A THOUSAND MILES OF FOX TRAILS IN MICHIGAN'S RUFFED GROUSE RANGE[1]

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The tracking technique has been used by several investigators for the study of the larger predatory animals. Stebler (1939) says: "Stated simply, the method consists of following the trails left by these mammals and interpreting from the clues they may leave, their activities and behavior." Murie (1936) notes: "It is practically equivalent to observing an animal for a long period of time under natural conditions."

The method has been used rather extensively by biologists of the Michigan Department of Conservation to study the winter habits of wolves (*Canis lupus*), coyotes (*Canis latrans*), bobcats (*Lynx rufus*), and red foxes (*Vulpes fulva*). Our weather usually solves the most serious limitation of the technique by providing suitable tracking snow from late November to early April.

Arnold (1956) trailed foxes to determine their winter food habits in the agricultural areas of southern Michigan, the principal pheasant range of the state. His study involved following fox trails a thousand miles. We conducted the present study primarily to determine the effects of red foxes on ruffed grouse (*Bonasa umbellus*) during the winter in the northern "wild land" portion of the state. Field work began in the fall of 1955 and continued for three winters.

The areas selected for study were in the northern half of the Lower Peninsula. A large share of the work was done on the Gladwin Field Trial Area (8 square miles) and the Rifle River Area (7 square miles). Both are state-owned and were used by Palmer (1956) for his survey of grouse on hunted and unhunted areas. His work continued during this study, providing needed population data on ruffed grouse.

Cover types at Gladwin and Rifle River are typical of most of the Lower Peninsula's ruffed grouse range (Schofield, 1960).

METHODS

Our procedure in tracking foxes varied little from those of Arnold (1956). We followed trails in the snow and recorded fox habits, kills, food eaten, and cover type preferences. At the completion of each day afield these observations were entered on standard tracking record forms. We measured distances by counting paces with pocket "tally-whackers" (Veedor counters).

Early in the study it became apparent that white-tailed deer (*Odocoileus virginianus*), shot and left in the woods during the November hunting season, were the primary winter food of foxes on the study areas. An attempt was made to measure this waste of deer and to determine the amount of venison available to foxes (Schofield, 1960).

RESULTS

Food Habits

Deer shot and wasted by hunters during the November deer season made up the bulk of the winter food of foxes on the areas studied. Mice (*Microtus* and *Peromyscus*) and shrews (mostly *Blarina brevicauda*), porcupines (*Erethizon dorsatum*), and cottontail rabbits (*Sylvilagus floridanus*) were prominent food items. Table 1 presents a summary of the fresh kills and other items located along 1,109 miles of fox trails in the ruffed grouse range during three winters (December 1955 to April 1958). On the average, foxes visited one deer carcass for each 5.5 miles of trail. Early in the winter, viscera from field-dressed deer were important food. Porcupines noted frequently along the trail were probably shot by hunters.

Evidence of fox predation on game species was negligible. Five cottontails, two bobwhites, and one snowshoe hare were the only game *killed* by the foxes we followed. None of the 19 dead grouse found along the trails were killed by the foxes while they were making the more than a thousand miles of trails we followed. We were sure from the available evidence that hawks or owls killed at least four of the birds. Of course, some of the others might have been killed earlier by foxes.

Foxes spent a lot of time hunting mice and shrews, but we had difficulty in determining their success. Often just a drop of blood on the snow would be the only evidence indicating a kill. In Table 1, these small mammals are lumped together because of the impossibility of distinguishing whether a mouse or a shrew had been taken. We collected fox scats along the trails to obtain further information on the importance of these animals in the winter diet. By analyzing this material, it was possible to identify remains of mice and shrews much more easily than by visual inspection of the fox trail. Results of the scat ana-

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TABLE 1.—FRESH KILLS AND OTHER ITEMS LOCATED ALONG 1,109 MILES OF FOX TRAILS

Item	Fresh Kills	Fox Visits
MAMMALS		
White-tailed deer (*Odocoileus virginianus*)		203
Mice and shrews[1]	123	57
Porcupine (*Erethizon dorsatum*)		43
Cottontail rabbit (*Sylvilagus floridanus*)	5	25
Mole (*Scalopus* sp. and *Condylura* sp.)	5	8
Raccoon (*Procyon lotor*)		6
Skunk (*Mephitis mephitis*)		6
Snowshoe hare (*Lepus americanus*)	1	5
Black squirrel (*Sciurus carolinensis*)		5
Muskrat (*Ondatra zibethica*)		4
Fox squirrel (*Sciurus niger*)		3
Red squirrel (*Tamiasciurus hudsonicus*)		2
Weasel (*Mustela* sp.)		2
Mink (*Mustela vison*)		2
Red fox (*Vulpes fulva*)		2
Cow (*Bos taurus*)		1
Woodchuck (*Marmota monax*)		1
Unknown mammal		9
BIRDS		
Ruffed grouse (*Bonasa umbellus*)		19
Blue jay (*Cyanocitta cristata*)		3
Bob-white quail (*Colinus virginianus*)	2	1
Hawk (*Buteo* sp.)		2
Mourning dove (*Zenaidura macroura*)		1
Domestic chicken (*Gallus gallus*)		1
Canada goose (*Branta canadensis*)		1
Woodcock (*Philohela minor*)		1
Unknown bird		1
MISCELLANEOUS		
Deer entrails		121
Fish (Pisces)		2
Frog (*Rana* sp.)		2
Ruffed grouse eggs		1
Garter snake (*Thamnophis sirtalis*)		1
Painted turtle (*Chrysemys cinerea*)		1

[1] Most of the shrews were *Blarina brevicauda* and most of the mice belonged to the genera *Microtus* and *Peromyscus*.

lysis revealed deer, mice, and rabbits as the most important winter foods (Table 2).

Food Availability

Food habits studies are not complete without some consideration of the availability of the food. During this study, ruffed grouse and snowshoe hares were near the bottom of their 10-year cycles. Yet, fresh grouse sign occurred along 67 percent of the fox trails followed. Biologists tracking foxes flushed 223 ruffed grouse, 1 bird per 5 miles walked. Snowshoe hare tracks occurred along 55 percent of the fox trails and cottontail sign along 39 percent.

Biologists from the Houghton Lake Wildlife Experiment Station conducted intensive ruffed grouse censuses on the Rifle River and Gladwin areas. They computed early fall, December, and spring populations for a square-mile unit on each area. For the purposes of this study, I averaged their December and spring population figures to get an estimate of the winter density of birds on each area. These calculations indicated that there was a winter population of two to four birds per 100 acres on the study units during the three winters we tracked foxes. Earlier censuses by Palmer (1956) indicated that grouse numbers declined considerably from the "high" years of the cycle—1950, 1951, and 1952. During these years his censuses showed winter grouse populations of 5 to 10 birds per 100 acres for the study units.

Biologists assigned to the Rifle River and Gladwin areas during the deer seasons of 1956 and 1957 located and marked 41 illegally shot deer. Fox trackers later located 27 of these marked deer and 34 additional unmarked carcasses. Lincoln-index calculations indicate an annual waste of slightly over four deer per square mile on the two study areas.

Antlerless deer in this part of Michigan probably averaged about 100 pounds live weight, providing foxes with over 400 pounds of potential food per section. Foxes in this part of the state have practically no competition from other scavengers during the winter. Consequently, this amount of venison will support a high fox population during this critical period.

Daily Range of Foxes Trailed

Scott (1943) estimated from his observations "that an arc drawn on a one-mile radius would or-

TABLE 2.—FREQUENCY OF FOOD ITEMS IN 138 RED FOX SCATS FROM WINTER PERIODS, 1955–57

Food Item	Percent Occurrence
MAMMALS	
White-tailed deer (*Odocoileus virginianus*)	68.1
Cottontail (*Sylvilagus floridanus*)	23.2
Meadow vole (*Microtus pennsylvanicus*)	21.7
Deer mouse (*Peromyscus* sp.)	18.8
Porcupine (*Erethizon dorsatum*)	8.0
Shrew (*Blarina brevicauda*)	7.2
Muskrat (*Ondatra zibethica*)	6.5
Skunk (*Mephitis mephitis*)	3.6
Snowshoe hare (*Lepus americanus*)	2.9
Flying squirrel (*Glaucomys* sp.)	2.2
Prairie mole (*Scalopus aquaticus*)	2.2
Cow (*Bos taurus*)	2.2
Black squirrel (*Sciurus carolinensis*)	1.4
Red-backed vole (*Clethrionomys gapperi*)	0.7
Pine vole (*Pitymys pinetorum*)	0.7
Weasel (*Mustela* sp.)	0.7
Striped ground squirrel (*Citellus tridecemlineatus*)	0.7
Unknown mammals	8.0
BIRDS	
Ruffed grouse (*Bonasa umbellus*)	3.6
Unknown birds	8.7
MISCELLANEOUS	
Vegetation	31.9
Traces of fox hair	2.9
Unknown material	5.8

TABLE 3.—COMPARISON OF COVER TYPE PREFERENCES OF RED FOXES IN WINTER WITH COVER TYPES AVAILABLE

Type	Gladwin Field Trial Area		Rifle River Area	
	Percent of Fox Trails in Type	Percent of Area in Type	Percent of Fox Trails in Type	Percent of Area in Type
Aspen	40.4	35.4	36.6	41.5
Oak	39.1	40.9	9.9	2.0
White birch	1.7	7.2	1.0	tr.
Open	8.0	6.4	12.4	13.6
Conifer swamp	3.7	6.3	8.7	6.9
Marsh (old beaver floodings)	0.4	1.8	4.4	5.6
Lowland brush	3.8	0.4	15.8	9.0
Lakes and rivers	2.0	0.9	8.8	8.0
Swamp hardwoods	0.9	0.7	2.2	13.2
Pine	tr.	tr.	0.2	0.2

dinarily circumscribe the movements of the resident individual, pair, or family" of foxes in Iowa. As it was not possible to follow day-to-day movements of individual foxes in our study, we attempted to determine daily range from the trailing data. A total of 84 foxes were jumped from their daytime beds. The average distance traveled from the point of interception of the fox trail to its bed was 3.64 miles. The straight-line distance from the point of interception to the fox bed averaged almost 1 mile (.94).

Arnold and Schofield (1956) calculated the nightly hunting range of the red fox in the southern agricultural area of the state to be 1.4 square miles. This was based on the assumption that the observer, on the average, intercepts a fox trail at the midpoint and the average distance from the point of interception to where the fox was jumped should approximate the radius of a circle equal in size to the area over which the fox hunts in one hunting period.

Whether this assumption is true is not known, but it does offer a method for comparing daily movements of foxes between the two areas. As the average straight-line distance from the point of interception of the fox trail to the fox bed was calculated as .94 mile in the north, the nightly hunting area of foxes there would be 2.8 square miles, twice as large as the area hunted nightly by southern Michigan foxes.

Cover Type Preference of Foxes Trailed

Scott (1943) attempted to determine the fox's relationship to different cover types by counting paces taken along trails in each type. Because of the difficulty in following an individual fox, the method did not prove productive in Iowa. We had fairly good success staying on individual fox trails and we carefully recorded distances traveled in each cover type (Table 3). Foxes that were followed seemed to have shown a slight preference for lowland brush on both the Gladwin and Rifle River areas and to have hunted in the oak type a little more than expected at Rifle River. Conversely, white birch, marsh, and conifer swamp types were avoided at Gladwin as was the swamp hardwood type at Rifle River. It is recognized that some bias was introduced by the trailing habits of fox trackers. For example, there was a distinct reluctance for biologists to follow fox trails across the ice on beaver floodings.

SUMMARY

Biologists trailed red foxes 1,109 miles in Michigan's ruffed grouse range. Predation on game was negligible. The primary winter food of foxes was illegally killed deer, left from the fall hunting season, amounting to slightly over 4 deer per square mile and providing foxes with about 400 pounds of food per section. Foxes still hunted mice extensively.

Foxes in the northern half of the Lower Peninsula hunted about 2.8 square miles nightly and apparently ranged farther than southern Michigan foxes. The northern foxes showed a slight tendency to prefer lowland brush areas.

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