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It is understandable that virtually all of the efforts of County Conservation Boards during the last eight years have been devoted to parks, stream access, and similar areas of broad public purpose. This emphasis will continue. However, a start has been made in projects of a dominantly scientific and educational nature. These latter projects are clearly within the County Board law. Nevertheless, the fullest cooperation of all agencies is needed to achieve the highest scientific and educational values in conservation.

Literature Cited

Ennis, J. Harold. 1962. *Iowa Acad. of Sci.* 69: 219-223.

———, 1960. How to Preserve Your Area For Its Natural Values. Information Bulletin No. 4. The Nature Conservancy, 2039 K Street N.W., Washington 6, D.C., page 1.

Rush, Wilbur A., Wilkinson, George, and Barton, Thomas A. 1959. *Guide for County Conservation Boards.* Iowa State Conservation Commission.

Iowa Squirrels: Hunting Statistics, Sex and Age Ratios, and the Influence of Mast and Agriculture

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Abstract. Fox and gray squirrels, *Sciurus niger rufiventer* Geoffroy and *S. carolinensis pennsylvanicus* Ord, are commonly hunted in Iowa. Average hunting success for 12 years as reported by hunter-cooperators was 0.8 squirrels bagged and 1.8 seen per gun hour. Significant variations in hunting success from one season to another were found. One squirrel was reported crippled for every 14.8 killed. Fox squirrels comprised 87.1% of the total kill; grays, 12.9%. Conservation officer contacts indicated actual hunting success was below that reported by hunter-cooperators. The cooperators were assumed to be hunters with above average skill as compared to average ability of those contacted by conservation officers. Hunters average 6.1 trips per season and spent an average of 2.8 hours per trip. The average size of hunting parties was 1.4. Hunting success varied little through the season. Two-thirds of all hunting effort was expended during the first month each season. Dogs were found detrimental to hunting success.

Sex ratios of 119.2 males/100 females for fox and 110.3 males/100 females for gray squirrels were found. Age ratios varied somewhat from year to year. In fox squirrels the 14-year average was 53.9% juveniles; in grays, 49.4% juveniles. A simple method of measuring tree mast yield is described. The data indicate mast yield influences production of squirrels and subsequent hunting success in Iowa, although not as drastically as has been reported in other states. Evidence is presented which indicates the mast influence is mitigated somewhat by intensive agriculture. Squirrels probably rely

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more on grain food in Iowa than in more heavily wooded states.

Tree squirrels provide an important outlet for hunting recreation in Iowa. Traditional mid-September opening of the squirrel hunting season, in contrast to later openings on all other game except rabbits, permits early autumn hunting when other species are not available. A survey of hunting resources in Iowa (Anonymous, 1956) showed 18.7% of all hunting trips completed were for squirrels. They rank third behind pheasants and cottontails as a hunting resource in Iowa.

Fox squirrels (*Sciurus niger rufiventer* Geoffroy) and gray squirrels (*Sciurus carolinensis pennsylvanicus* Ord) are the two species commonly hunted in Iowa. The former is found throughout the state wherever sufficient tree growth exists to provide denning sites. Gray squirrels are limited primarily to the larger timbered areas, often in rough terrain, of the northeast and southeast corners of Iowa, and to the eastern and south-central borders and adjacent counties.

This paper presents results of hunter-cooperator contacts officer field contacts, mast surveys, and sex and age ratio studies, gathered over a period of 14 years. Differences between hunting success, reproduction, and mast production from a heavily wooded portion of Iowa and the more intensively cultivated remainder of the state are drawn and an explanation attempted. The information presented can serve as basic guidance for squirrel management in Iowa. It should also provide a background of information from which more intensive research on squirrels can be directed.

Methods

Hunter-Cooperator Contacts. Each year, beginning in 1950, a list of known squirrel hunters from all portions of Iowa was compiled. These hunters were mailed a form, asked to fill it out, and return it to the Conservation Commission at the end of each season. The forms provided space for recording from each hunting trip the number of squirrels of both species seen, killed, and crippled; sex of squirrels bagged; number of hunters per party; number of hours hunted; whether or not a dog was used; county hunted; and type of gun used.

Most years between 400 and 500 hunters were contacted. Noncooperators were systematically eliminated from the list. Several cooperators returned reports 10 or more consecutive years. Over a 9-year period, 4,321 contacts were made with 424 usable reports returned, representing a response of 9.8%. Colin (1957) reported 3% return from a similar study in Alabama.

Officer Field Contacts. Beginning in 1960 conservation officers recorded the objective, party size, hours afield, location, and success of hunters contacted in the field. These data were used to compute hunting success, expressed as squirrels killed per gun hour.

Forleg Collections. Hunter-cooperators were asked to save one fore-foot from each squirrel bagged. Beginning in 1958 conservation officers were requested to collect forefeet while making bag checks. These were used in age determination as described by Petrides (1951). All squirrel feet were boiled in water until soft, then the distal ends of radii and ulnae were visually examined to determine age. Separation of the distal epiphyses from the diaphyses was the criteria for distinguishing juveniles. Fusion indicated adults. Collection from the various counties were analyzed and recorded separately. Bones of fox squirrels were distinguished from grays by coloration. The former have a pinkish color; the latter, white.

Mast Surveys. Starting in 1958, technically trained personnel (foresters, game managers, and biologists) of the Iowa Conservation Commission, recorded annually their estimate of production of hickory nuts, walnuts, and acorns. Each observer recorded local production classes as "abundant," "moderate," and "poor" for the species with which he had contact. The reports were compiled by assigning values of "1" for poor, "2" for moderate, and "3" for abundant. An index of statewide production of any species was calculated by adding all values for it and dividing by the number of observations for that species. The statewide index of production for all nut-bearing trees was computed by adding all values for all species and dividing by the total observations of all individual species. This method was similar to one reported by Allen (1952) but offered the advantage of compilation useful in quantitative comparisons. Uhlig (1956) describes a similar method of evaluating mast yield.

Results

Hunting Success. During 14 years hunter-cooperators returned 661 useful reports on which were recorded 4,062 hunting trips. This gives an average of 6.1 trips per season for cooperators. Kidd (1955) found Louisiana hunters averaged 6.5 trips per season. In Mississippi, Redman (1953) reported 7.2 hunts per season average. Another writer (Packard, 1956) reported 4.0 and 3.9 average number trips during two seasons in Kansas.

Average number of hunters per party as reported by cooperators for all years was 1.4. Packard (op. cit.) reported 1.6 for one year and 1.7 for another. The average hunting party spent 2.8 hours afield per trip. Redman (op. cit.) also found 2.8 party hours per trip.

Twelve seasons data were available for computation of statewide hunting success (Table 1). During 14,576.7 gun hours (12-year total) 26,338 squirrels were observed, and of these, 11,909 were bagged. These data give an average of 1.8 squirrels seen per gun hour and 0.8 bagged, or 1 squirrel killed for every 2.2 seen. Uhlig (op. cit.) found 37% of all squirrels seen were killed. In the present study average number squirrels seen per gun hour ranged from 1.5 in 1956 to 2.3 in 1951. Squirrels bagged per gun hour ranged from 0.6 in 1963 to 1.2 in 1951. In Illinois, Brown and Yeager (1945) believed the success per hour ranged from 0.5 to 1.0 squirrels.

Table 1. Squirrel hunting success in Iowa as reported by hunter-cooperators, 1950-1963*.

Year	Gun hours	Squirrels seen	Squirrels bagged	Squirrels seen per hour	Squirrels bagged per hour
1950	2,046.4	3,350	1,578	1.64	0.77
1951	841.8	1,846	969	2.27	1.19
1952	1,536.0	2,822	1,306	1.84	0.85
1955	1,297.9	2,316	1,135	1.78	0.87
1956	1,590.6	2,385	1,134	1.50	0.71
1957	1,298.2	2,292	1,005	1.77	0.77
1958	1,499.5	2,887	1,287	1.93	0.86
1959	1,320.5	2,318	906	1.76	0.69
1960	1,027.5	2,070	875	1.97	0.85
1961	750.3	1,553	658	2.07	0.88
1962	837.0	1,629	707	1.95	0.84
1963	558.5	870	349	1.56	0.62
Totals	14,576.7	26,338	11,909	1.81	0.82

* Data for years 1953-54 are not available.

The Chi-square method was used to test significance of the variations in annual kill per hour from the expected kill per hour for each of 12 seasons. The variations were found to be highly significant (Chi-square = 237.63, .01 level = 24.725). Allen, (op. cit.) states that hunting success varied from year to year depending on squirrel abundance.

Hunters reportedly crippled 802 squirrels, or 1 cripple for every 14.8 killed. Brown and Yeager (op. cit.) believed 15% of all squirrels shot were lost as cripples. Baumgartner (1940) reporter, of those shot at, 11% of the fox squirrels and 18% of the grays were crippled. Redman (op. cit.) found 3.7% of those shot escaped. Because in the present study the reports are voluntary, the cooperators may report fewer cripples than actually occur. However, as will be shown further in the paper, the superior ability of the hunter-cooperators when compared to average Iowa squirrel hunters may result in an actual low rate of crippling loss. Atkeson and Hulse (1952) reported slightly greater crippling loss with .22 rifles than with shotguns on the Wheeler National Wildlife Refuge. However, the senior author (Atkeson, 1958) found more crippling with shotguns in a later study on the same area.

Analysis of hunting effort for 1958 through 1963 shows 986 trips (65.7%) were made prior to October 16, 392 (26.1%) from October 16 to November 15, and 123 (8.2%) after November 15. Obviously, the major portion of the hunting effort occurs during the first month each season. The writer believes a very large percentage of all squirrel hunting occurs during the opening weekend. Uhlig (op. cit.) found that interest in squirrel hunting declined rapidly after the first week.

Data from 11 seasons were analyzed to compare success for the first month with success for the remainder of the season. Practically no difference existed and was not significant ($t = 0.50$, .05 level $= 2.10$).

Most Iowa hunters do not use dogs for squirrel hunting. Data from nine seasons show 1,217.4 gun hours (11.4%) recorded by hunters who used dogs and 9,498.6 hours (88.6%) by hunters without dogs. Hunters who used dogs saw 1.5 and bagged 0.7 squirrels per hour, while those who did not use dogs saw 1.9 and bagged 0.8 squirrels per hour. These differences in squirrels bagged per hour for nine seasons were not significant ($t = 1.56$, .05 level $= 2.12$). Evidently, Alabama hunters have better trained dogs as Colin (op. cit.) found hunters with dogs in that state were most successful. In the present study hunters with dogs saw 2.0 squirrels for each one killed; hunters without dogs saw 2.3 for every squirrel killed.

Conservation Officer field contacts indicate consistently lower hunting success statewide than do the reports from hunter-cooperators (Table 2).

Table 2. Comparison of squirrel hunting success as reported by hunter-cooperators and conservation officers.

	Squirrels bagged per gun hour	
Year	Hunter-cooperators	Official contacts
1960	0.85	0.56
1961	0.88	0.64
1962	0.84	0.56

The data indicate that for comparisons from year to year officer contacts are most reliable for estimates of hunting success. The type of hunter who is interested enough to participate in a cooperative reporting project is very likely to be an expert squirrel hunter and can be expected to bag squirrels regardless of abundance or population fluctuations.

Types of Guns. Hunter-cooperators reported types of guns used 335 times. Rifles reportedly were used by 239 (71.3%), shotguns by 83 (24.5%) and miscellaneous handguns and muzzle loaders by 13 hunters (4.2%). Rifles were nearly always of .22 caliber. Hunters used .410 and 12 guage shotguns in nearly equal numbers, with other gauges reported, but used less frequently. The writer believes 12 gauge shotguns are used more in Iowa than the data indicate. Most authors report 12 gauge shotguns used in preference to other guns (Allen, (1943); Allen, op. cit.; Baumgartner, op. cit., Brown and Yeager, op. cit.; Colin, op. cit.; and Redman, op. cit.).

Relative Importance of Species. Data from 12 years reveals 11,461 fox squirrels (87.1%) and 1,693 grays (12.9%) were bagged. These data cannot be used as criteria for relative abundance of the species, however, as 45.3% of all fox squirrels reported seen were bagged while 39.6% of the grays were bagged. Percentage bagged of the two species differed significantly only at the .10 level of confidence ($t = 1.87$, .10 level $= 1.73$). Allen, (op. cit.) also found larger numbers of fox squirrels killed of those seen than grays.

Gray squirrels are more wary, and move more often and rapidly than fox squirrels. This could account for the difference in percentage bagged. Fox squirrels are far more important than grays to squirrel management in Iowa as a whole. However, in Allamakee, Winneshiek, and Clayton Counties of northeast Iowa, at least half of the squirrels are grays.

Sex Ratios. Hunter-cooperators reportedly bagged 6,174 males and 5,180 female fox squirrels. In grays, 848 males and 769 females were reported (Table 3). These data give sex ratios of 119.2 males per 100 females for fox squirrels and 110.3 males per 100 females for gray squirrels. Chi-square was used to check the difference in reported number of males for each of 14 seasons against a hypothetical 50:50 ratio. In fox squirrels, the difference was highly significant (Chi-square = 66.40, .01 level = 27.688), for grays it was not (Chi-square = 4.963). In fox squirrels males outnumbered females each of 14 years. In grays males were bagged more often in 13 of 14 years. The small sample size in gray squirrels may not be sufficient to show statistical variations from 50:50 sex ratio.

There seems to be considerable variation in sex ratios reported in the literature. In various sections of the gray squirrel range a number of authors found a preponderance of males (Allison, 1953; Brown and Yeager, op. cit.; Colin, op. cit.; Kidd, op. cit.; Redman, op. cit.; and Robinson and McT. Cowan, 1954). On the other hand Chapman (1938), Shorten (1951), and Uhlig (op. cit) found a preponderance of female grays. Longley (1963) reported more males than females in one sample and fewer in another.

There is less discrepancy in reports on fox squirrels. Baumgartner (op. cit.), Brown and Yeager (op. cit.), Hoover and Yeager (1953), Packard (op. cit.), and Yeager (1959) all agree that males outnumber females in fox squirrel populations. Allen, (op. cit.) states that sex ratios in fox squirrels vary widely from year to year. The data presented here do not bear out this statement. Because the present data are taken from cooperator reports, factors of bias may enter. Possibly the hunters are less reluctant to report males than females. Males may be more vulnerable to hunting because of greater activity or wider range. The writer would tend to favor the latter explanation if bias actually is present. However, it is possible that the sex ratios obtained in this study are representative of populations in Iowa.

Table 3. Sex ratios of fox and gray squirrels reported by hunter-cooperators in Iowa over a 14-year period, 1950-1963.

	Fox squirrels		Gray squirrels	
Year	Sample size	Males/100 females	Sample size	Males/100 females
1950	1,623	130.6	201	113.8
1951	770	118.7	115	109.1
1952	1,230	115.8	97	115.6
1953	750	114.3	54	170.0
1954	530	123.6	51	131.8
1955	960	126.9	101	106.1
1956	832	110.6	119	105.2
1957	823	114.9	168	110.0
1958	1,021	107.9	146	102.8
1959	744	124.1	126	85.3
1960	701	115.7	173	103.5
1961	504	120.1	112	124.0
1962	576	117.4	115	113.0
1963	290	133.9	39	129.4
Totals	11,354	119.2	1,617	110.3

Age Ratios. Uhlig (1957) states in regard to gray squirrels that the annual fluctuation in population density seemed to depend on the number of juveniles in the fall population. The statement should apply to fox squirrel populations as well. During the 14 years of study, 789 adult and 769 juvenile gray squirrels were aged by the epiphyseal fusion method. This gives a juvenile/adult ratio of 97/100, or 49.4% juveniles. Samples of gray squirrel forelegs were too small some years to determine a proper range (Table 4). Adult fox squirrels totaled 4,464; juveniles 5,227. The ratio of juveniles/adults was 117/100, or 53.9% juveniles. The age ratio in fox squirrels ranged from 101/100 in 1959 and 102/100 in 1963 to 144/100 in 1953. Juvenile fox squirrels did not vary significantly from the 14-year average of 53.9% (Chi-square = 12.475, .05 level = 22.362).

Considerable variation in reported age ratios can be found in the literature. In fox squirrels Allen, (op. cit.) states that the normal fall age ratio should be about 60% juveniles. Several authors have reported a preponderance of juveniles in fox squirrels (Moran, 1953, Packard, op. cit.; and Yeager, op. cit.). Allen, (op. cit.) stated that juveniles usually comprise 50% of the hunters' take. Other authors have found a majority of adults in the bag (Brown and Yeager, op cit.; Chapman, op. cit.; and Kidd, op. cit.).

Brown and Yeager (op. cit.), Marsh (1951), Colin (op. cit.), and Kidd (op. cit.) all reported more adult grays than juveniles. A majority of juvenile grays were reported by Moran (op. cit.), Redman, (op. cit.), and Uhlig (op. cit.). Longley (op. cit.) reported a population turnover of 50-60% in gray squirrels.

Table 4. Age ratios of fox and gray squirrels taken by Iowa hunters: 1950-1963.

	Fox squirrels		Gray squirrels	
Year	Sample size	Juveniles/ 100 adults	Sample size	Juveniles/ 100 adults
1950	545	134	63	117
1951	242	110	55	104
1952	566	129	21	62
1953	639	144	32	146
1954	485	114	37	95
1955	322	127	23	360
1956	374	128	35	192
1957	391	127	33	136
1958	1,015	107	251	111
1959	1,053	101	157	94
1960	1,145	115	150	69
1961	1,157	115	152	67
1962	937	129	339	126
1963	821	102	210	65
Totals	9,691	117	1,558	97

The writer is convinced that many of the studies showing a preponderance of adults in fall populations are based on aging techniques which are not accurate. Aging by external morphological characteristics is difficult at best when a large proportion of the population is comprised of juvenile squirrels which have reached adult size. Kirkpatrick and Hoffman (1960) found difficulty in aging male gray squirrels by external sex morphology at 10-11 months. The problem is admitted by at least one other author (Kidd, op. cit.).

Influence of Mast on Squirrels. Annual production indices of nut-producing trees are presented in Table 5. The more important mast-bearing trees in Iowa are; burr, white, black and northern red oaks; black walnut; and shagbark hickory. All of these are found throughout the state and are abundant. The pin, blackjack, shingle, and chinquapin oaks are common trees but have limited ranges in Iowa.

Mast production does vary in Iowa from year to year. Indices range from 1.3 in 1958 to 2.2 in 1962. It should be noted that an index of "1" would indicate little or no production, and "3" would indicate maximum production with all trees producing at full capacity. It is unlikely that either of these two extremes would appear any one season over an area as large as Iowa when 13 different species are considered.

A number of writers discuss the importance of mast production to squirrel welfare. In general it is agreed that mast failure any one year can cause delayed breeding, poor hunting, low juvenile production, and above normal harvest of lactating females during the following year (Allen, op. cit.; Christisen and Korschgen, 1955; Colin, op cit.; Kidd, op cit.; and Packard, op. cit.). In addition, researchers from northern states report mortality during winters when mast is scarce (Allen, op. cit.; and Longley, op. cit.). Uhlig (op. cit.) on the other hand, found only one year when poor hunting followed a poor mast crop.

Table 5. Indices of mast yield by species in Iowa: 1958-1963.

	Index of production*					
Species	1958	1959	1960	1961	1962	1963
Black walnut	1.3	2.2	2.0	1.7	2.3	1.6
Butternut	1.0	1.9	1.7	1.2	2.3	1.4
Shagbark hickory	1.1	2.3	1.9	2.1	2.2	1.9
Bitternut hickory	1.4	2.1	1.9	1.7	2.0	1.8
White oak	1.1	2.3	1.9	1.4	2.5	1.9
Burr oak	1.2	2.3	2.1	1.9	2.0	1.7
Swamp white oak	1.0	1.7	1.0	1.0	1.5	1.0
N. red oak	1.8	2.0	2.0	2.0	2.0	2.0
Black oak	1.6	1.8	1.7	1.6	2.2	1.9
Pin oak	1.2	2.2	2.5	1.9	2.1	1.9
Blackjack oak	1.0	2.0	1.0	1.0	2.0	2.0
Shingle oak	1.0	2.0	1.0	1.7	1.7	2.0
Chinquapin oak					3.0	3.0
Average all species	1.3	2.1	1.9	1.7	2.2	1.8

* The index of production is based on observations which are recorded as "abundant, moderate, or poor". Numerical values are assigned these observations as follows: Abundant—3, moderate—2, and poor—1. Index of production for one species for any one year is derived by totaling the numerical values and dividing by the total observations of that species.

Severe shortage of acorns can cause mass emigration in squirrels (Schorger, 1947; Larson, 1962; and Shorten, 1954). It seems that these mass movements develop during late summer and early fall, the normal time for autumn dispersal (Baumgartner, 1943). Schorger (op. cit.) recorded movement of both fox and gray squirrels which began about mid-August in 1946. It appears gray squirrels are more frequently involved in mass movement than fox squirrels. The reason for this probably is fox squirrels depend less on forest foods than do grays (Allen, op. cit.; and Brown and Yeager, op. cit.). This would seem true in Iowa as gray squirrels are found more in heavily timbered areas than are fox squirrels. The writer received verbal reports of mass emigration from northeast Iowa, a heavily timbered area, during the fall of 1958 following mast failure. This phenomenon was not witnessed personally, but the descriptions were similar to those reported by Schorger (op. cit.) and seemed valid.

Comparisons of mast indices, juvenile production, and hunting success statewide are presented in Table 6. The results are inconclusive, but it will be noted that poor hunting success during 1959 and 1963 followed poor production of young in both species. Only one of the two years, 1959, however, followed a poor mast year. Other factors, such as winter weather or juvenile emigration, mentioned above, must be involved in lowa. Also, because in most portions of the state the land is intensely cultivated, it follows that squirrels can find food anytime in most locations whether or not the acorn crop has been a success. It must be remembered in examining the table that the importance of fox squirrels in the bag far outweighs gray squirrels.

Table 6. Mast production for previous seasons compared to age ratios and hunting success in Iowa: 1958-1963.

Year	Mast index for previous year	Juveniles per 100 adults Fox	Gray	Bag per gun hour
1958	..	107	111	0.9
1959	1.3	101	94	0.7
1960	2.1	115	69	0.8
1961	1.9	115	67	0.9
1962	1.7	129	126	0.8
1963	2.2	102	65	0.6

The Woodland Influence. Forest covers only 7.3% of the total land area of Iowa (Thornton and Morgan, 1959). The forested lands are not evenly distributed throughout the state. To test the impact of large forested areas on squirrel populations in a state devoted primarily to agriculture, data from five counties (Allamakee, Clayton, Dubuque Fayette, and Winneshiek) in northeast Iowa were compared to data from the remainder of the state (Table 7). The five counties have a combined land area of 2,202 thousand acres, 18.3% of which is forested. Only 6.6% of the 33,667 thousand land acres of all other counties is forested.

Mast indices from the two areas show similar up or down trends most years. The average index for the five counties is below that from all other counties. This may result from greater dispersion and open growth of trees in the primary agricultural area (area "B"),

Table 7. Comparisons of mast indices, squirrels bagged per gun hour, and squirrel age ratios from a relatively wooded area of Iowa with those from an agricultural area: 1958-1963.

	Mast indices		Kill/gun hour		Age ratios: juveniles/ 100 adults			
					Wooded area		Agric. area	
Year	Wooded area	Agric. area	Wooded area	Agric. area	Fox	Gray	Fox	Gray
1958	1.40	1.32	0.86	0.86	163	105	98	135
1959	1.91	2.16	0.40	0.75	73	79	104	130
1960	2.00	1.98	0.69	0.90	. .	.	. . .	. .
1961	1.70	1.70	0.72	0.92	92	58	116	77
1962	1.78	2.23	0.81	0.85	143	132	127	100
1963	1.40	1.85	0.36	0.69	108	50	101	128
Average	1.70	1.87	0.67	0.83	121	91	109	108

which could give higher mast yields. However, the difference was not significant statistically ($t = 0.99$, .05 level $= 2.23$). The kill per gun hour averaged 0.67 for the five wooded counties (area "A") and 0.83 for area "B". This was a significant difference at .10 confidence level ($t = 2.02$, .10 level $= 1.81$). The range in kill per gun hour was 0.40 in 1959 to 0.86 in 1958 (difference of 0.46) for area "A" and 0.69 in 1963 to 0.92 in 1961 (difference of 0.23) for area "B." The difference in range of kill per gun hour possibly shows a population stability obtained in primarily agricultural areas, perhaps due to more dependence by squirrels on grain crops—a more stable food source.

Data on differences and fluctuations in production (age ratios) tend to bear out this hypothesis. Age ratios for agea "A" range from 73 juveniles per 100 adults, to 168 (difference of 95) in fox squirrels, and 50 to 132 (difference of 82) in grays; compared to ranges of 98 to 127 (difference 29) for fox and 77 to 135 (difference 58) in gray squirrels for area "B." The data indicate more fluctuation in production occurs in wooded areas. These differences were not statistically significant for fox squirrels ($t = 0.44$, .05 level $= 2.31$) but were highly significant for gray squirrels ($t = 7.77$, .01 level $= 3.36$).

Conclusions

Squirrels are not as dependent on mast as has been indicated for other regions because of the availability of grains resulting from intensive agriculture in Iowa. Hunting success probably reflects squirrel populations. The Iowa data indicates low juvenile production means poor hunting success. But low production and poor hunting does not always follow poor mast yield for the preceding fall.

There must be influence on squirrel welfare in Iowa other than mast production. The writer believes that weather factors during winter and early spring may be very important. Extended periods of deep snow, sub-normal cold, and high winds may reduce squirrel vitality until juvenile production may be curtailed or delayed. Mast abundance or failure may be the factor which determines squirrel welfare during and following abnormally severe winters. This possibility needs further exploration in a northern agricultural area such as Iowa.

Literature Cited

Allen, Durward L. 1943. Michigan fox squirrel management. Mich. Dept. Cons., Game Div., Pub. 100. Lansing.

Allen, John M. 1952. Gray and fox squirrel management in Indiana. Federal Aid Bull. No. 1 Indianapolis.

Allison, Ray. 1953. North Carolina gray squirrel investigations. North Carolina Wildl. Res. Comm. P-R Proj. 26-R, Raleigh.

Anonymous. 1956. The Iowa hunting and fishing survey—1955. Iowa Cons. 15(II): Supplement. 1-7 pp.

Atkeson, Thomas Z. 1958. J. Wildl. Mgmt. 22(1): 99-100.

Atkeson, Thomas Z. and David C. Hulse. 1952. J. Wildl. Mgmt. 16(2): 230-232.

Baumgartner, Luther L. 1940. The fox squirrel: Its life history, habits, and management in Ohio. Abst. of Doctoral Dissertations. No. 33. Ohio State Univ. Press.

Baumgartner, Luther L. 1943. J. Wildl. Mgmt. 7(2): 193-202.

Brown, Louis G., and Lee E. Yeager. 1945. Bull. Ill. Nat. Hist. Survey 23(5): 449-536.

Chapman, Floyd B. 1938. Trans. No. Amer. Wildl. Conf. 3: 677-684.

Christisen, Donald M. and Leroy J. Korschgen. 1955. Trans. No. Amer. Wildl. Conf. 20: 337-357.

Colin, Wayne F. 1957. Alabama squirrel investigations. Final Rep. P-R Proj., W-25-R.

Hoover, Robert L. and Lee E. Yeager. 1953. J. Mammal. 34(3): 359-365.

Kidd, Joseph B. 1955. La. Cons. 8(2): 10-11, 21-22.

Kirkpatrick, Charles M. and Roger A. Hoffman. 1960. J. Wildl. Mgmt. 24(2): 218-221.

Larson, Joseph S. 1962. J. Mammal. 43(2): 272-273.

Longley, William H. 1963. Amer. Midland Nat. 69(1): 82-98.

Marsh, Al. 1951. J. Tennessee Acad. Sci. 26(1):15-21.

Moran, Richard J. 1953. Ill. Acad. Sci. Trans. 46:258-262.

Packard, Robert L. 1956. The tree squirrels of Kansas: Ecology and economic importance. Univ. Kans. Museum Nat. Hist. and State Biol. Survey., Misc. Publ. No. 11.

Petrides, George A. 1951. J. Mammal. 32(1): 111-112.

Redman, Howard R. 1953. Trans. No. Amer. Wildl. Conf. 18: 378-389.

Robinson, D. J. and I. McT. Cowan. 1954. Canad. J. Zool. 32(3): 261-282.

Schorger, A. W. 1947. J. Mammal. 28(4): 401-403.

Shorten, Monica. 1951. Proc. Zool. Soc. London. 121(2): 427-459.

Shorten, Monica. 1954. Squirrels. Collins, St. James Place, London.

Thornton, Philip L., and James T. Morgan. 1959. The forest resources of Iowa. U.S.D.A. Forest Service. Forest Survey Release No. 22.

Uhlig, Hans G. 1956. The gray squirrel in West Virginia. Cons. Comm. of W. Virginia, Div. Game Mgmt. Bull. No. 3.

Uhlig, Hans G. 1957. J. Wildl. Mgmt. 21(3): 335-341.

Yeager, Lee E. 1959. J. Wildl. Mgmt. 23(1): 102-107.