SOCIAL ORGANIZATION OF THE WESTERN FOX SQUIRREL

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ABSTRACT

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THE WESTERN FOX SQUIRREL

By

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During a two-year study of a discrete wild population of fox squirrels, the existence of an intricate and stable hierarchal form of social structure was documented. Animals were ranked by both the percentile and tabular method of hierarchy delineation, based on interactions obtained at an artificial feeder during consecutive winters. The hierarchy was a straight line mixed sex arrangement with males generally more dominant than females. Hierarchal status advanced with increased age. Extent of minimum home range did not increase with social rank. It was concluded that where food and shelter are adequate, spatial requirements would not limit population numbers.

Inventories of two discrete populations of fox squirrels were made by trapping at a single central feeder during the time of winter food scarcity. Population estimates based on a seven day trapping period at the feeder compared favorably with the actual woodlot squirrel populations.

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PART I

SOCIAL ORGANIZATION OF

THE WESTERN FOX SQUIRREL

SOCIAL ORGANIZATION OF THE WESTERN FOX SQUIRREL

The behavioral aspects of wildlife management have received increased attention and application in recent years. Of particular interest and importance are the conspecific interactions between individual animals and their relationship to the surrounding environment. The usual consequence of social interaction or aggression is the formation of intraspecific territories or social hierarchies (Davis 1964, Fisler 1969). Bakken (1952), Flyger (1955), and Pack et al. (1967), in their studies of gray squirrels, concluded that this animal demonstrates dominance behavior that results in the formation of social hierarchies. Allen (1943) concluded that fox squirrels were probably not territorial to any extent and recommended that more research be done on the social behavior of the animal.

While involved in a population study by live-trapping fox squirrels (Sciurus niger), the author observed a significant overlap of individual home ranges as well as aggressive behavior among individuals. This behavior suggested that the species maintains a social system similar to that of gray squirrels (Sciurus carolinensis), rather than a strong territorial form of behavior like that of red squirrels (Tamiasciurus spp.) (Smith 1968). Research was initiated to test the hypothesis that fox squirrels probably have a social system similar to that of gray squirrels.

Allen (1943) recognized the necessity of knowing to what extent an animal is (or is not) territorial in habit and what, if any,

restrictions this might impose on populations and hunting season productivity. Stokes and Balph (1965) describe the intimate association that animal behavior has with population ecology and management of the animal and its habitat. They state that an understanding of behavior is needed to determine how social interactions within the population in turn affect the animals' ability to reproduce and survive either directly or through changes in their physiology.

The author wishes to thank J. Kessel and W. Schmidt for their assistance in making observations. Special thanks is accorded to L. W. Gysel, who while providing guidance and support allowed freedom to pursue those aspects of the study which seemed most significant.

STUDY AREA

The research was conducted in Hudson Woodlot, an 18-acre woodland on the farm property of Michigan State University, where hunting is prohibited. The study area is a closed, mature, all-aged beech-maple stand with only a very small number of other species present. The largest trees attain a D.B.H. of 30 inches and provide an abundance of den sites. Only 10 acres were considered to be fair squirrel habitat, since the southern 8 acres of the woodlot consist largely of pole-size trees which are less frequently used by squirrels. Along the north and west boundaries of the stand is cropland usually planted to field corn, while the open areas near the southern and eastern boundaries are used as pasturage. The distance to the nearest woodlot exceeds ¼-mile in any direction, and the squirrel population was considered to be discrete.

The woodlot is only fair squirrel habitat, since there is a paucity of mast-producing trees, with the exception of the sporadically producing American beech (Fagus grandifolia) (Gysel 1971). Here, as in much of southern Michigan, wintering squirrel populations may in many instances be dependent on waste corn left by the fall harvesting operations (Allen 1943).

METHODS

Trapping activities began in January of 1971 and continued until May of 1972. The observation periods each year were January through April, the time when food was relatively scarce and animals would readily come to an artificial source of food. Mean temperature for the January to May period in southern Michigan is 27.0° F during an average winter.

An artificial feeder (Sharp 1958), constructed with chicken wire and filled with ear corn, was used to concentrate squirrels both for trapping purposes and to increase the possibility of social interactions (Fig. 1). The feeder was placed in the woodlot in December of 1970 and left there until the study was complete in April of 1972. The feeder, which held a bushel of ear corn, was hung 6 feet high on the bole of a large maple tree. Selection of the tree was based upon two criteria: It was located in the center of the best squirrel habitat on a tree with a large crown intertwined with other nearby trees, allowing arrivals or departures via this route if the animals so desired. After a period of one month most squirrels in the woodlot were visiting the feeder. Six live-traps were placed in a semicircle at the base of the

Figure 1. A basket feeder filled with corn was used to draw squirrels both for trapping purposes and behavioral observations.

feeder and were prebaited for 2 weeks prior to trapping -- a method described by Sharp (1958). The traps were of a collapsible metal (wire) variety which measured 9 x 9 x 24 inches. Success was extraordinary, and nearly all of the population was captured in 7 trap-days. (Later observations disclosed one unmarked animal identified by her characteristic pelage. This animal, dubbed Nancy, was captured later after behavioral observations were complete and trapping resumed.) As a result of the trapping in 1971, nearly all the population had been captured and marked when behavioral observations resumed in January of 1972.

Trapped animals were sexed, weighed and aged where possible according to techniques described by Allen (1943). As Allen noted, however, aging live fox squirrels is not always a clear-cut proposition, so not all animals could be clearly separated as juvenile or adult particularly during the winter. Age determinations of adults were speculative and were assigned as 1.5+. In 1972, after year-long trapping activity, ages were known for a greater proportion of the animals, although the rapid turnover of squirrels kept the age of some a well-guarded secret.

A numbered aluminum tag was placed in each ear in the fashion described by Sharp (1958), and each animal was dyed in a characteristic pattern using Nyanzol A (Fitzwater 1943). Females were given black tail tips, and all animals were named to facilitate recording of data and subsequent reference. The markings proved indelible and quite conspicuous, staining the fur a purple-black hue that persisted until the spring-summer moult. Laboratory work on animals was greatly simplified by use of the anesthetic metofane

(methoxyflurane), a relatively non-volatile compound widely used by veterinarians for small animal surgery. Metofane, an anesthetic with a wide safety range between anesthetic and toxic levels, has been used with favorable results by other investigators (V. F. Flyger, personal comm.).

Most observations were made from a blind constructed in a down treetop 130 feet from the feeder tree. A spotting scope magnified the animals when necessary to verify their markings. Later a tent blind was erected only 20 feet from the feeder in order to document social interactions on film.

Grid trapping operations were begun in April of 1971 and were designed to unearth data on squirrel movements and home range. In August of 1971, four additional feeders were placed in the woodlot and trapping continued to further establish home range parameters. Observation of squirrels immediately following release gave no indication of den tree locations. Most animals seemed confused and distressed, and did not move toward the same tree or even in the same cardinal direction as in previous releases. Animals took refuge in the nearest tree in some cases.

Social interactions were based upon aggressive activity around the feeder. An individual was judged to be dominant if it displaced a squirrel already at the feeder or if it failed to be evicted by the interloper. If the newcomer was dominant, it was credited with winning the interaction. At times aggressive behavior was observed among squirrels on the ground below the feeder.

Pack et al. (1967) and Ozoga (1972) utilized both the tabular method of hierarchal arrangement illustrated by Davis (1964) and

the percentile rank formula employed by Komai et al. (1959) in arranging their peck order data. Application of the percentile rank formula of Komai et al. (1959) required that each animal listed interact with at least five other animals in order to be ranked. (Of 12 animals trapped and marked in 1971, 10 satisfied these requirements, while 13 out of 21 animals marked could be ranked by this method in 1972. The higher the rank of a squirrel, the lower the ranking number, e.g., the highest ranking squirrel would be number one.) Both populations were also ranked by the tabular method.

An attempt was made to measure the association, if any, of home range with hierarchal rank. Home range determinations were made using the "minimum home range" method described by Mohr (1947), for squirrels that had been trapped or seen in more than five locations.

The Spearman rank correlation (Seigel 1956) was used to determine the degree of association between the tabular method and the percentile rank method of hierarchy determination, and also to measure the relationship of rank to age and home range.

Since weather conditions have been documented as a controlling influence on fox squirrel activity (Hicks 1942), an effort was made in this study to correlate squirrel activity with weather and social rank.

RESULTS

General Behavior:

Squirrels came to the feeder freely, and if uncontested most animals hung by their hind feet or sat on top of the feeder while eating kernels of corn removed with forepaws or jaws. Characteristically,

the germ portion of the kernel was eaten, the remainder dropped to waiting birds or other hungry squirrels on the ground. The dominant animal nearly always assumed and maintained a position on the feeder and did not allow other animals access while he was in possession (Fig. 2). On the ground, however, aggressive activity was displayed less frequently, and as many as three or four animals might feed peaceably all in close proximity to one another (Fig. 3). A squirrel feeding on the tree seemed to enjoy relative security as well as abundant food. Though apparently completely engrossed in feeding, a slight movement from the blind would often frighten a squirrel from the tree. This position gave the dominant squirrel a decided advantage over his counterparts on the ground; although they were vigilant, it was the squirrel on the tree which always took alarm first. The response to an alarm stimulus was usually immediate departure without tail flicking or barking. When the dominant departed, the animals on the ground would then jump to the tree to try to identify the source of alarm.

Although these animals were not hunted, they were exposed to normal predation, since the red fox (Vulpes fulva), red-tailed hawk (Buteo jamaicensis) and great-horned owl (Bubo virginianus) were common in and around the woodlot. Presence of these predators might account for the extreme wariness among squirrels which made observations difficult. Some squirrels would flee when an observer approached within 150 yards of the feeder. One squirrel was killed by a great-horned owl in mid-morning, and another was found dead near a fox den in the woodlot.

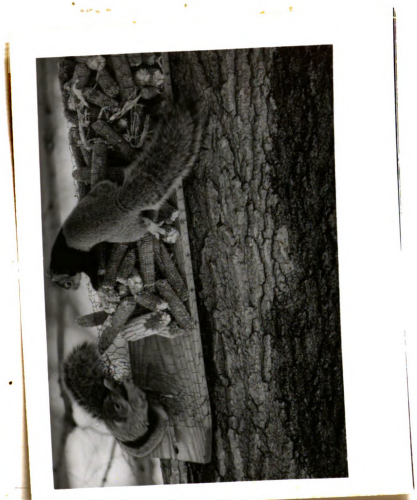

Figure 2. Bob (top) initiates an aggressive threat and displaces the subdominant Oscar from his position on the feeder.

Figure 3. Dominants were intolerant of other squirrels on the feeder tree, however on the ground they usually fed together peaceably.

Social Behavior:

Based on interactions, a social hierarchy was determined by ranking most animals who came to the feeder. Of 12 animals marked in 1971, 10 were ranked on the basis of 72 interactions made during 135 hours of observation. In 1972, 13 out of 21 marked were ranked, on the basis of 198 interactions during 101 hours of observation. The hierarchies were straight-line arrangements involving both sexes, similar to those discovered by Flyger (1955) and Pack et al. (1967) for gray squirrels. The data are arranged by the tabular method in Tables 1 and 3, and by the percentile method in Tables 2 and 4. In the 72 interactions of 1971, there were no reversals, so apparently the hierarchy was very stable and had been well established when observations began. During 1972 two reversals were noted between Howard and Simone, two squirrels adjacent to one another on the hierarchy. These reversals did not necessarily reflect a change in rank, however, for Howard later restored himself to his usual dominant position. The correlation coefficient between the percentile and tabular methods was .95 for 1971 and 1.00 for 1972, the first of which is highly significant at the 1 percent level, the second a perfect correlation.

Trap Response:

Sharp (1958) noted that the dominance hierarchy of gray squirrels could be used to advantage when employing an artificial feeder for trapping purposes. He stated that a dominant squirrel may never get caught in a trap, for it remains on the feeder and few animals (or none) can drive it from this position. During the 7-day trapping

Table 1. Social hierarchy of 10 fox squirrels ranked by the linear method, Hudson Woodlot, Michigan State University, 1971.

INDIVIDUAL SQUIRREL (X)					FREQUENCY OF VICTORIES BY INDIVIDUAL (X)									INTERACTIONS WON
Social Rank	Name	Tag No.	Sex	Age	Bob	Gene	Oscar	Irene	George	Nancy	Niles	Kathy	Tom	Sonya	
1	Bob	11	M	A		2	6	3	1	1	2	3	3	2	23
2	Gene	9	M	A			1	3	2	---	3	5	1	2	17
3	Oscar	989	M	A				2	---	1	2	4	---	---	9
4	Irene	7	F	J					1	---	---	4	1	2	8
5	George	8	M	A						1	---	1	---	---	2
6	Nancy	5	F	J							---	2	---	1	3
7	Niles	996	M	J								5	2	1	8
8	Kathy	995	F	J									1	---	1
9	Tom	993	M	J										1	1
10	Sonya	991	F	J											0

Table 2. Social hierarchy of 10 fox squirrels ranked by the percentile formula, [a]Hudson Woodlot, Michigan State University, 1971.

Individual Squirrel (X)					No. of Squirrels X Victorious Over	No. of Squirrels Victorious over X
Social Rank	Name	Tag No.	Sex	Age		
1	Bob	11	M	A	9	0
2	Gene	9	M	A	7	1
3	Oscar	989	M	A	4	2
4	Irene	7	F	J	4	3
5	Niles	996	M	J	3	3
6	George	8	M	A	2	3
7	Nancy	5	F	J	2	3
8	Tom	993	M	J	1	5
9	Kathy	995	F	J	1	7
10	Sonya	991	F	J	0	6

[a]Percentile social rank of individual calculated by formula: $X = (A + B)/2$

when A = percentage of squirrels encountered that X dominates
B = 100 percent minus the percentage of squirrels dominating X.

Table 3. Social hierarchy of 13 fox squirrels ranked by the linear method, Hudson Woodlot, Michigan State University, 1972.

INDIVIDUAL SQUIRREL (X)					FREQUENCY OF VICTORIES BY INDIVIDUAL (X)												INTERACTIONS WON
Social Rank	Name	Tag No.	Sex	Age	Gene	Oscar	Tom	Harold	Don	Howard	Jean	Simone	John	Walt	Sherri	Jennie	Kathy	
1	Gene	9	M	2.5		1	1	---	---	1	---	---	---	---	---	1	---	4
2	Oscar	989	M	2.5			5	2	3	2	3	4	3	2	1	1	1	27
3	Tom	993	M	2.0				4	2	3	5	1	3	4	2	1	1	26
4	Harold	16	M	2.0					4	3	6	2	3	3	6	4	1	32
5	Don	42	M	2.0						8	3	5	4	8	5	3	1	37
6	Howard	43	M	1.0							12	4	1	10	7	3	1	38
7	Jean	22	F	1.5								3	1	1	1	1	---	7
8	Simone	15	F	1.0									4	4	1	---	---	9
9	John	26	M	.5										5	3	1	---	9
10	Walt	29	M	.5											4	1	1	6
11	Sherri	28	F	.5												---	2	2
12	Jennie	47	F	.5													1	1
13	Kathy	995	F	1.5														0

Table 4. Social hierarchy of 13 fox squirrels ranked by the percentile formula, [a]Hudson Woodlot, Michigan State University, 1972.

Individual Squirrel (X)					No. of Squirrels X Victorious Over	No. of Squirrels Victorious over X
Social Rank	Name	Tag No.	Sex	Minimum Age (years)		
1	Gene	9	M	2.5	4	0
2	Oscar	989	M	2.5	11	1
3	Tom	993	M	2.0	10	2
4	Harold	16	M	2.0	9	2
5	Don	42	M	2.0	8	3
6	Howard	43	M	1.0	7	5
7	Jean	22	F	1.5	5	5
8	Simone	15	F	1.0	3	6
9	John	26	M	.5	3	7
10	Walt	29	M	.5	3	8
11	Sherri	28	F	.5	1	8
12	Jennie	47	F	.5	1	9
13	Kathy	995	F	1.5	0	7

[a]Percentile social rank of individual calculated by formula: $X = (A + B)/2$

when A = percentage of squirrels encountered that X dominates
B = 100 percent minus the percentage of squirrels dominating X.

period in 1971, a parallel to Sharp's observations evolved. With one exception, the sequence of capture followed hierarchal rank fairly well, with the subdominants being caught first and the dominants later in the trapping period. Therefore, results obtained by trapping around a feeder would probably not reflect the true age or sex structure of the population being sampled early in the trapping period. A solution is to allow the feeder to become depleted after a few days of trapping, thus forcing even the most dominant animals to enter the traps for food.

Hierarchal Structure:

Hierarchal rank was markedly affected by both age and sex of the members. Table 5 lists the average rank for four categories for 1971 and 1972. In both years adults ranked significantly higher than juveniles, and males ranked higher than females. Since more accurate data regarding age structure was available for the 1972 population, a correlation of age with social rank was made (Figure 4) and found to be highly significant at the 1 percent level.

Home Range:

Allen (1943) concluded that any "cut and dried" approach to home range determination is more likely to be misleading than helpful due in part to seasonal modifications and food availability. The efficacy of home range determination by trapping is also questioned by Hayne (1949a) and Flyger (1960) who note that home range increases with the number of captures. Few squirrels in the 1971 hierarchy were trapped or seen frequently enough for home range determinations; however, in 1972 trapping and observation data from November, 1971 to May, 1972 were used to delineate home ranges for 11 animals. A correlation of home range with social rank was made (Figure 5) and found to be nonsignificant.

Table 5. Average social rank for categories of fox squirrels.

	Average Social Rank			
	1971[a]		1972[b]	
	Linear	Percentile	Linear	Percentile
Adults[c]	2.75	3.12	5.0	5.0
Juveniles	7.33	7.08	9.3	9.3
Males	4.50	4.25	5.0	5.0
Females	7.00	7.22	10.2	10.2

[a]Based on 10 squirrels

[b]Based on 13 squirrels

[c]Age 1.5 or older

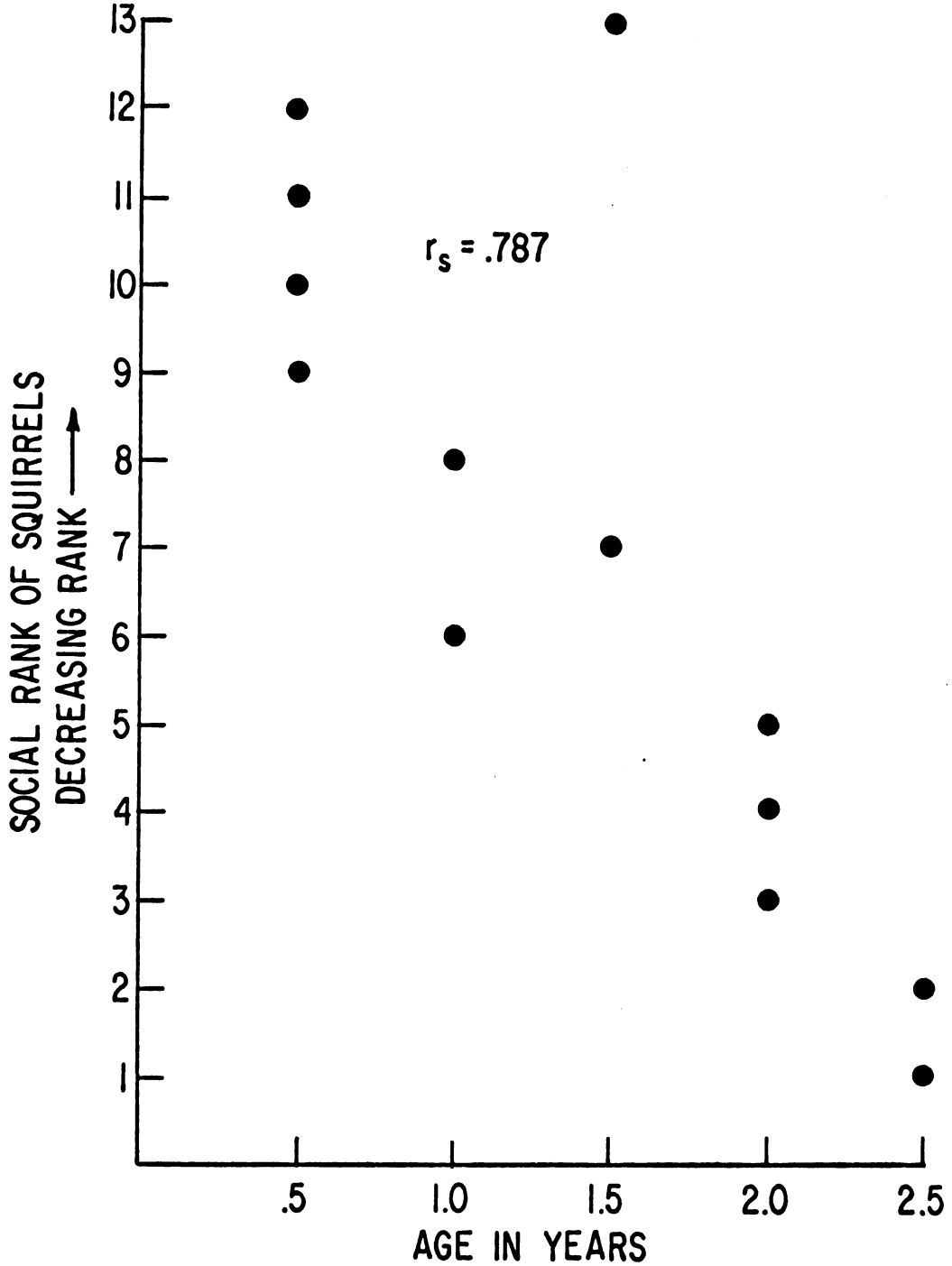

Figure 4. Effect of age on social rank for the 1972 Hudson Woodlot Population of fox squirrels. ($P<0.01$).

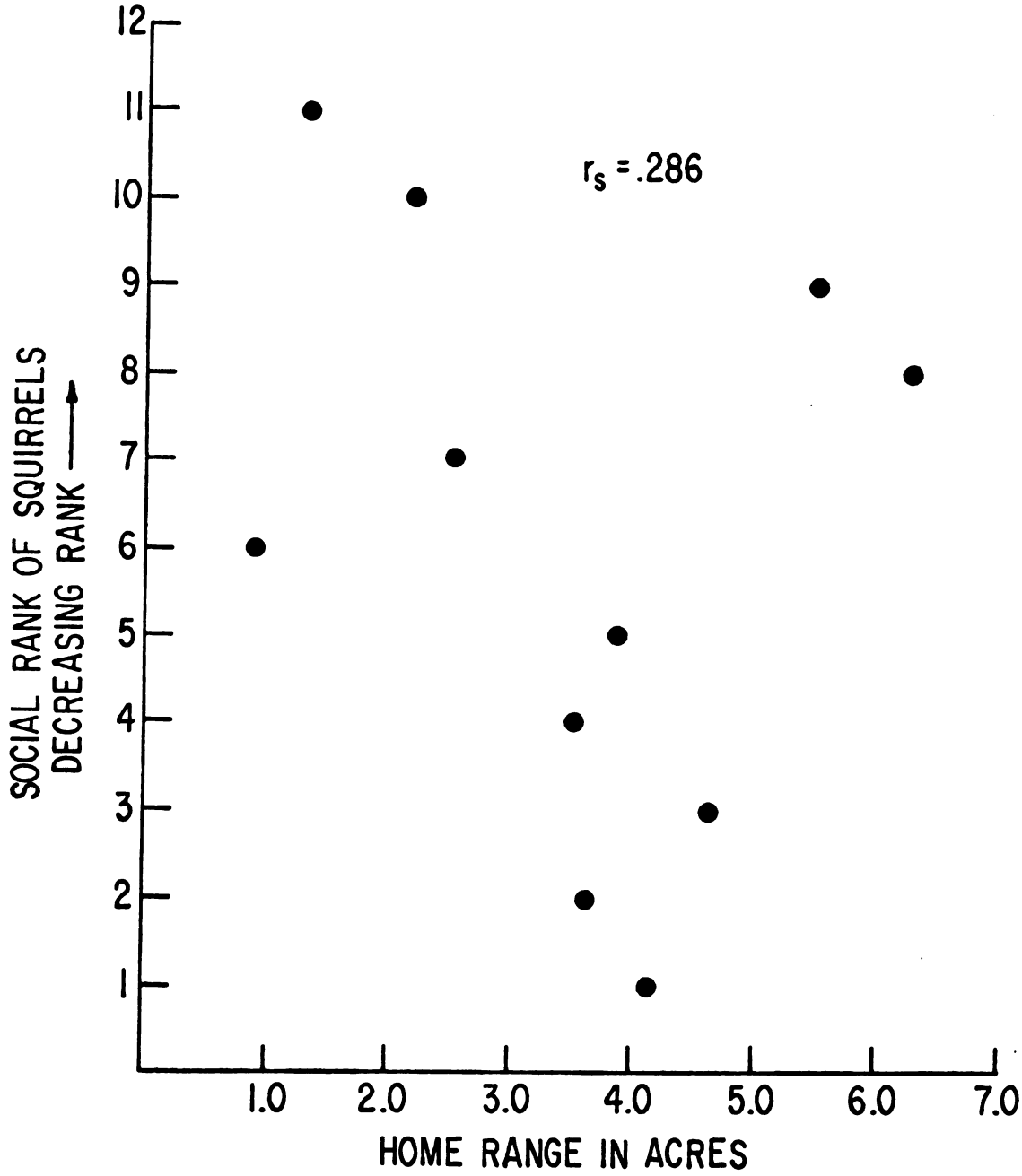

Figure 5. Effect of size of minimum home range on social rank for the 1972 Hudson Woodlot population of fox squirrels. (n.s.).

Breeding Behavior:

Unfortunately, breeding behavior was never observed during the two winter observation periods. Dense sugar maple reproduction significantly reduced visibility around the blind, and this, along with the extreme wariness of the animals, reduced opportunities to observe mating behavior.

Pack et al. (1967) noted that for gray squirrels, high ranking males are involved in most sexual contacts and probably leave more offspring than subdominant males. It is also quite likely that fox squirrel dominants would, as in feeding, maintain precedence in mating encounters.

Weather:

Attempts to correlate specific climatic conditions with movements or social rank were unsuccessful due to the multiplicity of factors induced by capricious Michigan winters. Activity on a given day seemed to be inextricably linked to weather on the previous days and days to come. A good example of this occurred on February 5, 1972, when winds were gusting to 43 knots and several different animals of high and low rank appeared at the feeder. This was the first day of a severe storm, and squirrels seemed to be aware of the consequence of waiting it out on an empty stomach. On the other hand, on many relatively warm days few squirrels were seen at the feeder.

DISCUSSION

A well-defined hierarchy very likely exists in fox squirrel populations, due to normal competition, though the feeder used to

concentrate squirrels may generate unusual social pressures and cause significant refinement of the structure. Some animals whose home range might infrequently overlap, are drawn to the feeder and exposed to one another for the first time. The author witnessed this first meeting on several occasions when two squirrels (of low rank) displayed fear of one another. After a relatively long period of avoidance behavior on the ground, one would rush at the other. Subsequent interactions were accomplished without delay, and reversals were almost never noted. This implies that strong individual recognition is necessary to maintain a dominance hierarchy, a tenet supported by Guhl and Ortman (1953) in their work on domestic chickens, as well as by Flyger (1955) and Pack et al. (1967) in their gray squirrel studies.

Overall weather conditions varied a great deal during the two study periods. The winter of 1971 was harsh both in terms of protracted cold temperatures and snowfall. Over a foot of hard crusted snow covered the ground from mid-December to mid-March; a condition that effectively denied squirrels access to their normal food supply. However, during the second winter little snow fell, and frequent warm spells reduced the snow cover to a minimum or to a nonexistent condition, thus allowing animals to exploit their normal food sources.

Weather conditions over a long period of time seemed to affect squirrel behavior in hierarchy formation to some extent. The severity of the first winter prompted early formation and led to very consistent behavior patterns. Interactions were always swiftly accomplished and the victor nearly always took his position on the feeder. In 1972, however, observations began earlier and overall weather conditions were far less severe.

Another pertinent factor in hierarchy formation was the large component of very young squirrels (6) in the 1972 population, animals with less experience. These young animals were at first unsure of their positions, but soon adjusted quite well into the social structure. Frequently, low ranking animals were observed approaching the feeder, but would leave when they saw dominants were already present. Often low ranking animals were seen as much as 100 yards from cover in the corn field searching for waste corn, and in this position were extremely vulnerable to predation. On several occasions animals were run down by the author on foot, a testimonial to their vulnerability. In all probability, cobs returned to the woodlot from the field by low ranking animals could be usurped by the dominants. This was not actually observed, but circumstantial evidence substantiates that it occurs, and lends credence to the belief that dominance is of strong survival value.

Day-to-day weather conditions did not appear to affect squirrel activity, at least in any consistent predictable manner, for both high and low ranking animals would appear at the feeder during a variety of weather conditions. While dominants would feed to repleteness in one hour and then depart, low ranking animals would sometimes remain three or four hours eating discarded fragments and awaiting access to the feeder. Certainly, there is survival value in dominance for exposure to cold and predation are significantly reduced.

During the second winter a few animals seemed to prefer eating on the ground rather than on the tree, and careful judgment was required to discern who was truly the dominant. This tendency decreased as the winter progressed and the "normal" behavior of feeding on the tree

became the rule. Much of the abnormal activity centered around Howard, an adult male whose origin was probably associated with urban living. He was the only squirrel during two years of observations who would be aware and tolerant of human presence without rapid departure.

Irene, the highest ranking female in 1971, was extremely antagonistic toward other subdominants. Oddly enough, Simone, the highest ranking female in 1972, was also a despot and would not allow some subdominants to feed even on the ground under the feeder. These two animals would sometimes chase other squirrels from the vicinity of the feeder, behavior that could be mistakenly interpreted as territorial to the casual observer.

Actual conflict between squirrels was rare, and interactions were quickly and smoothly accomplished. Sometimes one animal would chase another, but the subdominant was clearly established and always exhibited avoidance behavior.

Of 12 animals captured in January, 1971, only four remained in the January, 1972 population of 20 animals. This attrition rate is certainly severe but quite plausible considering the number of predators present in the woodlot. The extent of emigration was unknown, but considered to be small.

Observation during the second winter enabled the gathering of additional data to substantiate fox squirrel hierarchal behavior and changes in the structure over the course of a year. In addition, after one year of trapping, animals could be aged more accurately and the relationship of age to hierarchal rank more easily determined. Upward shifts in rank did seem to occur with age particularly with males. Gene, who was second in 1971, became the most dominant animal

in the woodlot. Oscar moved from third to second place, and Tom, who was number 9, moved up to third place the second winter. Kathy, however, who was third from the bottom in 1971, dropped to the bottom position in 1972. When trapped, Kathy appeared to be in good physical condition and was known to have carried a summer litter of young animals, so was apparently normal physiologically. The results are inconclusive, but tenure is probably an important factor in achieving high social rank, though aggressiveness is likely linked to genetic factors and increased age and experience does not guarantee advancement.

The percentile method of hierarchy determination as proposed by Komai et al. (1959) and utilized by Pack et al. (1969) and Ozoga (1972) is a useful method of defining hierarchy structure. Although it is easy to use, generally requires fewer observations, and takes into account hierarchal inconsistencies, it does have one shortcoming; it assumes that a given animal will have a heterogeneous exposure to other members of the hierarchy. This situation may not occur because of non-random feeding habits. For example, in the 1971 hierarchy, Tom is ranked above Kathy by the percentile method, but in actuality was dominated by Kathy. The tabular method in this case is correct while the percentile method is in error. These inconsistencies, however, are few and small in magnitude, as evidenced by the close correlations obtained by the two methods.

The elaborate and precise hierarchal system developed by fox squirrels allows the conclusion that they are social animals. Fisler's (1969:28) contention that "the concepts of territory and hierarchy should be considered as opposite extremes of a continuum of mammalian organizational systems," leads to the conclusion that fox squirrels

with their intricate hierarchies probably exhibit very little territoriality or suffer intraspecific restrictions on their home ranges. The poor correlation between social rank and home range strongly implies that this conclusion is correct. One general characteristic of territories or home ranges is that more food exists within the occupied area than is utilized (Calhoun 1952). This restriction of the privilege of occupying space irrespective of food abundance imposes limitations to population growth (Davis 1950). Fox squirrels travel long distances during periods of winter food shortage (Allen 1943), which would necessitate crossing territorial boundaries, if they existed, to obtain access to a point source of food such as a corn field. The social hierarchy arrangement allows exploitation of an abundant food source by many individuals rather than the restrictive use by only one animal as in a territorial system. In short, a hierarchy system allows a greater number of animals to occupy a given area than does a territorial system. If adequate food and shelter are available, spatial requirements would probably not restrict population numbers of fox squirrels, certainly a very important management implication.

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PART II

APPLICATION OF A SIMPLE METHOD FOR CENSUSING FOX SQUIRRELS

APPLICATION OF A SIMPLE METHOD FOR CENSUSING FOX SQUIRRELS

The development of efficient and expedient census methods has been the subject of much concern and distress for wildlife investigators. Arboreal mammals such as squirrels are particularly difficult to census, because many of the usual methods relying on vocalization, tracks or habitat disturbance are unworkable. Most commonly, squirrel populations have been measured by direct trapping or some additional modification involving sight records and/or tag returns from hunting, generally time-consuming methods. Friley (1955), using live traps to capture squirrels, found the Lincoln Index (Davis 1963:107) method of calculating preseason hunting populations of fox squirrels (Sciurus niger) more reliable for indicating trends in animal numbers than per-unit effort trapping success. Leaf nest counts as an index of squirrel abundance, were used by Goodrum (1937), though he expressed dissatisfaction with the results in some habitats, as did Allen (1943) in all Michigan situations. Allen (1943) used in his studies direct trapping generally applied in a grid pattern to monitor population levels. Flyger (1959) compared three census methods, two using the Schnabel (1938) modification of the Lincoln Index, and the third based upon time-area counts as proposed by Goodrum (1940). The first was based on trapping results, the second on the visually determined ratio of marked to unmarked animals (trap-sight records) obtained during observations. He found the latter gave the most satisfactory results. Nixon et al. (1967) also used grid trapping results for their comparison of various mathematical predictions of population numbers. They concluded that assumptions must be made which may not be true in regard

to trap response but that, in lieu of better methods, mathematical functions may be used to produce population estimates. Sharp (1958) took advantage of the social hierarchy described by Flyger (1955) and lack of territoriality in gray squirrels to attract animals with a feeder to a central location for trapping. He emphasized that conditioning animals by prebaiting is the key to success in trapping. The intent of this paper is to report the results obtained using the same procedure for censusing fox squirrels, where sight records of previously trapped and marked animals provided a judgment as to the efficacy of the method.

STUDY AREA

Two woodlots on the farm property of Michigan State University in Ingham County comprised the study area. These woodlots were nearly equal in both size and species composition. Toumey Woodlot, the first, is a 20-acre old-growth beech-maple stand surrounded by pasture land, while Hudson Woodlot located ¼-mile away is an 18-acre all-aged beech-maple forest. Field corn is usually planted on the north and west boundaries of Hudson Woodlot, while pasturage is the main use for the areas adjacent to the south and east boundaries. Both woodlots contain wild, relatively discrete, unhunted populations of fox squirrels. Their wildness could be a result of predator pressure and infrequent human activity in the area. The woodlots contain few mast trees other than the sporadically producing American beech (Fagus grandifolia) (Gysel 1971) and consequently do not normally carry high populations of squirrels. In Michigan wintering squirrels often rely on auxiliary food supplies such as field corn (Fouch 1961).

METHODS

Trapping activities began in July, 1970 in Toumey Woodlot and continued until March of 1972, for a duration of 21 months. Hudson Woodlot trapping was initiated in January, 1971 and continued 17 months until May of 1972.

Trapping was done on a year-round basis during nearly every month of the study periods and was accomplished by two basic methods. The first was an application of the feeder system advocated by Sharp (1958) for gray squirrels to attract the animals to the traps at a given location. The second was an evenly distributed grid system wherein each trap serviced an area of .90 acres. The grid provided an opportunity to test the distance squirrels would travel to some central location such as a feeder for trapping.

The feeders were simply basket arrangements made of chicken wire and wood which could hold a bushel of ear corn (Sharp 1958). When hung on a tree, they were readily accessible and visible to squirrels within the woodlot and could provide food without service for long periods of time. Six traps were placed in a semi-circle below the feeder and also baited with ear corn. The traps were of a collapsible metal (wire) variety which measured 9 x 9 x 24 inches. As Sharp (1958) noted, the behavioral mannerisms of squirrels at the feeders make their capture possible. Fox squirrels have a hierarchal form of social arrangement and do not appear to suffer intraspecific restrictions on their home ranges (Bernard 1973). This makes feasible trapping at a central location without fear that territorial boundaries might restrict animal movements to a central location. Five feeding stations were maintained for much of the time in each woodlot, and at selected

intervals four were emptied to test whether animals would transfer their activity to one central feeder. Allen (1943) observed that fox squirrels usually travel over a ten-acre area on a seasonal basis. When five feeders were operating, each serviced approximately four acres, coverage thought to be adequate to attract most squirrels in the woodlots. When only one central feeder was operating, the maximum distance a squirrel in the woodlot would have to travel became 800 feet. In addition to the grid and feeder methods of trapping, another population monitor was maintained. Both woodlot populations were being observed as part of a behavioral study, and the identity of nearly all animals was established. All animals captured were ear tagged and most were dyed with Nyanzol A (Fitzwater 1943) in a characteristic pattern that allowed visual identification of individuals. Much time was spent in the woodlots, particularly from January through March, making behavioral observations, so that sight ratios of marked to unmarked animals could be maintained. When no unmarked animals were seen or trapped, the population was considered to be inventoried. Therefore, both trap and sight records were used to determine what was considered to be an efficacious estimate of the actual number of squirrels in the respective populations (Figs. 1 and 2). The minimum number of squirrels known to be alive in a given month was determined by adding the number seen or trapped that month to those marked during an earlier trapping period but not seen or recaptured until some subsequent date (Figs. 1 and 2). It is felt that the population estimates, especially during January through March, very nearly represented the actual number of animals present since trapping was frequent and observations nearly continuous.

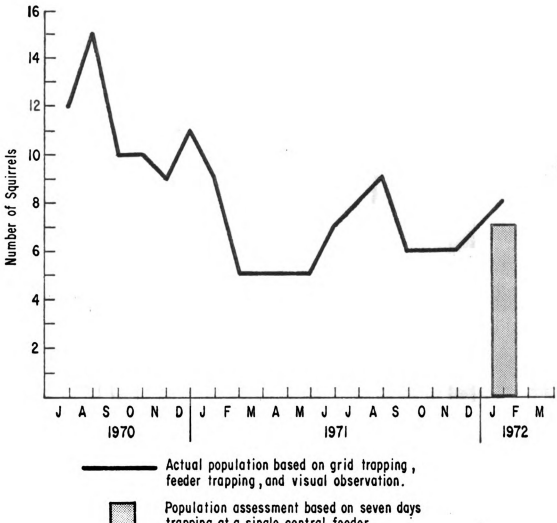

Figure 1. Fluctuation of the Toumey Woodlot fox squirrel population showing estimate based on feeder trapping.

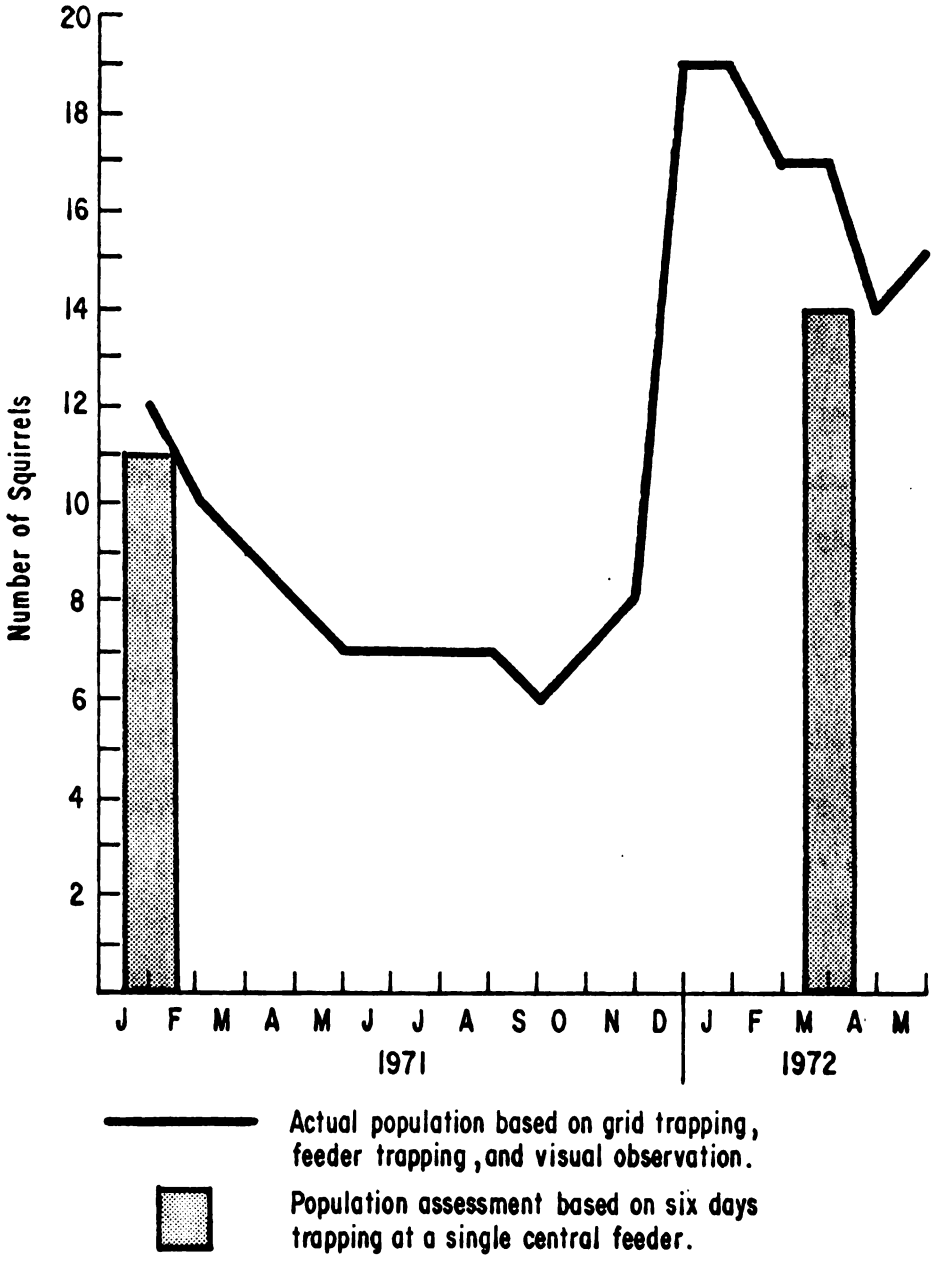

Figure 2. Fluctuations of the Hudson Woodlot fox squirrel population, showing estimate based on feeder trapping.

The question to be answered was whether animals could be induced to come to a single point source of food and thereby become trapped with a minimum of effort, with the attendant conviction that a representative proportion of the population had been captured. All grid stations and feeders except the central one in each woodlot were depleted at least two weeks prior to trapping at the single central feeder. This allowed squirrels time to transfer their feeding forays to the single remaining feeder. Here, trapping periods varied in length from four to seven days during the difficult winter period for squirrels (Figs. 1 and 2). During the second half of these periods, the central feeder was also emptied of corn to ensure that the only source of corn was contained in the traps. The trapping periods were not continuous but were in part chosen in response to weather conditions. Trapping was always preceded by a conditioning period where traps were propped open and animals allowed free access to bait (corn) within the traps.

RESULTS

A short trapping period of 7 days or less during periods of winter food scarcity proved efficient for capturing nearly all animals present in the woodlots (Figs. 1 and 2). The Hudson Woodlot population was inventoried during 1971 and 1972, and the Toumey animals only in 1972. In Toumey, trapping at the single feeder for seven days yielded seven animals (88%), when the actual population was considered to be eight. All the animals were taken during the first four days of trapping. The January, 1971 Hudson Woodlot population was actually twelve animals, and the estimate based on six trap days was eleven animals or 92% of

the population. In March of 1972 the Hudson population was considered to be 17 animals, and the feeder estimate was 14 animals, or 82% of the actual population. This estimate was based on six trap-days, though all squirrels were caught by the fifth day. Animals which had previously been taken at one or more of the other four feeders readily transferred their feeding forays to the central feeder when it alone held corn. Grid trapping periods following the inventory based on the single feeder resulted in the capture of only one new animal, a strong indication that the feeder could draw squirrels from the entire woodlot. Intentions were to attempt the method during other seasons, but overall trapping success was inconsistent and a reliable estimate could not be made.

DISCUSSION

As in any approach to censusing animals, there are advantages and shortcomings to be considered. One major drawback of this method is the effect food shortage or abundance may have on trapping success. As Barkalow et al. (1970) noted, in an exceptionally good mast year squirrels may be overwhelmed by food and thus be literally untrappable. The application of direct trapping as a census method, therefore, requires a food shortage to function efficiently. This condition occurs with some certainty in Michigan nearly every year, for even though autumn food may be abundant, crusted snow and ice usually make it unavailable to foraging squirrels during the January through March winter period. Examination of field conditions will aid the investigator in deciding when and if these or other conditions of food shortage exist. Application of the method during two winters of markedly varied

snow conditions showed quite favorable results. In 1971 deep crusted snow made access to buried food supplies difficult if not impossible. In 1972 the snow cover was far less permanent, and at frequent intervals squirrels had free access to their usual food sources. During the periods between thaws, however, animals came well to the feeder and were quite easily trapped. By necessity the season for censusing, using feeders and live traps, becomes the winter period of food scarcity, not always the most desirable time to obtain population data. However, early winter numbers of animals, though somewhat less, may approximate fall numbers. The data in Figures 2 and 3 reflect higher numbers of animals in January than in November, most certainly a result of increasing effectiveness of trapping as food became more difficult to obtain. Winter estimates are useful since they reflect population numbers at a time when normally only mortality is operating, as opposed to fall when mortality, migration, and even natality may be acting.

Another pertinent factor to consider is the effect weather conditions may have on trapping success. For example, severe weather in very early winter may lead to reduced or complete cessation of squirrel activity (Allen 1943); however, by mid-January most squirrels in the woodlot became quite active. Severe cold spells or stormy weather sometimes restricted movements on a day-to-day basis, but the investigator can judge these conditions and trap during more "normal" weather conditions.

Consideration should also be given to the possibility of catching a predator such as the raccoon (Procyon lotor) at the trapping site. If this situation should occur, the location may be rendered ineffective

until the offender is removed. During winter in Michigan, this is seldom a problem, though it could become a serious drawback in more southern states where raccoons and other omnivores remain active through the winter months.

With shortcomings considered, however, the method has worked well for Michigan fox squirrels in winter, giving good results when compared to known populations. The centrally located feeder appeared to attract animals over an 18- to 20-acre area, and perhaps could be expected to be effective over an even larger area. Sharp (1958) found that one feeder for 28 acres was adequate to attract most gray squirrels for trapping, and fox squirrels have been known to travel more than a mile during severe winters (Allen 1943). It is entirely possible that one feeder for 30 acres might suffice, though the efficiency of the method might decline. Another advantage is the small number of traps needed and the length of time needed to service them. An hour was required to service 20 traps on a grid system, while only 15 minutes was needed to check the six traps at a feeder station.

The social behavior, particularly the dominance hierarchy, plays an important part in determining success of this method. When two or more animals appear at the feeder, the subdominants are forced from the feeder to the ground and the traps, where their capture is virtually assured. A trapped animal does not frighten others nearby, but rather seems to reinforce them that all is well. On one occasion, all six traps held animals. In woodlots with large populations, more traps should be utilized to ensure that a trap is available for each approaching squirrel.

Present evidence shows that feeder trapping is an efficacious method of capturing squirrels, requiring relatively limited time and equipment. Further investigation of the method is in order on a larger scale, especially in different geographical situations where effects of winter are not so predictable.

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