CARRYING CAPACITY OF SOUTHERN MICHIGAN GAME RANGE

The term "carrying capacity" was employed by Errington to indicate the maximum number of quail that could come through the winter on a given area in a year offering optimum weather and other conditions. For present purposes this term will not be used in its specific sense. The game administrator must of necessity concern himself with large areas and average conditions. Moreover, not all of our figures on southern Michigan game are for the winter season. Some are not population figures at all, but kill records that indicate the relative productivity of different types of range. All of these must be used, even though data for every area can not be reduced to the same terms.

None of our three most important farm-game species was plentiful in Michigan under primitive conditions. The pheasant, of course, was not here at all. The rabbit and fox squirrel were restricted to the vicinity of the small prairies in the southwestern portion of the state. With the clearing of the land these two mammals spread out over the entire southern peninsula. But they are still found in abundance only in the lower third, a range which coincides with our most productive agricultural area.

Glaciation in Michigan left a complex pattern of soils, which vary greatly in their agricultural productivity. They vary similarly for game.

Good farming areas generally yield large crops of pheasants. Marginal farmlands are Michigan's best cottontail habitat. Rabbits are not found in abundance either in land so good that it is intensively farmed nor in land so poor that it is not farmed at all. Fox squirrels are produced wherever there is upland woods, which makes them of particular importance as game in submarginal lands where agriculture is unprofitable and where oaks have "taken over".

Other things being equal, a fertile soil will probably produce more of any of these species. We believe that this accounts, in part, for the abundance of game which undoubtedly existed half a century ago when what is now our best farmland was only partially cleared. It has since been cleared so completely and is so intensively cultivated that animals such as the rabbit, quail, and squirrel, which need brush or woodland, can no longer exist in large numbers. Thus, due to the activities of man, the native productivity of various units of range is not the same as their actual productivity under present conditions.

This discussion will deal with four sample areas which have been studied by the Game Division during the past five years. These tracts differ widely in their soil and cover conditions and serve to illustrate some of the principles just outlined. They will be treated in the order of their fertility,

the poorest soil first.

Swan Creek Wildlife Experiment Station (Allegan County)

The Swan Creek Wildlife Experiment Station comprises approximately 5,000 acres, of which roughly two-thirds is second-growth oak woods interspersed with abandoned fields. The remainder is represented by the Kalamazoo River bottom. The oak upland is largely Plainfield sand, a fifth-class soil too poor for subsistence farming. It supports black and white oak, and a remnant of white pine, but not the hickory that is found in farmland woodlots.

The sandy upland in this tract does not support pheasants at all. A few are found where agricultural areas adjoin the woodland, but these can not properly be credited to the "sand plains".

In a two-year study completed in 1940, this area was also found to be poor rabbit habitat. The spring population in 1938 and 1939 on 960 acres averaged 36.7 cottontails per section, or one per 17.4 acres. Fall numbers were not even double this, being 56.1 animals per section, or one per 11.4 acres. The weak point in the yearly schedule of the rabbits on this area came in the breeding season. The failure of a large number of young to survive to fall is apparently what determines the low population. As the oak woods is

open in character, and the fields support anything but a lush vegetation, an evaluation of the habitat indicates a lack of ground cover and consequent high susceptibility of young rabbits to predation. These animals were found most numerous in young coppice growth, and a system of rotation cutting, leaving brush heaps, is now being tried as a means of increasing the carrying capacity of this type of land.

The second-growth oak of the Allegan area appears to have a lower carrying capacity for fox squirrels than typical oak-hickory woodland. In 1938 the investigations at the experiment station showed a fall population of approximately a fox squirrel per three acres. There was an increase in 1939 to about a squirrel per two acres, which may or may not have been due in part to a state-wide closed season which was in effect in 1938. The 1940 figures showed a further increase to about a squirrel per 1.5 acres. Black and gray squirrels, upon which there is a permanent closed season, have also been increasing conspicuously in the river bottom at the station, and this fact, with the additional 1940 increase in fox squirrels, leads us to believe that our squirrel abundance is due not so much to the closed season of 1938 as to a cyclic trend. The plentiful mast crop of 1939 may also enter in.

In summary, the sandy upland at the Swan Creek experiment station is not habitable for pheasants, it is fair cottontail range, and good fox squirrel habitat. It will be profitable to compare this status with an area of poor farmland.

Kellogg Farm (Kalamazoo County)

The Kellogg Farm is for the most part third-class farm land. It lies on an outwash plain and the most important soil is Bellefontaine sandy loam. That part of the area which was censused comprises 500 acres and includes the bird sanctuary. About 55 percent of the farm is cultivated for annual crops or hay, and 25 perdent is in permanent grassland. Approximately 18 acres, or 3.6 percent is in brush coverts, 20 acres, or 4 percent, is in plantations of conifers, 2 percent is in marsh, and 6 percent in woodlots. The remainder is occupied by Wintergreen Lake. This tract contains an abundance of natural and planted cover which is well distributed for wildlife.

Pheasants have not been hunted on the Kellogg Farm during the past ten years, and fall population figures were obtained by Game Division field men, using bird dogs, in the years 1935, 1936, 1937, and 1938. During this period the fall census averages showed that from 25 to 35 pheasants were using the tract each year. We were especially interested in pheasant populations because of

a restocking experiment that was carried out in the summer of 1933 when 300 game-farm-reared birds were liberated there. In spite of total protection from shooting the pheasant population one year following the stocking was practically the same as it was four years later. It seems reasonable to conclude that the restocking had little or no effect upon the subsequent productivity of the tract for this species. Experience has shown that the fall pheasant population of this area, totalling about 36 birds per section, is about what can be expected on some of Michigan's less fertile agricultural land.

Our intensive study of the wildlife populations of the Kellogg Farm in 1935-37 indicated that winter losses accounted for less than a third of the birds, and that, like the rabbits at Swan Creek, the low population level could be ascribed to the failure of the breeding stock to produce a large crop of young during the summer.

For rabbits the Kellogg Farm is the best area we have studied. By a box-trap-plus-hunting census in 1935 the fall population was found to be about 228 animals, of which 154 were shot. In the following year, by a different method, a population of 225 was calculated, of which the kill took 126. If these two years are reliable index, this 500-acre area supports a fall population density of near 288 rabbits per section, or one animal per 2.2 acres. It has been

clearly demonstrated that it is possible to shoot over half of the rabbits on this tract in the fall without inhibiting the productivity of the following year. Hunting has not been intensive every huhting season but seldom in the last eight years has the Kellogg Farm yielded less than 100 rabbits.

This tract has been a sanctuary for fox squirrels as well as pheasants. Thus no hunting season crop was taken, but in the winter of 1935-36 a series of 61 squirrels were handled on approximately 30 acres of woodlot. It is fairly certain that this figure includes an unknown number of non-resident animals, but the population was probably one-plus per acre at that time. The following winter squirrel numbers declined sharply, apparently due to an epidemic of mange, but there is no question that on the average this oak-hickory woodland supports a high population of fox squirrels.

Summarizing, the Kellogg Farm is poor for pheasants and good for rabbits and squirrels. Within limits it is representative of some of our poorer agricultural land.

Rose Lake Wildlife Experiment Station (Clinton County)

This tract lies on a moraine 12 miles east of the city of Lansing. Its soils are variable, ranging from first to fifth-class farmland within a

short distance. Kettle holes and marshes with brushy fringes are well distributed in the region and there are numerous small oak-hickory woodlots. Observations are available on about 2,000 acres of state and private land.

Formerly this was a fairly productive agricultural area; but destructive cropping practices have greatly reduced the fertility of most of the well-drained soils. On the station proper, which includes 1181 acres, a program of soil replenishment through liming, manuring, and long rotations has been instituted. This has greatly increased the proportion of pasture and idle land. At present approximately 39 percent of this area is cultivated, 25 percent is in pasture, 13 percent in woodlot, 13 percent in brush, and 10 percent in marsh. As various units of depleted soil are brought back into production the acreage of cultivated land will increase until about 65 percent of the area is so used.

At the Rose Lake station a system of controlled hunting is used by which the kill on 2,055 acres was obtained in 1939 and on 1,525 acres in 1940. An 800-acre census block was driven with men immediately preceding the open season in both years. Seventy-nine birds, including both sexes, were flushed each year. However, field work during summer and fall of 1940 indicated that the birds were slightly more plentiful than in the year before. This did not

show up in the census apparently because of the heavier upland cover resulting from a wet season in 1940. It is true also that the increase over 1939 probably was not enough to be beyond the statistical error in the census method. For obvious reasons the man-drive is considered to be only an index of relative abundance from year to year rather than a total count.

Figure I shows the relationship of the census, kill, and hunting pressure figures for the two years. For all practical purposes the pheasant population was much the same in the two fall seasons. The kill also was similar, although slightly lower in 1940. But the hunting pressure was roughly three-fourths again as great in 1940 as in 1939. This was due to increased publicity and the fact that no hunters were turned away.

It appears that we have here a case of "diminishing returns" in the presence of excessively heavy hunting. The 176 hours of hunting per hundred acres in 1940 took approximately the same number of birds that 99 hours took in 1939 even though populations were very comparable. Difficulty has been experienced in getting good sex ratios, but if we presume that four out of five cocks were killed, the pre-season population of pheasants was about 156 birds per section. This is about four times the population of the Kellogg Farm.

In spite of apparently good cover conditions, rabbits were not numerous

Fig.I - Relationship of the pheasant kill, hunting pressure, and pre-season census figures at the Rose Lake Wildlife Experiment Station.

at Rose Lake in the years immediately preceding 1940. In 1939 the hunting season yield was 38.5 rabbits per section, or 1 per 16.6 acres. In 1940 a conspicuous increase occurred in the numbers of this species. The kill totals showed a harvest of 96.9 rabbits per section, or one per 6.6 acres. These are kill records, and good figures are not available for the actual populations on the tract. The important point is that some factor other than the physical nature of the habitat was keeping rabbit populations down. There were reports in this vicinity of rabbits being found dead in their forms. One such animal was autopsied by our pathologist but with negative results. The past and present conditions at Rose Lake remind us that even our best efforts in the field of habitat improvement are not going to guarantee a uniformly high population of game animals. We have hardly begun to understand, let alone control, cyclic fluctuations in numbers.

As was previously pointed out the upland woods on this area differs from the Allegan oak woods in that it contains hickory. It resembles the Kellogg Farm woods but contains more shagbark and less bitternut hickory.

In the 1939 open season 48 fox squirrels were killed on 84 acres of woodlot, or a yield of 57 animals per 100 acres of woods. In 1940 the kill was 39 squirrels on 102 acres, or a decline of about 19. It is known that at

least one of the woodlots was overshot and practically depopulated in 1939. It was repopulated again during 1940, but perhaps not completely so. Box trapping showed the spring population in 1940 to be about 43 adult squirrels per hundred acres; and the fall number was slightly more than one animal per acre. In the year before, the population was probably nearer two to the acre, although good figures were not obtained.

In connection with the Rose Lake program figures were secured on three Michigan State College woodlots in the fall of 1940. These approach the beech-maple climax type, although they are not typical. One was subjected to limited hunting and two have been permanent sanctuaries. Fall censuses with box traps indicated a fox squirrel population ofone animal per 1 to 2 acres. These woodlots have populations comparing favorably with oak-hickory woodland, although due to a lack of hunting the figures are not too significant.

Summing up, the Rose Lake tract is a better farming area than the Kellogg Farm. It supports much better pheasant populations; it is fair for rabbits and this species is on the increasel Squirrel humbers are similar to those at the Kellogg Farm but higher than those at Allegan.

Prairie Farm (Saginaw County)

In Saginaw County work has been done on an 6400-acre area of low lake-bed clay. The tract has been diked and ditched, and water is kept down by a pumping station. Formerly this area was a cattail marsh and there is a shallow overlay of muck in places. It is all first-class farmland. The Prairie Farm is owned by the Farm Security Administration who have cooperated in obtaining kill records since 1937. A Pittman-Robertson study of the pheasant has been in progress there for two years.

This region is much more fertile for agriculture than any so far discussed. The principle crops are sugar beets, corn, and beans. Fallow fields and ditch banks support a vigorous growth of giant ragweed, sunflower, and other herbs which provide ample summer and winter cover. In addition there two large units of willow and aspen brush that is progressively being cleared. The woods type is principally soft maple with local mixtures of elm, ash, and basswood.

Approximately 70 percent of this area is now in agricultural production. About 11 percent is in light brush or fallow fields. Dikes and canals constitute 6 percant, woodlots 7 percent, and heavy brush 5 percent. Only about one percent is pastured.

The Prairie Farm was lightly hunted in 1937 and only 616 cock pheasants

Due to subsequent publicity it has been heavily hunted, under a controlled hunting system, for the past three years. Under these conditions we have obtained a much better idea of the true productivity of the tract for pheasants. Table I gives the hunting pressure, in terms of gun hours, and the kill for each year from 1937 to 1940.

Table I
Pheasant kill at the Praire Farm, Saginaw County, Michigan

Year	Total Kill	Kill per Section	Total Gun-hours	Gun-hours per section
1937	616	47	8,168	622.3
1938	1,244	94	14,068	1,071.4
1939	1,318	101	21,481	1,636.6
1940	1,058	81	14,999	1,142.8

It is to be noted that although hunting pressure rose sharply in 1939, being half-again as much as in 1938, the kill increased only seven pheasants per square mile. This suggests that beyond a certain point the hunting on this area was "excess" in that it is not rewarded by additional birds killed. This is the same principle that was even more graphically illustrated for the Rose Lake station. It appears that the amount of hunting on the Prairie Farm in 1938 and 1940 was about that necessary to harvest the crop of birds, and the productivity of the area can be said to be 90 to 100 cock birds per square mile.

Due to differential activity between cocks and hens good sex ratios have not been obtained on this unit of range. But if four-fifths of the cocks were shot, which seems within reason, the fall population numbered somewhere near 350 cocks and hens to the section. Compared with the Kellogg Farm figure of 38 it gives a fairly good measure of the difference between good and poor pheasant habitat.

An additional point of interest in connection with the Prairie Farm study was a reduction of cover which occurred from 1938 to 1939. Due to the breaking of fallow ground and the clearing of brush, more than half of the best "escape" cover on the farm was eliminated in one year. The fact that this was not reflected in any radical fluctuation in the kill suggests that cover has not yet been reduced below what the present pheasant population needs. Heavy brush now occupies about 5 percent of the tract.

The Prairie farm has shown a poor productivity of rabbits and fox squirrels. In 1939 a total of 329 rabbits, or 25.1 per section, were killed. In 1940 only 249, or 18.9 per section, were taken. This can be contrasted with the Kellogg Farm production of 197 rabbits to the quare mile in 1936.

The woodlots and the fringe of trees along the river and dikes yielded a hunting-season crop of 32 fox squirrels in 1939 and 34 in 1940. This reflects

both the small amount of woods and the low productivity of what is there. Due to its scattered character the fox squirrel habitat can not easily be measured in acres.

Summary and Conclusions

Native fertility and recent use by man cause a wide variation in the game productivity of southern Michigan lands. A study of four sample areas shows that the numbers of pheasants, rabbits, and fox squirrels are consistently correlated with agricultural types.

At the Swan Creek Wildlife Experiment Station in Allegan County a sandy upland too poor for subsistence farming was found to support no pheasants and a fall population of 56 rabbits per section. In the black and white oak woods of the tract fox squirrds have increased from 1 per 3 acres to near 1 per 1.5 acres in the past three years.

The Kellogg Farm in Kalamazoo County is a tract of marginal farmland. It supports a small pheasant population, approximately 36 birds per section in the fall, and a high fox squirrel population, numbering one-plus per acre of oak-hickory woodlot. It is the best tract studied for rabbits. An abundance of well-distributed natural brush and artificially-planted conifers apparently enable the tract to support a fall rabbit population of near 288 per square mile. A hunting-season crop of 197 to the square mile has been taken without impairing subsequent

production.

The Rose Lake Wildlife Experiment Station is an area of morainic farmland better, in agricultural status, than the Kellogg Farm. This area supports a fall pheasant population of approximately 156 birds per section and yields a kill of about 69 cocks for the same unit. Rabbits have been increasing on the tract and reached a production of 97 animals per square mile in 1940. Fox squirrels are plentiful in the oak-hickory woodlots, with one-plus per acre in the fall. The hunting season yield was more than one per 2 acres in 1939.

The Prairie farm in Saginaw County is a tract of fertile lake-bed soil. It has a fall pheasant population of near 350 pheasants to the section and yields 90 to 100 cocks. There is little brush cover and only about 25 rabbits per section have been shot. A small amount of bottomland woods has produced but few fox squirrels.

From these studies it appears that the intensive agricultural use of the land does not particularly bother the pheasant, but that such use removes the brush and woodland required by rabbits and squirrels respectively. Marginal farmland, with waste areas containing brush, is Michigan's best rabbit range. These areas also support oak-hickory woodland which is probably the state's most productive fox squirrelhabitat, but pheasant production is usually low. Sub-

marginal lands too poor for agriculture usually are occupied by black and white oaks. This is a fair to good habitat for fox squirrels, but poor for rabbits. Such range often supports no pheasants at all.

HDR:rmb
2-13-41