pressure is not as great in such localities. Hunters from the southern counties increase the pressure when they go north for the grouse season. Hunters in Washtenaw County exert little effect upon grouse for two reasons, 1) they generally believe that there are no grouse to be had and 2) many of them prefer the easier hunting of open fields and woods.

#### Agricultural Practices:

Following a set plan of rotation varies in this county as it does in the north. Carter, who is share-cropping the field on the north side of Mud Lake, is using a four year rotation with clover following the wheat which he put in this fall. Some use this four year rotation and others, while realizing the importance of rotation, have a

tendency to let the crops remain in the same fields until they show a decreased yield, upon which the rotation is changed. There are young, progressive farmers coming into the county, some of whom have had college agricultural training. They are using better methods.

Woodlot management concerns itself with a supply of fuel wood supplemented with occasional saw logs. There are comparatively few woodlots which are not grazed. Grazing in some cases even extends into the lowland hardwood.

Fence rows, especially in sheep pastures, are almost bare except for a few trees. Thistle does not seem to have gained the hold it has in Ohio pastures. Some farmers make a practice of cutting and burning "dirty fence rows." Where groups are able to pool their resources, drainage projects are being carried out. There are valuable things for grouse even in the agricultural practices now in use. Where crops adjoin nesting or brood areas, insects (23) and dusting spots are available. When the rotation places clover adjacent grouse habitat, this also is a valuable food during fall and winter (pp. 88-93). Of course, certain shrubs do continue to grow - they are not all taken out - and these provide food. Poison ivy, grape, and Virginia creeper are not as often cut as are heavy growths of shrubs.

Cultural Indices Contrasting  
the  
Northern and Southern Counties of the Lower Peninsula

	Children per 1000 women	% Low income farms	% Tenancy on farms	% Farm wage workers	% Land value per capita of rural farm popu. 1930	% Farm pro- duce con- sumed on farms 1929	% Rural fami- lies resid- ing on farms 1930
	1930 <sup>1</sup>	1929 <sup>2</sup>	1935 <sup>3</sup>	1930	1930	1929	1930
Northern counties	818	53	12	22	434	23	58
Southern counties	590	38	21	31	998	12	42

<sup>1</sup> Children under 5 years of age per 1,000 women 20-44 years of age, rural population, 1930.

<sup>2</sup> Percent of farms producing less than \$1,000 gross income, 1929.

<sup>3</sup> Including croppers in the south.

Farms, Acreage, and Land Area - 1945

	(Counties)	
	<u>Gladwin</u>	<u>Washtenaw</u>
Farms - number .....	1,306	3,006
Approximate land area in farms - acres .....	321,920	458,240
Land in farms - acres .....	161,897	37,545
- owned by operator - acres .....	117,778	250,202
- rented by operator - acres .....	44,119	125,251
Average size of farms - acres .....	124.0	124.9
Crop land harvested:		
farms reporting .....	1,217	2,823
acres .....	53,481	19,386
average per farm .....	* 44	6
Crop failure:		
farms reporting .....	37	192
acres .....	276	1,480
average per farm .....	* 7.3	7.1
Crop land idle or fallow:		
farms reporting .....	152	743
acres .....	1,835	14,131
average per farm .....	10	* 19
Crop land used only for pasture:		
farms reporting .....	507	1,391
acres .....	9,867	35,384
average per farm .....	* 19	18
Woodland pasture:		
farms reporting .....	781	1,225
acres .....	4,844	23,476
average per farm .....	6	* 19
Other land pastured:		
farms reporting .....	832	1,738
acres .....	37,965	59,399
average per farm .....	* 46	34
Woodland not pastured:		
farms reporting .....	210	730
acres .....	9,803	11,545
average per farm .....	* 47	17
All other lands:		
farms reporting .....	1,295	2,296
acres .....	6,816	36,652
average per farm .....	5	* 12
Crop land total:		
farms reporting .....	1,256	2,427
acres .....	65,469	244,381
average per farm .....	53	* 84
Land pastured:		
farms reporting .....	1,233	2,588
acres .....	89,676	118,259
average per farm .....	* 73	41
Woodland total:		
farms reporting .....	879	1,747
acres .....	51,647	35,021
average per farm .....	* 59	19

\* County with greatest average per farm.

Farm Dwellings and Population - 1945

	(Counties)	
	<u>Gladwin</u>	<u>Washtenaw</u>
<b>Dwellings on farms:</b>		
farms reporting .....	1,293	2,955
number of dwellings .....	1,495	*3,498
number occupied .....	1,232	*3,345
number unoccupied .....	* 263	153
<b>Average person per occupied dwelling:</b>		
average .....	* 3.69	3.46
number of persons under 14 years .....	1,164	*2,830
number of boys .....	785	*1,463
number of girls .....	829	*1,367
number of persons 14 years and over .....	3,364	*8,733
number of men and boys (14 and over) .....	1,722	*4,409
number of women and girls (14 and over) .....	1,642	*4,324
<b>Farm populations (people living in occupied dwellings on farms):</b>		
farms reporting .....	2,908	126
number of persons .....	*4,978	1,563

\* County with largest number of dwellings or persons.



A Brief Table Showing Value of Farm Property  
and  
Number of Cattle and Horses - 1945

		(Counties)	
		<u>Gladwin</u>	<u>Washtenaw</u>
1)	Average value per acre of lands and buildings ..	\$36.06	* \$91.22
	Farms 30 acres or over .....	\$4,583	\$12,761
2)	Value of implements and machinery:		
	Farms reporting .....	1,128	* 2,688
	Value .....	\$1,010,843	*\$5,127,325
3)	Value of livestock on farms .....	\$1,514,586	*\$5,641,235
4)	Cattle and calves:		
	Farms reporting .....	1,056	2,373
	Numbers .....	19,157	* 43,036
5)	All horses and colts including ponies:		
	Farms reporting .....	871	1,813
	Numbers .....	2,249	* 5,297

\* County with largest value or numbers.

## MANAGEMENT SUGGESTIONS

Because of the particular topography of southern Michigan, we find Detroit situated on the east and Kalamazoo and Grand Rapids on the west, not far distant from the lake front. Placed between these cities and reaching roughly from Lenawee County on the south to Oakland County on the north is the Interlobate Lake District. Jackson is practically within this area. It is here intended to consider management proposals for ruffed grouse in an area which has, in its three larger cities, a population of some 1,841,840 people. How can the 20% which King (24) uses to build up a grouse population be maintained under such a condition? A grouse management plan for this area would offer - if it works - an increased measure of recreation.

### Locality:

The locality has already been cited; it is suitable for grouse as it holds thousands of acres of marsh and swamp. As pointed out in the discussion of topography and drainage, the Saline and Huron Rivers are important in management considerations. The former vegetation of this area supports this reasoning. Such small streams as the Portage River become equally important.

### Type Management

There are three major land divisions to be considered; lowland, upland, and cultivated fields. Lowland is broken down into conifers, swamp hardwood, brush, and marsh. Upland is divided into mixed hardwood and brush. Cultivated fields include the broad groups of pasture and crop.

### Lowland:

Conifers. Evergreen cover is lacking. The Interlobate Lake District must be considered in the light of the necessity for such cover.

Where coniferous stands appear in small units as those on the Mud Lake area, an increased area of conifers will afford additional cover. Hardwood slashings of two acre extent are recommended. Black spruce should be planted in three or four groups of twenty-five each for every two-acre slashing. These groups may be ringed about by shrubs which come in naturally or if shrubs should prove scarce, they should be planted. Spruce could also be planted in the center of such openings. Such species as Michigan holly, nannyberry, mapleleaf viburnum, elderberry, dogwood, and dwarf blackberry are valuable species used in planting. Grape will create a more dense cover and contribute food. The important thing in such a proposal is that the interior is made more suitable for grouse, with a resultant even spread of population (5, 8-11, 13).

Cedar is recommended only where there is known to be a flow of fresh water. Areas of predominate cedar can be made of increased value by the creation of small openings with a planting of aspen or birch if necessary. This usually seeds in. Fruiting shrubs should also be considered. Poison sumac is almost always present and need not be planted. It is not recommended that a great deal of labor be spent on tamarack stands. When adjacent to hardwood, spruce, or cedar, a strip cutting along the edge of the tamarack will increase the food supply. Poison sumac, grape, and fallen tamarack often occur together in the tamarack stands and this combination offers natural cover. Sometimes situations will be found in which there are small mounds at places within lowland timber. This offers an excellent opportunity for the planting of beech and upland shrubs which, when ringed with lowland shrubs around the outer edge, will greatly increase available foods. Such

conditions may be seen on the Chelsea Game Refuge where a stand of beech occupies a mound. Before any planting is done, the necessary Ph (p. 81) for the particular shrubs used should be known and checked with the place of introduction (22).

Swamp Hardwood. The Pennsylvania Game Commission (30) used heavy thinning - 50% to 75% - in order to release shrubs. This seems to be a thing of short value. Opening a stand to such a degree may bring in heavy bramble, dogwood, coppice and reproduction which will demand maintenance for the best grouse conditions. Small quarter to one-half acre openings supplemented, if need be, with planting are of value to the grouse using such locations (13, 18). Zig-zag strips or openings with scalloped edges increase the edge (30). Tops and branches of the trees should be piled in the center or laid in wind-rows for extra cover (30). Grape tangles may be increased by partially cutting through the tree upon which the vine grows so that when the tree falls, it will still have sufficient sapwood and cambium to continue growth for a while (13, 18, 30). This offers dense shelter in the summer; the vines will offer food. Where shelter is scarce, coniferous plantings or high stumps with coppice growth will help (30). If trails cross the swamp hardwood, these should be kept open as they furnish proper conditions for the growth of shrubs (13, 18, 24). If food plants are near, they will come into the openings.

Brush. Brush provides fall feeding. Brush will be found to be of more value when in connection with the planting of conifers mentioned above. From 10% to 20% of brush should be allowed (18). Field edges and the edge of marsh land should be used for this purpose (18). Cutting strips will open the way for brush and these

should be maintained by occasionally cutting trees which may spring up (13, 18, 30). If used with equal areas of 30% to 50% of conifers and hardwood, and about 1% of open land, this will bring the most preferable spread of types (18).

Marsh. Marsh can be made more valuable to grouse by piling brush near growths of shrubs so that more cover will be available or by cutting back the cattails and releasing shrubs (13, 18). This, however, is a refinement and need not be done as grouse make less use of marsh areas.

Upland:

Mixed Hardwood. It is important that overgrazed hardwood stands be closed so that brush and reproduction might have a chance to return (13, 14, 18, 24, 26). Fire control, while perhaps not so necessary, should be considered under a large state project (13, 18). Areas can be allowed to seed in if parent trees are near, or planting should be carried out. Roads and trails are important in that they provide openings lined with brush (13, 18, 24). Dusting spots and grit are also made available (13, 18, 24). There are few stands which need thinning; the same technique of openings apply to these. Where wildlife foods are needed, there are several species which may be planted. Among these are: flowering dogwood, wild blackberry, black haw, hobblebush, smilax, witherod, elderberry, and rose. Planted along woodlot edges or trails, these shrubs find their greatest use to grouse and wildlife. Virginia creeper, bittersweet, grape, and cherry will contribute further food if allowed to grow along the fence adjacent the woodlot. An edge of shrubs eight feet wide will often attract woodchucks; their dens are valuable for rabbits. It is also particularly

desirable to maintain den trees and those weed trees which furnish wildlife foods. Hardwood reproduction must be periodically thinned in order that the edge might be maintained. Stands should not be allowed to go beyond 80% of crown closure as the herbaceous ground cover is then in danger of change. This applies to swamp as well as to upland (7-11, 13, 14, 17, 18, 22).

It is suggested that by use of the photometer in those stands holding grouse populations the proper amount of light may then be determined and thinnings carried out accordingly. It should be noted that such men as Jennings, Mason, and Clutier, while forbidding hunting, have not been able to increase grouse. There is little cutting and almost no grazing in the lowlands. It is therefore suggested that closing in of vegetation be investigated.

If upland hardwood stands of 70 acres or more can be established, these can be managed in just the same way as the swamp hardwoods (18). This will then be a direct parallel to those conditions which Fisher cited (20). Conifers should always be planted on the interior of the stands for reasons mentioned above (18). It should be remembered that timber stands are of greatest value to game when not over 600 feet wide (18). Space the openings and plantings in regard to this principle. The same system as that described for the plantings at Gladwin will apply here. Clover planted in the roads will afford another food for grouse. Slashing or burning may bring back aspen if it is needed. It is desirable to maintain areas of young hardwood from 4 to 8 inches in diameter with some conifers for spring nesting (13, 18). These young stands often furnish food for broods; slashings are also valuable in this respect.

Characteristics, Tolerance, and Habitat of Some Shrubs and  
Vines Recommended for Planting in Grouse Management

Common Name	Scientific Name	Growth*		
		Characteristics	Tolerance	Habitat
Nannyberry	<u>Viburnum lentago</u>	Tall (Sh)	6.0-8.0	Wet
Blackhaw	<u>Viburnum prunifolium</u>	Tall (S Sh)	6.0-8.0	Dry
Mapleleaf viburnum	<u>Viburnum acerifolium</u>	Tall (Sh)	6.0-8.0	Dry
High bush cranberry	<u>Viburnum opulus</u>	Tall (S Sh)	6.0-8.0	Dry
Pagoda dogwood	<u>Cornus alternifolia</u>	Tall (Sh)	6.0-8.0	Moist
Flowering dogwood	<u>Cornus florida</u>	Tall (S Sh)	6.0-7.0	Moist
Gray dogwood	<u>Cornus paniculata</u>	Tall (S)	6.0-8.0	Dry-Wet
Beaked hazel	<u>Corylus rostrata</u>	Tall (S)	6.0-8.0	Moist
American hawthorn	<u>Crataegus coccinea</u>	Tall (S Sh)	6.0-8.0	Dry
Mountain ash	<u>Pyrus americana</u>	Tall (S)	6.0-8.0	Moist
Staghorn sumac	<u>Rhus hirta</u>	Low (S)	6.0-8.0	Dry
Smooth sumac	<u>Rhus glabra</u>	Low (S)	6.0-8.0	Dry
Japanese rose	<u>Rosa multiflora</u>	Low (S)	4.0-8.0	Dry-Wet
American elder	<u>Sambucus canadensis</u>	Low (S Sh)	6.0-8.0	Dry-Wet
European elder	<u>Sambucus racemosa</u>	Low (Sh)	6.0-8.0	Dry-Wet
Flowering raspberry	<u>Occidentalis</u>	Low (Sh)	6.0-8.0	Dry-Wet
Climbing bittersweet	<u>Celastrus scandens</u>	Low (S)	4.0-7.0	Moist
Virginia creeper	<u>Psedra quinquefolia</u>	Low (S)	4.0-7.0	Moist
Grape	<u>Vitis spp.</u>	Low (S Sh)	7.0-8.0	Moist
Common nightshade	<u>Solanum nigrum</u>	Low (Sh)	4.0-8.0	Moist
Bitter nightshade	<u>Solanum dulcamara</u>	Low (Sh)	4.0-8.0	Moist
Michigan holly	<u>Ilex verticillata</u>	Tall (Sh)	4.0-6.0	Wet

\* S = sun  
Sh = shade

Brush. It is advisable to place these areas in strip form along the edges (13, 18). Often large areas of brush may be found adjacent swamp and upland; these are heavily used by grouse during fall and winter. A more equitable distribution of the birds could be achieved if brush strips are maintained along the other edges of the woods as well. Fifty foot strips of brush are not too much for state game lands (18). Old orchards could be utilized by allowing them to come into brush (18). Occasional pruning will keep the apples fruiting and the grouse may use them (18).

#### Cultivated Fields:

Overgrazed fields can result in erosion. As soon as the topsoil is gone, blow-outs often occur on the sandy moraines. This is particularly pronounced in some parts of the Gladwin area and has taken place to a slight degree in Washtenaw County.

Rotations become of value in that clover and insects are available. Where hedges are desirable they must be kept on the side of the fence away from grazing stock. Species suggested for planting have already been discussed. Where shrub borders or hedges are adjacent to woodlots and a downhill slope is present, the plantings can be so arranged as to have the lower growing species next to the ground on the upper side of the border (13, 14, 17). It is desirable to use at least three species - a tree, a shrub, and a vine. Small clumps of conifers will furnish cover for grouse and mammals if kept cut back at the top (13, 14).

#### State and Private Control:

State control must be centered in the recreation areas and game lands. Either the state must buy up the land needed for a complete area or else it must concentrate upon maintenance of its own areas



and a program in cooperation with the land owners. This entails education and aid in such things as plantings. The most difficult thing in such a set-up is that the land owner must be kept interested.

Under a farmers' organization, a management plan can be made to function. The township organizes and elects a president, secretary, and treasurer. In cooperation with state wildlife men lands are posted, refuges set up, and hunting restrictions put in motion. Permits to hunt are not necessary on the owner's land, but elsewhere on lands of the organization, a small fee is charged. Township residents who are not members and those who are outside the township are charged respectively higher prices for permits. The hunter is required to record his name, residence, and automobile and hunting license numbers. Strict rules regarding hunting within safety limits for stock and buildings are set up and enforced by elected officers, who also enforce the regulations for the areas. Under such an organization refuge then becomes possible. Predator control is not suggested as the value is doubtful (16). All profits of the association are divided, part going to the township school, part to the church, and part to the land owners on an acreage basis. This sort of organization is still continuing in the Pheasant Refuge Management System used in northwestern Ohio near Toledo (21).

The Williamston Plan is somewhat similar (2). The Plan rests upon cooperative posting of farm lands and admittance of hunters through written permits. It finds its strength in that the hunter's car remains in the farmer's yard until the hunter returns. The Pheasant Refuge Management System has the strong points of cooperative posting and written permit as well as a business foundation which contributes funds to the community.

## SUMMARY

- 1) Some stands holding grouse ten to twenty years ago do not hold them now because cutting, draining, and overgrazing have destroyed the habitat.
- 2) Grouse are found in stands of forty or more acres when the necessary vegetational types are present.
- 3) There is 1 grouse per 8 to 9 acres for the areas studied.
- 4) In nesting, the grouse is handicapped by weather and the small amount of suitable upland hardwood.
- 5) Conditions for grouse are more favorable in the northern counties of the lower peninsula because of more extensive woodland.
- 6) Once the general location of a brood is established, they may be easily observed throughout the season until they reach adulthood.
- 7) Small diameter stands are used by broods during the spring and summer.
- 8) Some broods were late this year and did not break up until October.
- 9) Grouse make use of conifers during inclement fall weather.
- 10) Plantation conifers are of value to grouse if they are adjacent to hardwoods and have scattered openings.
- 11) Roosting and feeding cover are similar in summer and early fall; different in spring and winter.
- 12) Summer cover for adults consists of trees, shrubs, and herbaceous vegetation with sedge only slightly used in the south.
- 13) Food preference is a matter of abundance and availability.
- 14) Intensive study with trapping and banding is necessary before the fate of broods is fully understood; until this is known, predation is not proven to be a lesser factor.


- 15) Game birds and herbivorous mammals offer little competition to grouse where food is abundant.
- 16) Fire and cutting may be favorable or unfavorable to grouse.
- 17) The glaciated topography of Michigan has a direct and indirect effect upon grouse.
- 18) Present land use practices are both favorable and unfavorable to grouse.
- 19) A southern Michigan grouse management plan will increase recreational facilities.
- 20) Sportsmen are interested in improving grouse habitat in the northern counties of the lower peninsula and there are some interested men in the southern counties.
- 21) Unless land is purchased by the state, private ownership will probably be the focal point in management suggestions.
- 22) The Gladwin Refuge has a higher population than southern Michigan because management has maintained an even transition of vegetational types, good interspersions, and abundant food.
- 23) Intensive agricultural practices limit grouse habitat in southern Michigan. The grouse habitat in the Gladwin area is not as adversely affected.

## Legend for Maps


### Fall Land Status

Wheat \_\_\_\_\_ 

Corn \_\_\_\_\_ 

Glover \_\_\_\_\_ 

### Construction and Cutting

Cutting \_\_\_\_\_ 

New Fence \_\_\_\_\_ 

### Grouse Observations

Flushed Adults \_\_\_\_\_ *x* /

Flushed Broods \_\_\_\_\_ *x* /

### Kills

Grouse Adult \_\_\_\_\_ *K* /

Grouse Juvenile \_\_\_\_\_ *K* /

Fox Squirrel \_\_\_\_\_ *S* /

Pheasant \_\_\_\_\_ *P* /

Opossum \_\_\_\_\_ *O* /










Rabbit \_\_\_\_\_ *R* /

Chicken \_\_\_\_\_ *C* /

Hawk \_\_\_\_\_ *H* /

Note: Similar symbols in white  
are used for brush types.

- Oldewin State Game Refuge 1
- Clare County Area 2
- Stinchfield Woods 3
- Chelsea Game Refuge 4
- Mud Lake 5
- George Resrve 6
- Waterloo Recreation Area 7

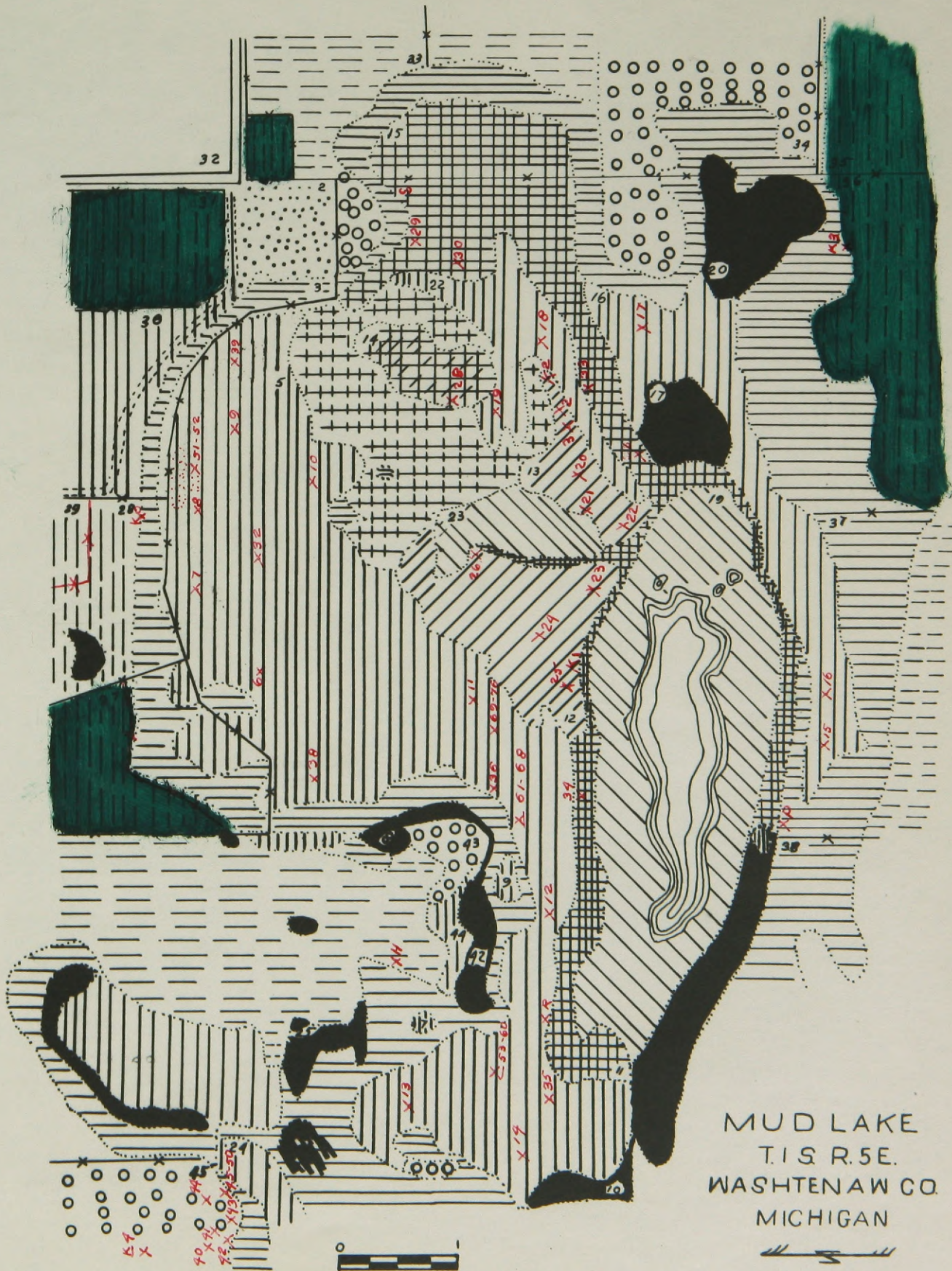
- Defiance 
- Fort Wayne 
- Mississinawa 
- Kalamazoo morainic system 
- Gladwin 
- West Branch morainic system 
- Higgins Lake Ridges 
- Moughton Lake Ridges 
- Port Huron morainic system 



STUDY AREAS IN RELATION TO MORAINES AND MORAINIC SYSTEMS OF MICHIGAN

H.L. Wilson '97

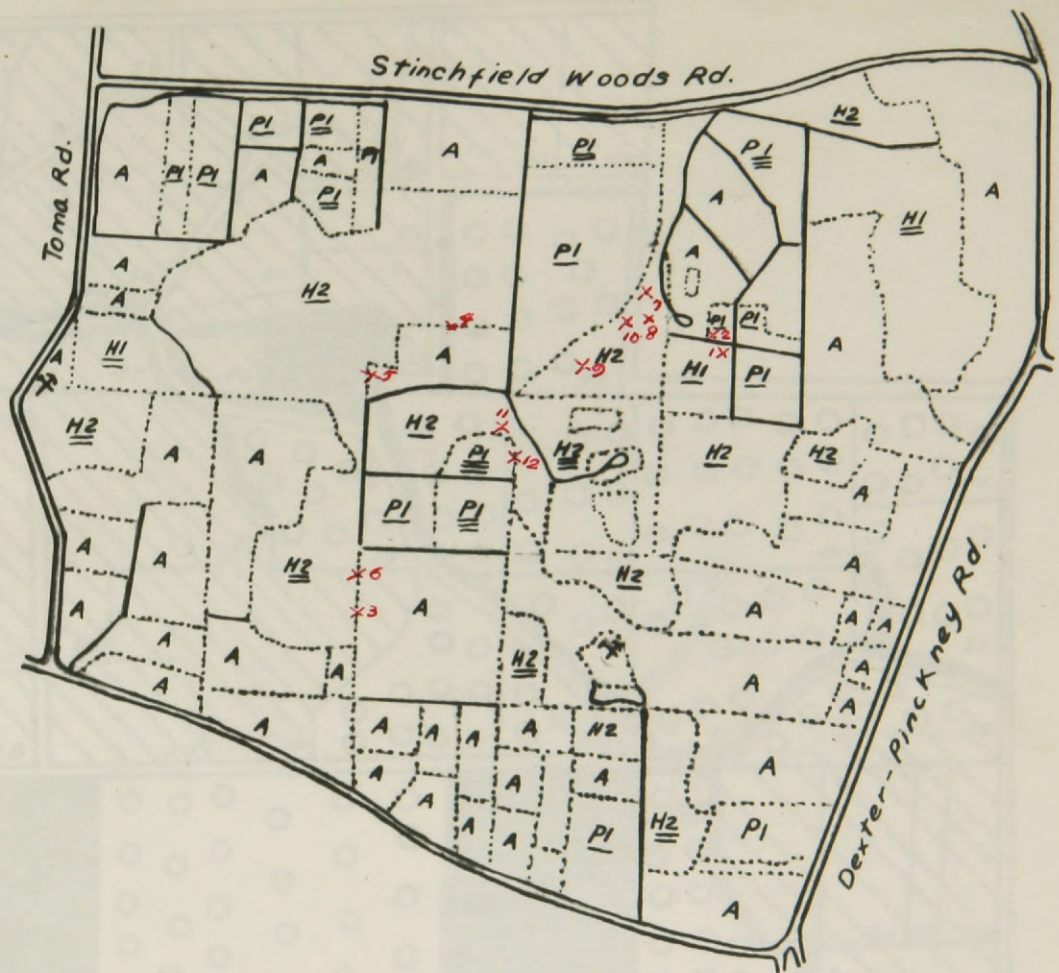
Tamarack	#	Leatherleaf ass.		Swamp hardwood	
Conifers	//	Pasture	==	fallow ground	∴
Marsh	=	Hardwood	oo	Cultivation	
				Aspen or y. birch	++



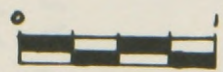
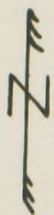
MUD LAKE  
T. 1 S. R. 5 E.  
WASHTENAW CO.  
MICHIGAN

0 1  
1 inch = 8 chains

H. L. Wilson '97



STINCHFIELD WOODS  
 T.1S. R.4E.  
 WASHTENAW CO.  
 MICHIGAN



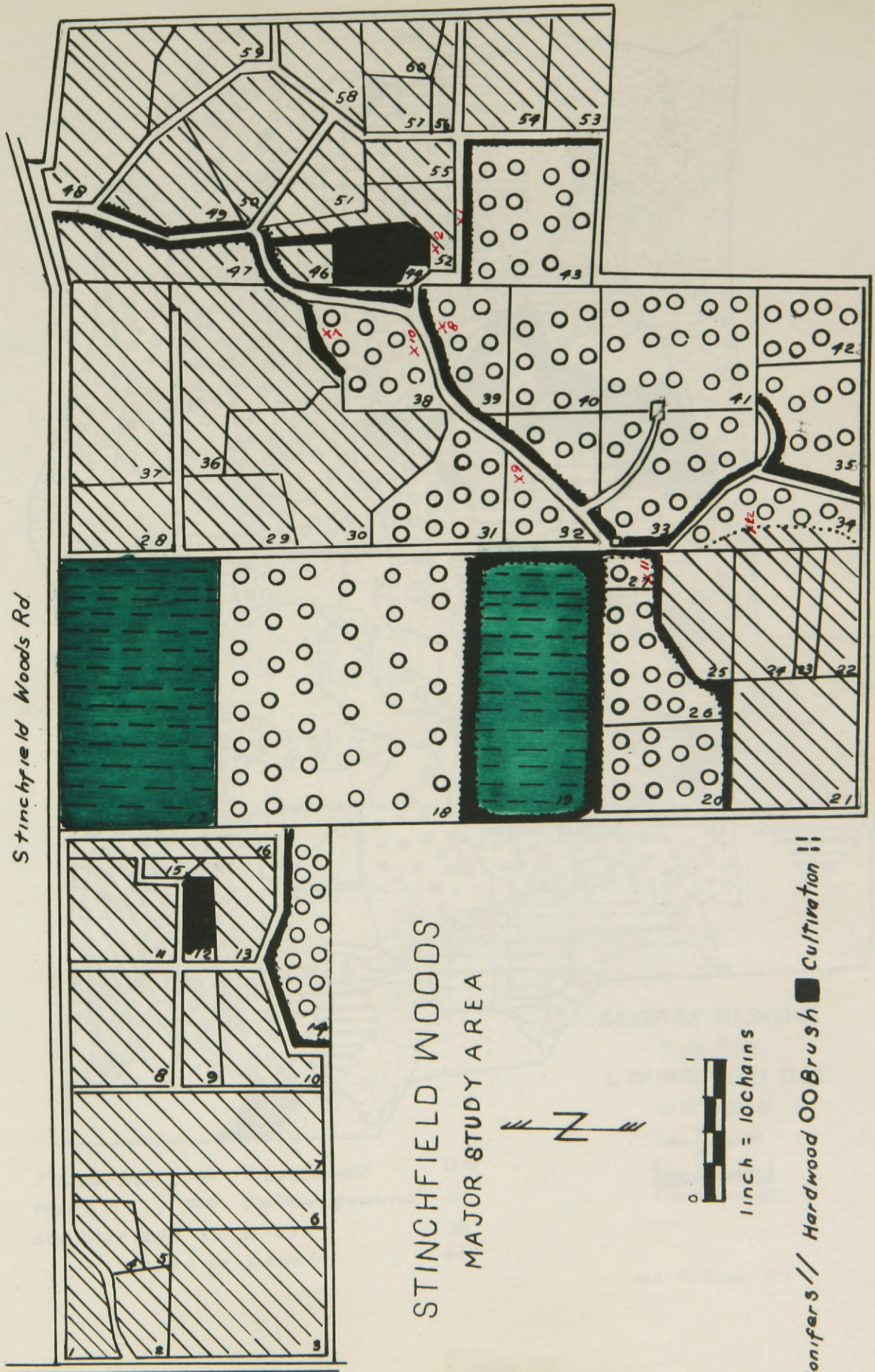
1 inch = 1665 feet

- A - agricultural land
- H - hardwood
- P - pine
- ≡ - full stocking
- ≡≡ - medium stocking
- ≡≡≡ - poor stocking
- 1 - Saplings
- 2 - poles
- 3 - saw timber
- ..... - typeline
- - poor road
- == - main highway
- X - gravel pit

Map from aerial photo.  
 Approximate location  
 of flushes shown -89-

H.L. Wilson '97

Stinchfield Woods Rd.



STINCHFIELD WOODS  
MAJOR STUDY AREA



1 inch = 10 chains

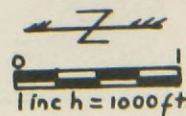
Conifers // Hardwood OO Brush ■ Cultivation ||

H.L. Wilson '47





GEORGE RESERVE  
 T. 1 N. R. 4 E.  
 LIVINGSTON CO.  
 MICHIGAN



Tamarack = Hardwood  
 Marsh = Fallow ground  
 Leatherleaf \ \ Brush  
 Aspen or y. birch

○ ○  
 ∴  
 ■  
 ++

H. L. Wilson '47

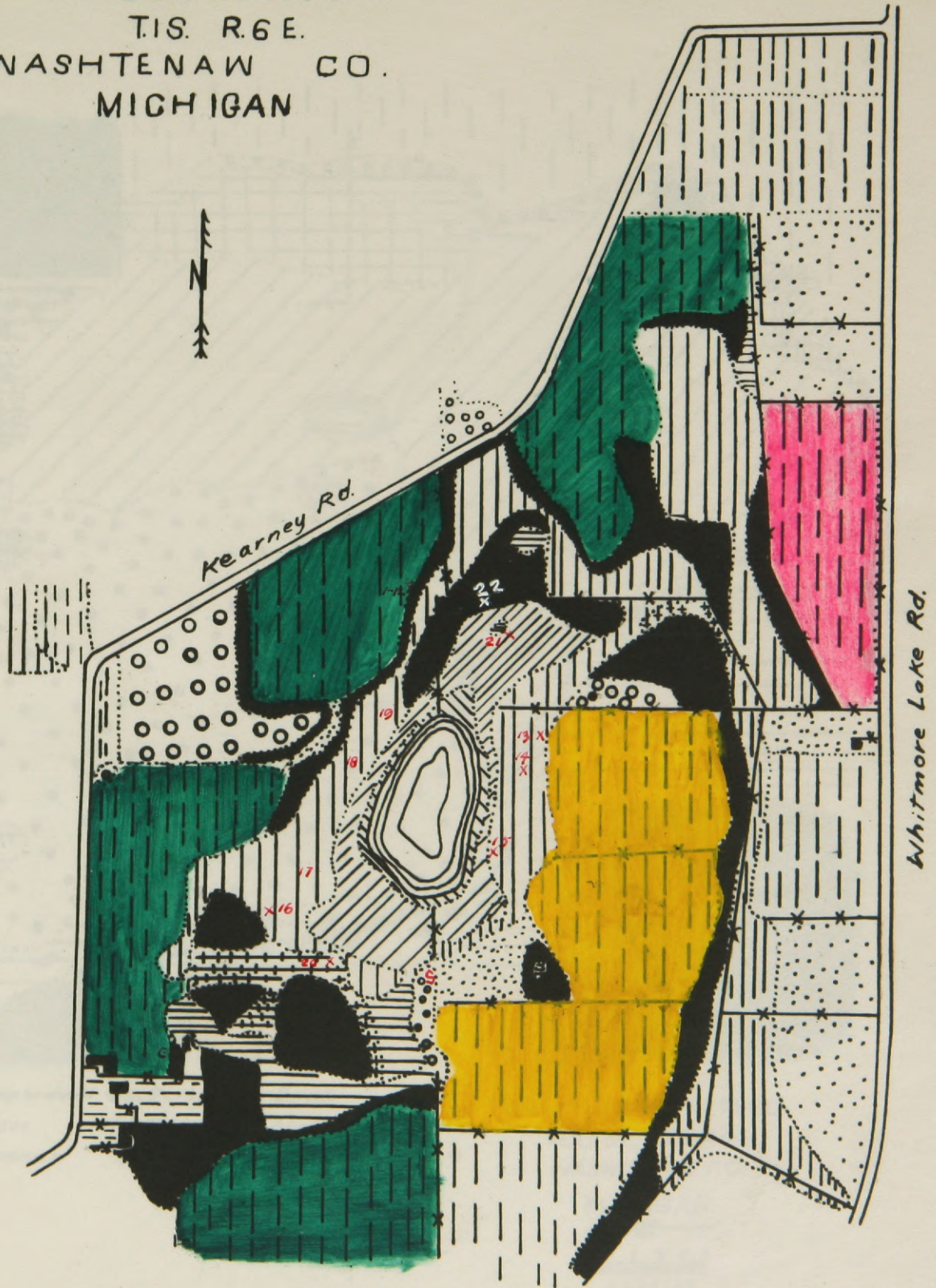


**EDWIN S. GEORGE RESERVE**  
 UNIVERSITY MUSEUMS  
 UNIVERSITY OF MICHIGAN

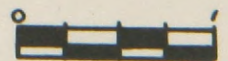
- LEGEND**
- BOUNDARY FENCE
  - RAILROAD
  - ROADS
  - TRAILS
  - TRAIL MARKERS
  - CONTOUR INTERVALS
  - BRIDGES
  - SPRINGS
  - ADJOINING WATER AND DIRECTION

DATE: 1953  
 SCALE: 1:50,000  
 DATUM: MEAN SEA LEVEL  
 CONTOUR INTERVAL: 5 FEET  
 JAN. 28, 1953  
 PUBLISHED BY: UNIVERSITY OF MICHIGAN  
 ANN ARBOR, MICHIGAN

MASON FARM  
 T.1S. R.6E.  
 WASHTENAW CO.  
 MICHIGAN

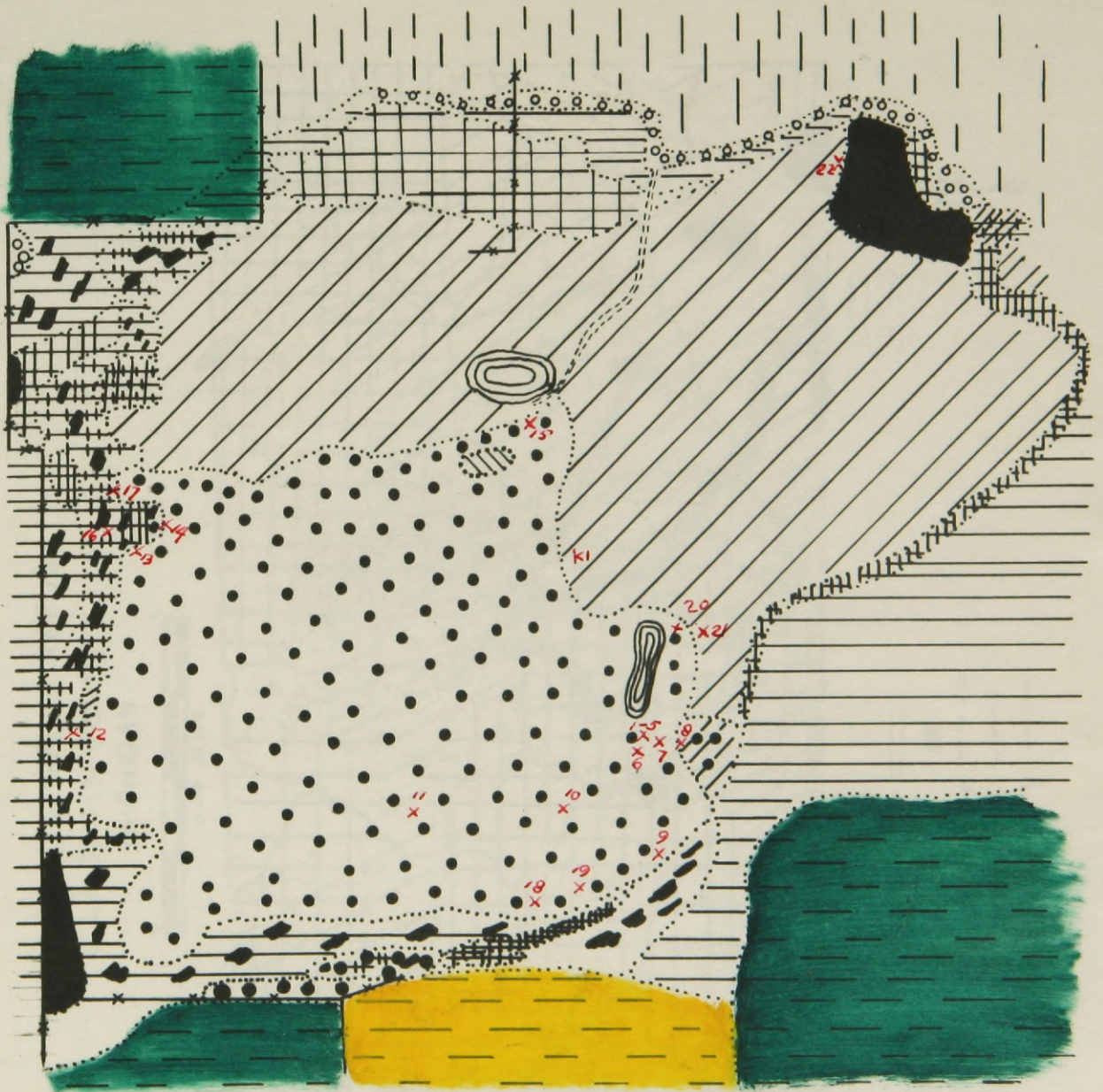


- |                  |     |                   |     |
|------------------|-----|-------------------|-----|
| Tamarack         | /// | Fallow ground     | ○ ○ |
| Marsh            | ≡   | Cultivation       | #   |
| Leatherleaf ass. | \\  | Swamp hardwood    |     |
| Pasture          | ≡   | Hardwood          |     |
|                  | ≡   | Aspen or y. birch |     |
|                  | ■   | Brush             |     |




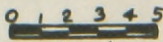
1 inch = 8 chains

H.L. Wilson '97

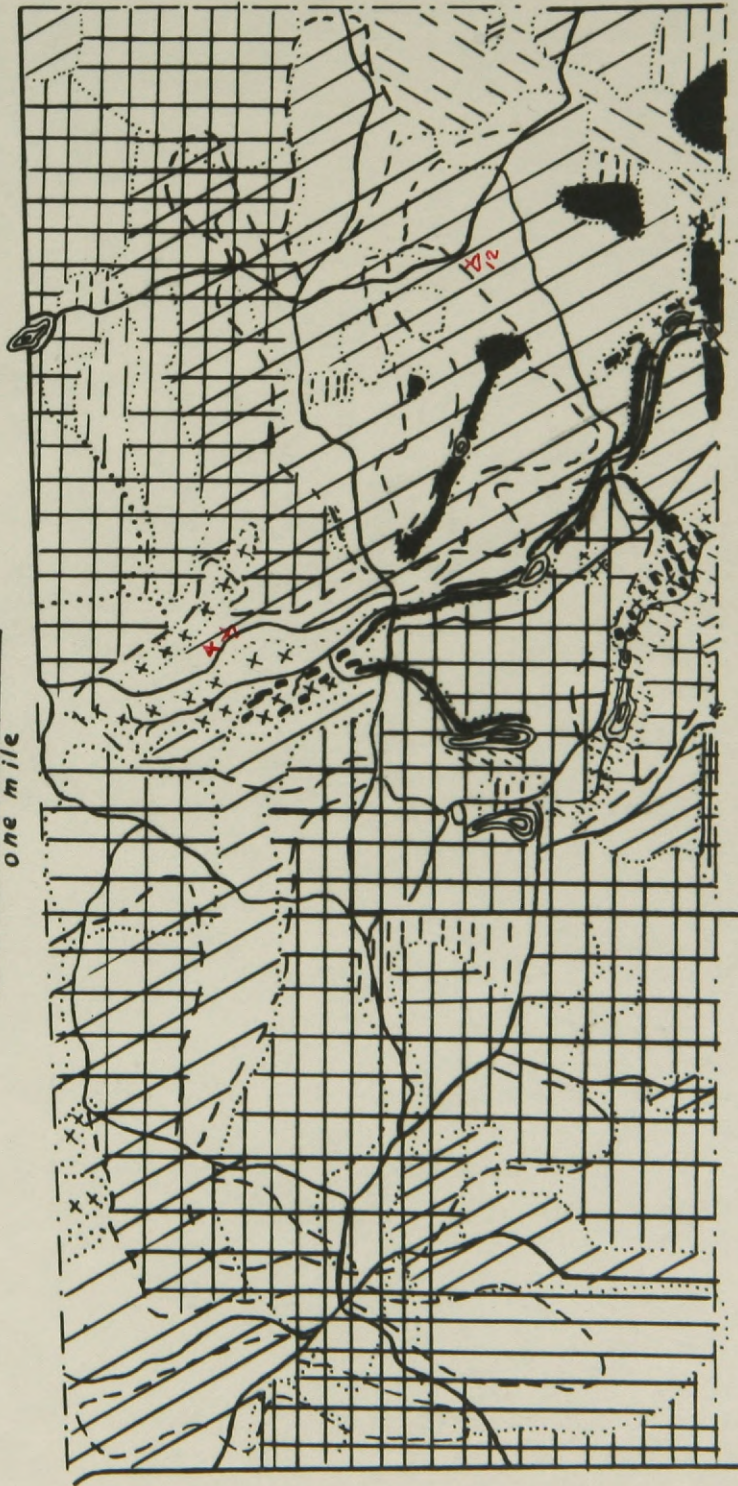


Swamp hardwood ●● Beech \\ Brush ■  
 Cedar // Pasture || Aspen †  
 Tamarack # Cultivated == Upland hardwood ○○

CHELSEA GAME REFUGE  
 SEC. 31, T.2S, R.4E.  
 WASHTENAW CO.

MICHIGAN  
  
  
 5 schains

GLADWIN GAME REFUGE  
GLADWIN COUNTY  
MICHIGAN



- |                 |    |           |       |
|-----------------|----|-----------|-------|
| Upland hardwood |    | Gross     | ==    |
| cedar           |    | Brush     | ■     |
| Other conifers  | XX | Fire lane | - - - |
| Oak             | #  | Road      | —     |
| Poplar          | \\ | Boundary  | - · - |

H. L. Wilson '47

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